A text-book of legal medicine.

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Draper, Frank Winthrop, 1843-1909.
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Publication/Creation

Philadelphia [etc.] : W. B. Saunders & Co., 1905.
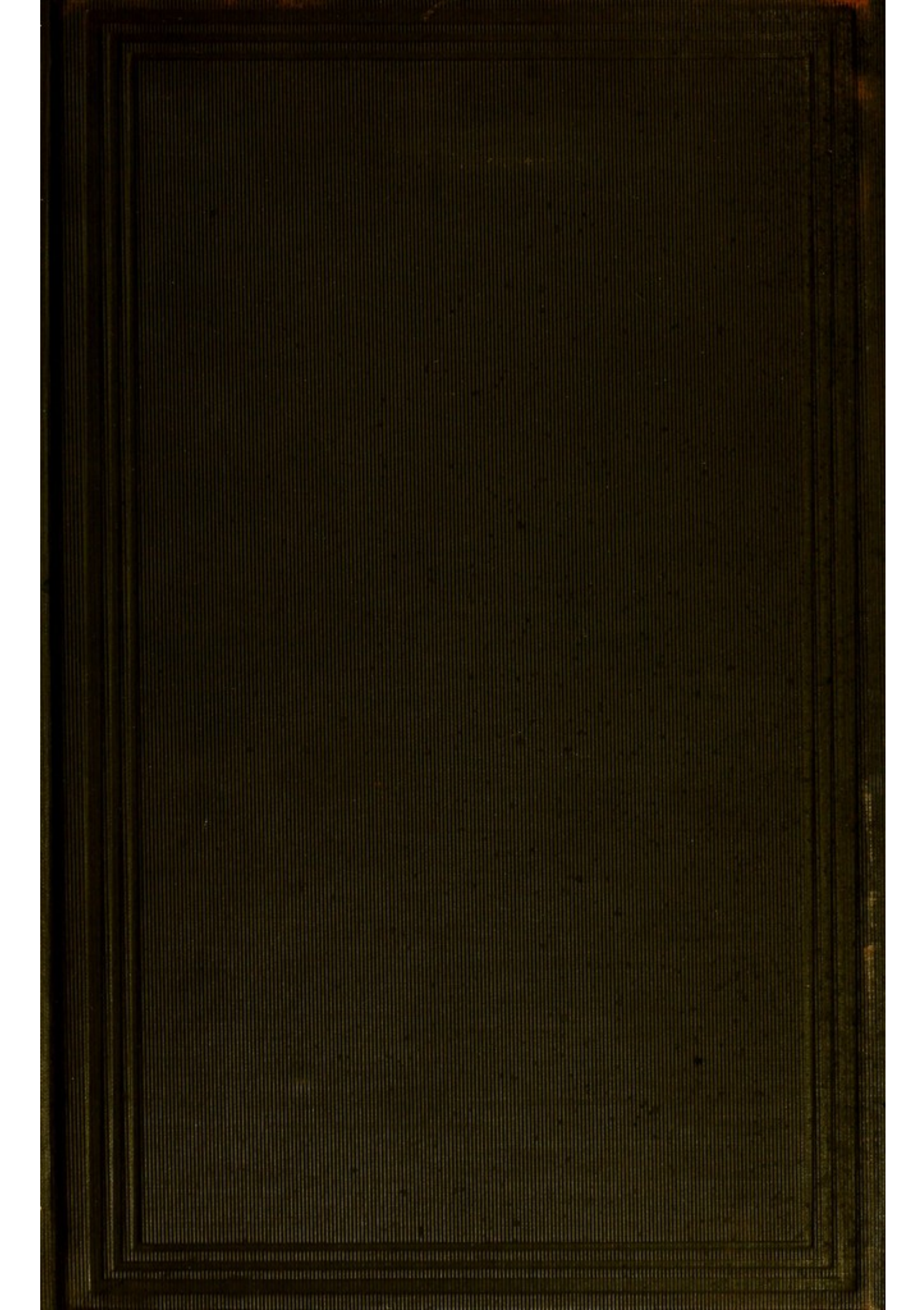
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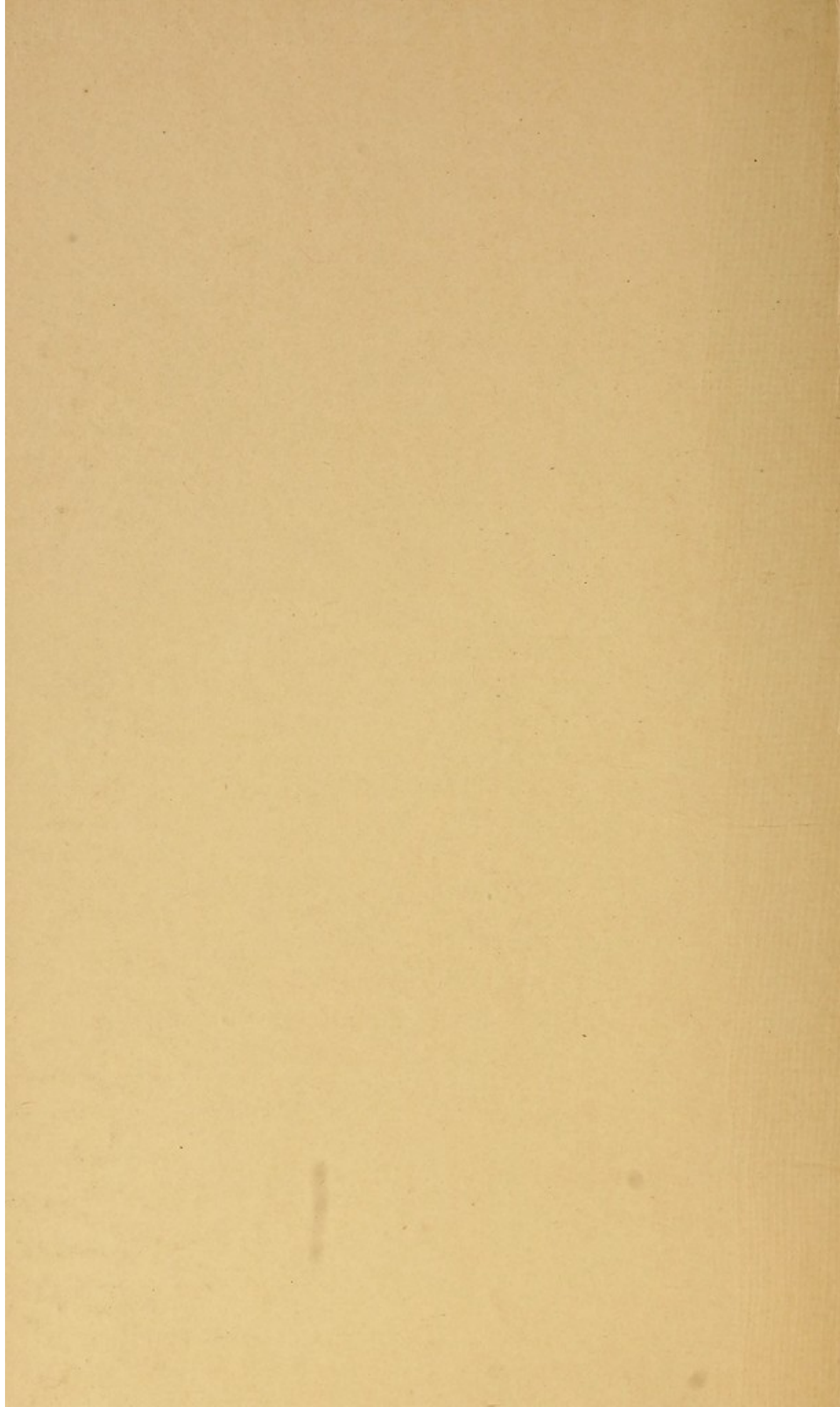https://wellcomecollection.org/works/uck7s58u
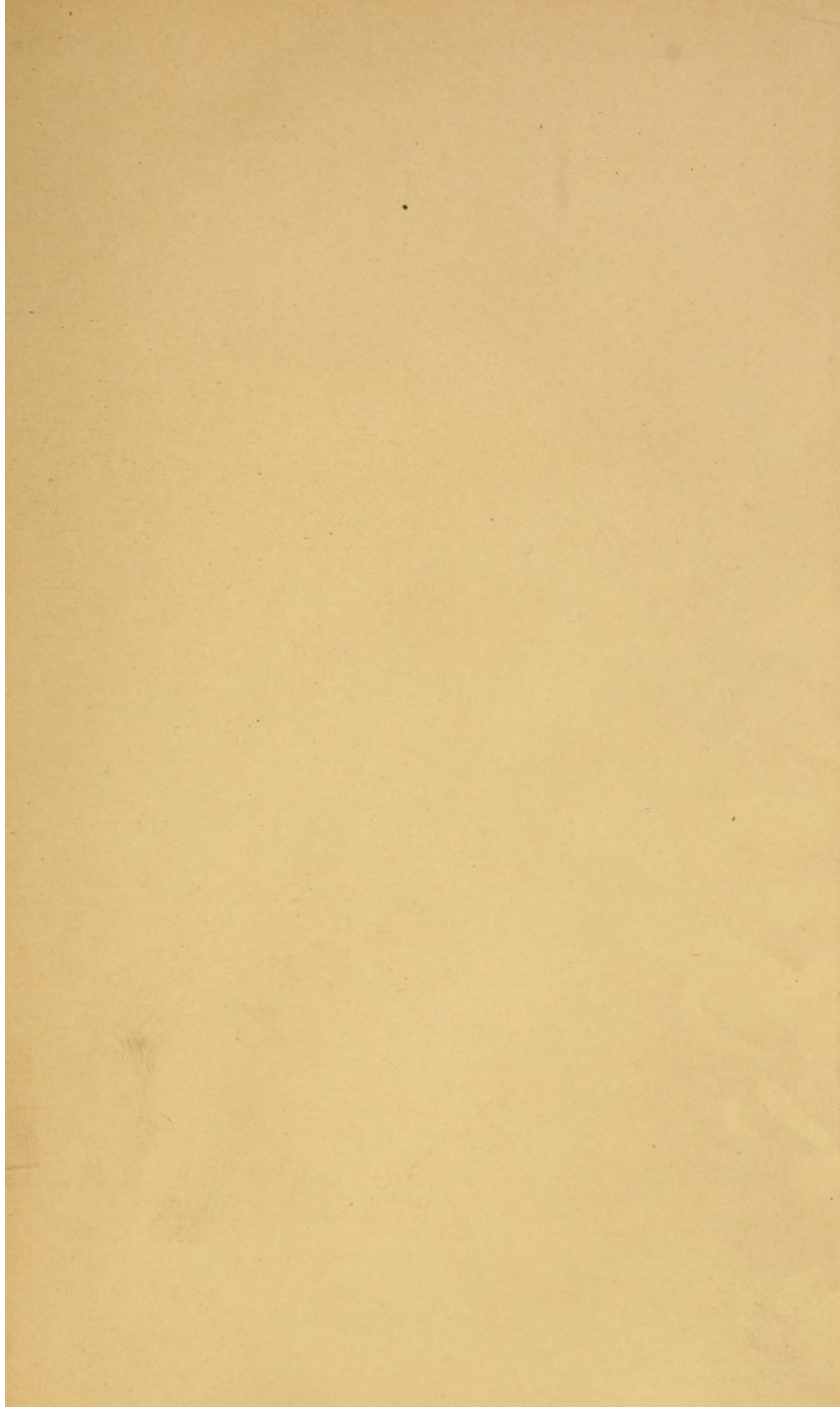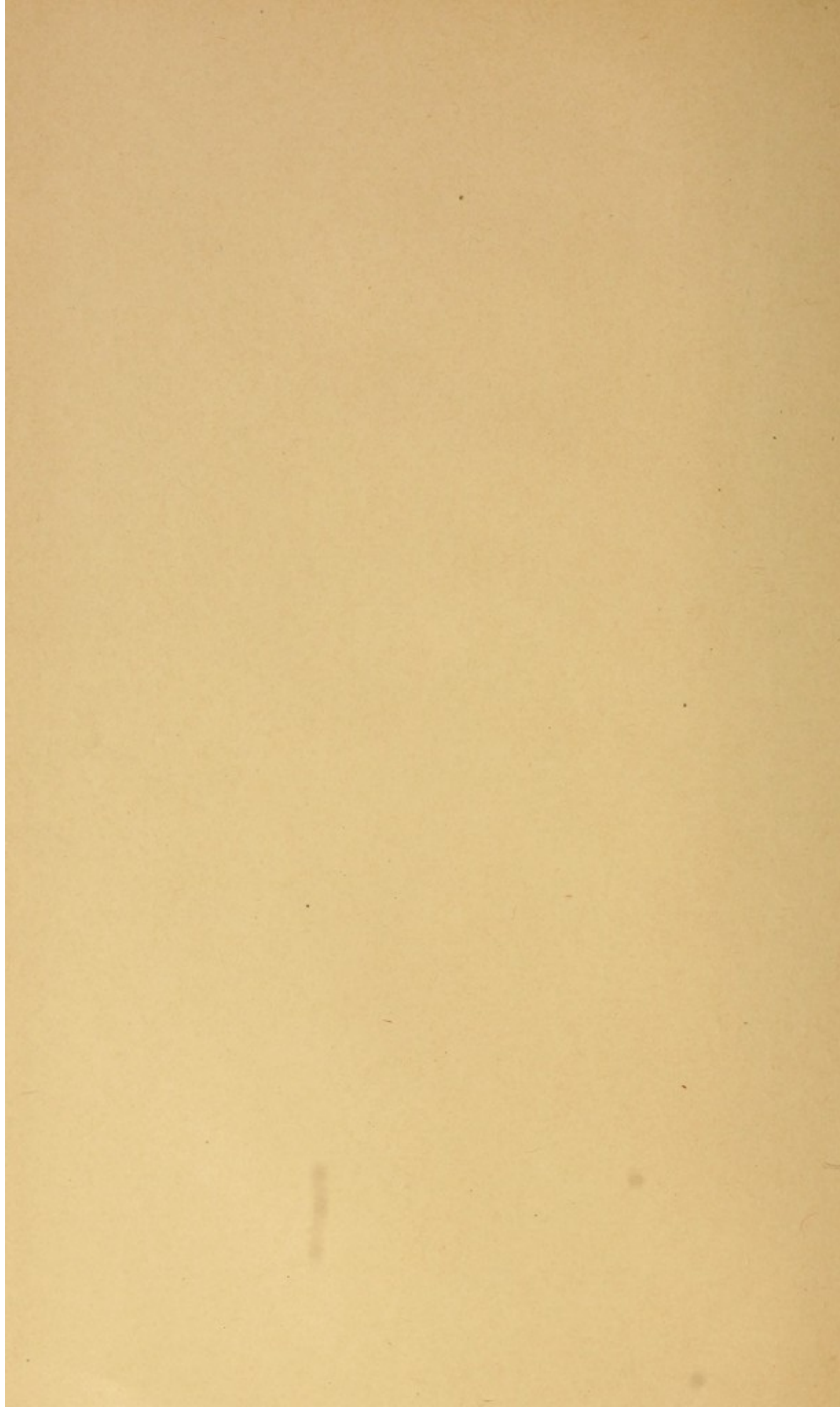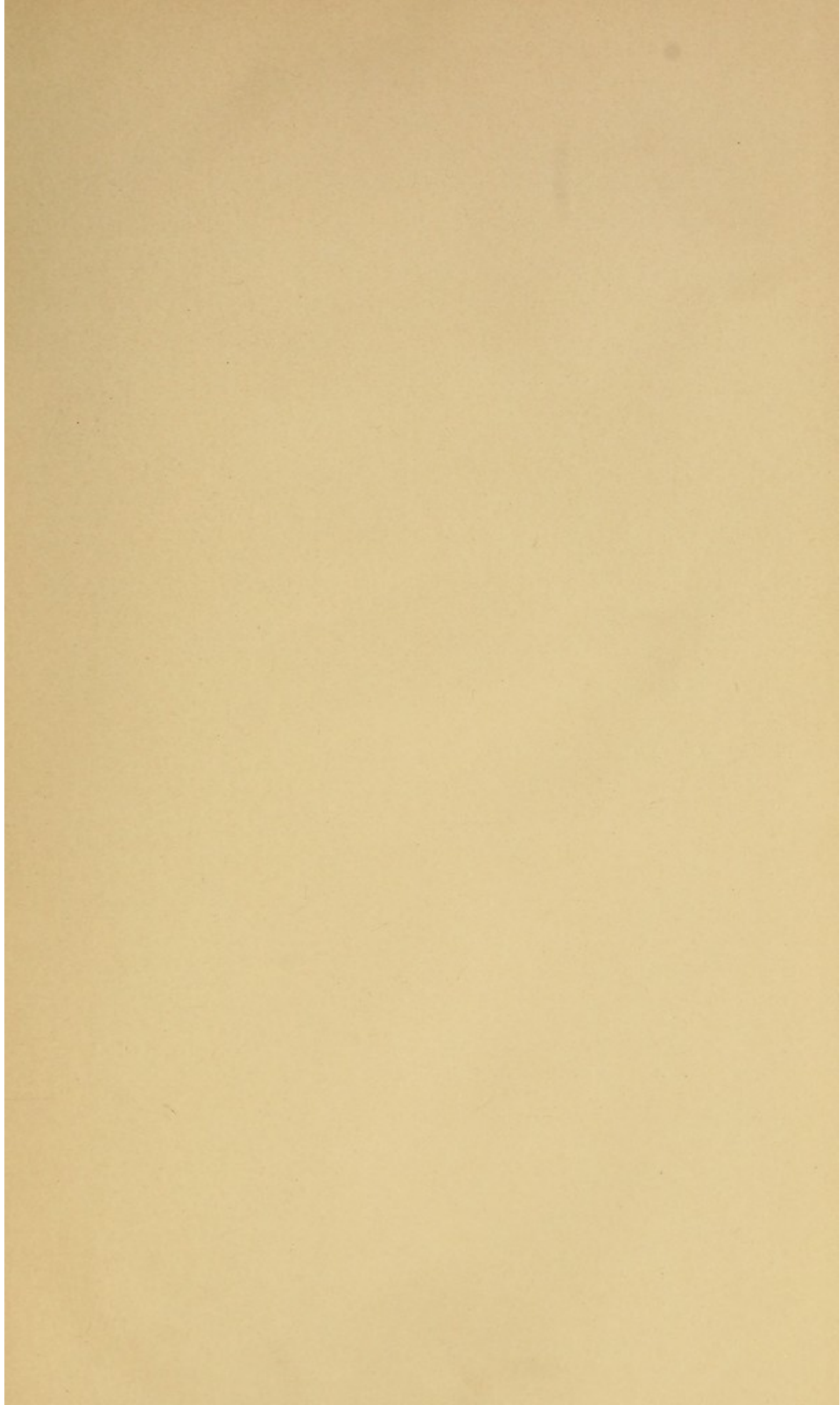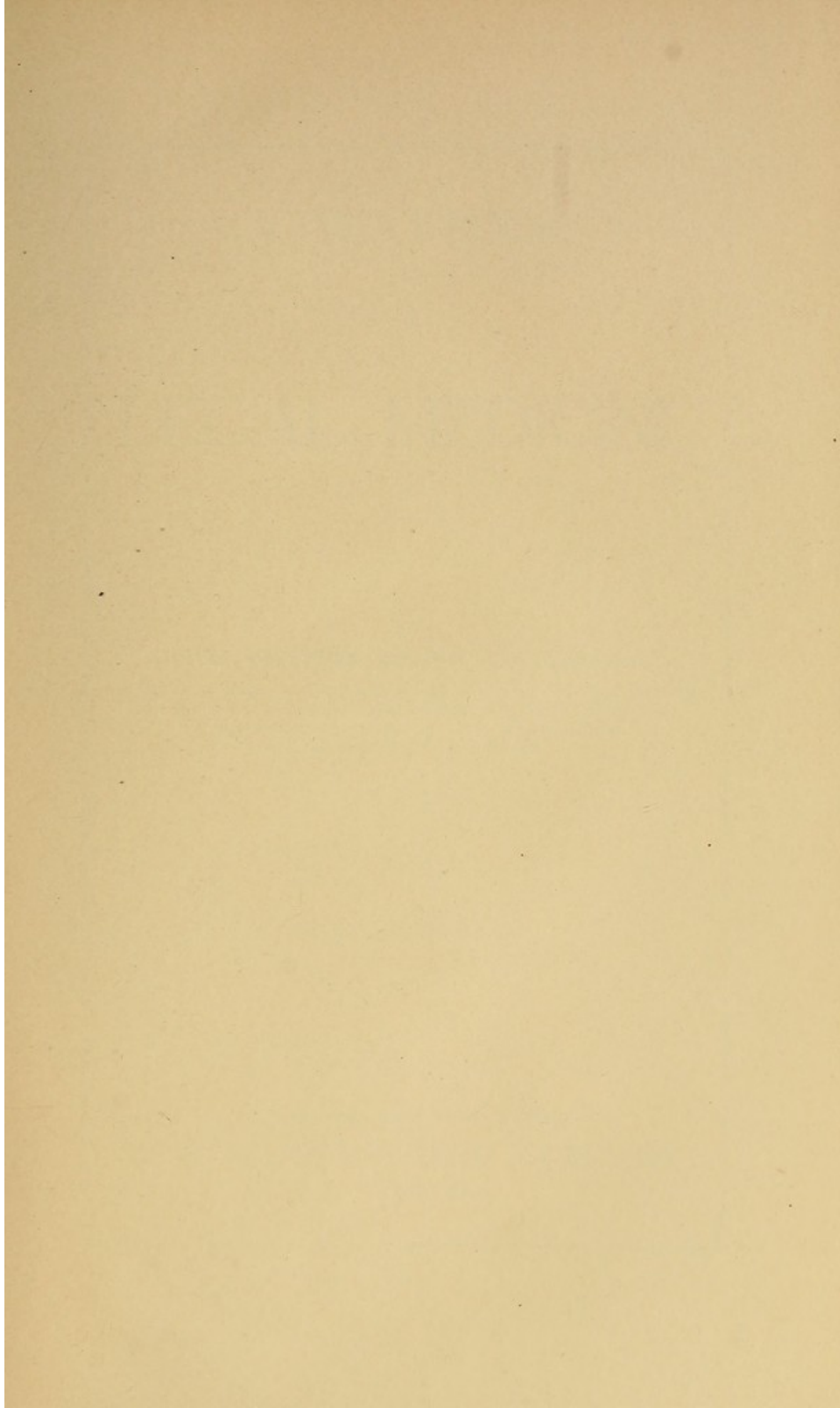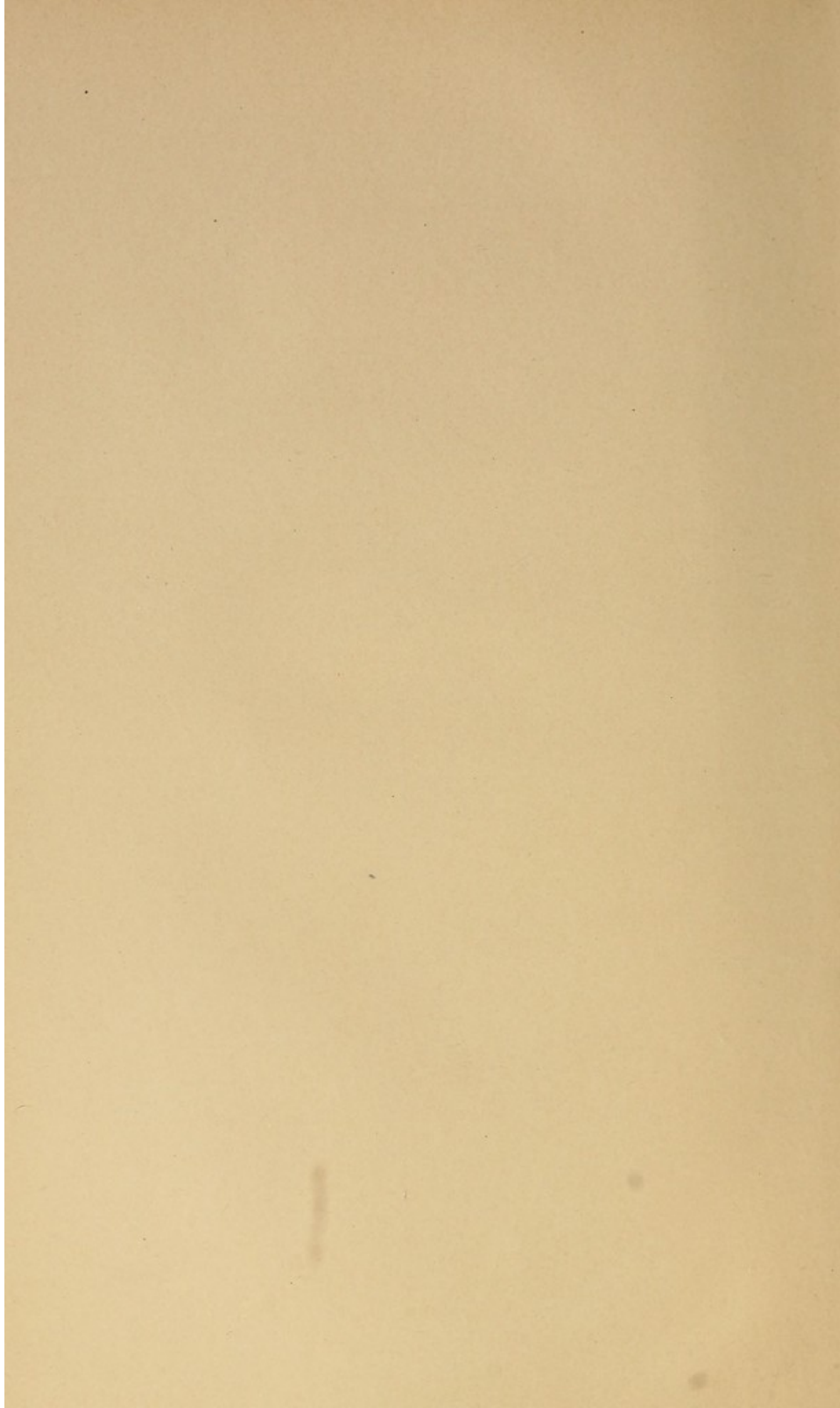
A TEXT-BOOK

of

LEGAL MEDICINE

BY

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FULLY ILLUSTRATED
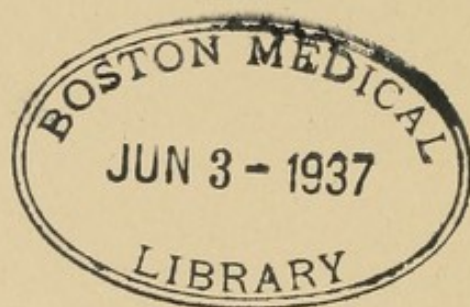
PREFACE.

THIS volume is prepared and published, primarily, as a help to medical students interested in Legal Medicine, but it is adapted as well to the needs of practitioners who wish to have the latest advances in Medical Jurisprudence at their service. The writer has ventured to cite illustrative cases for his text from the standard treatises of Forensic Medicine, and to these authors he desires to express his obligations; these he has supplemented with details from his own personal experience, which has been exceptionally full during the past twenty-eight years, as a medical examiner for the city of Boston, his investigations having comprised during that period over eight thousand deaths, under a suspicion of violence. The departments of Toxicology and of the Medico-legal Relations of Psychiatry have been purposely omitted from the volume, inasmuch as they have acquir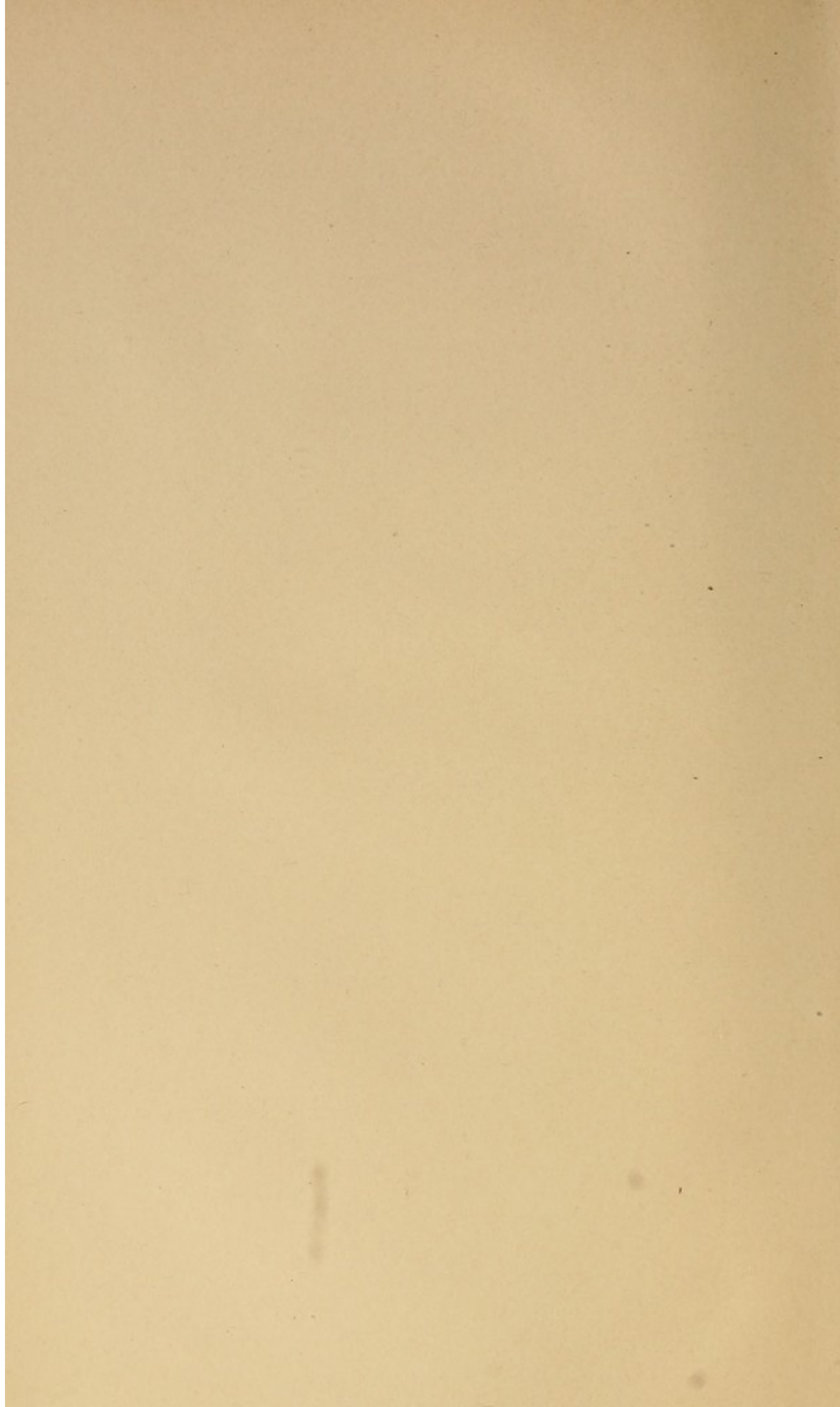ed an importance deserving, in each instance, independent treatment by specialists. The author makes no apology for limiting himself to Massachusetts Statutes in his citations of the law, believing, as he does, that these citations represent the most progressive and most intelligent expression of modern jurisprudence.

JANUARY, 1905.

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LEGAL MEDICINE.

CHAPTER I.

INTRODUCTORY.

Definition.—Legal medicine teaches the application of every branch of medical knowledge to the requirements of the law. It has generally been customary to regard legal medicine, medical jurisprudence, and forensic medicine as synonymous and interchangeable terms. The expression legal medicine had its origin in France, and the literature there is all entitled *Médecine légale.* Medical jurisprudence is an English title, and American writers have commonly adopted it ; while Forensic Medicine is an importation from Germany, and is an English adaptation from *Gerichtliche Medicin.*

So far as the writer knows, it was not until the appearance of Witthaus and Becker's standard work in 1894 that any serious attempt was made to distinguish one of these from the others, and to establish a difference in definitions. According to these authors, " Medicolegal science consists of two distinct branches : that treating of medical law, to which the designation Medical Jurisprudence properly applies ; and that relating to the application of medical, surgical, or obstetric knowledge for the purposes of legal trials—Forensic Medicine." But this attempt at differentiation is useless and objectionable. It obscures and complicates that which otherwise is clear and simple, and adds nothing to a good comprehension of the general subject, and it will be far better for the purposes of this Manual to avoid the proposed classification, and to hold to the common usage of teachers and writers, remembering that whether we use one term or another of the three, we mean that department of medicine which teaches the application of every branch of medical knowledge to the needs of the law, whether civil or criminal.

It is true that this rather sweeping definition has given opportunity for critical objection. There are those who main-

tain that legal medicine, while it is worthy of attention, scarcely merits the dignity of a special and independent place in the course of medical studies. Let medicolegal matters, they say, be considered under each department of teaching. Let the professor of chemistry teach the detection of poison, the identification of blood-stains, and the composition of animal fluids. Let the anatomist discuss the identification of the human skeleton, the proportions of the body, the determination of age and sex, the effects of exposure and decomposition, all pertaining to personal identity. Let the surgeon warn against malpractice in treating fractures and dislocations, and fully describe wounds and injuries. Let the obstetrician discuss the duration of pregnancy, the proofs of living births, the diagnosis of rape, delivery, and abortion. The professor of physiology may properly treat of asphyxia and allied subjects. The professor of pathological anatomy should give directions as to the technic of autopsies and describe various traumatic lesions. The instructor, it is urged, should not set apart certain lectures for medicolegal topics, but these subjects should be introduced in their proper relations throughout the course, thus covering the entire field of forensic medicine in its broadest sense. The days are past, they say, if indeed they ever existed, when all this comprehensive treatment could be well managed by a single mind, so vast and so rapid are the advances in science in the different departments of medicine, all of which must be laid under some contribution to serve the legitimate needs of legal medicine.

Now it is clear that such a scheme, while it has the merit of plausibility, is impracticable. In the nature of the case, it is unfruitful. An instructor gives instruction first and with most zeal in matters which especially interest him. He does not readily turn aside to discuss topics which, however important they may be, are more or less remote from his immediate themes. Moreover, it is evident that there are some things, the knowledge of which is essential to a full comprehension of medical jurisprudence, but which are outside any of the ordinary departments of instruction, and should therefore have independent treatment. Such topics, for example, as medical evidence in court and the legal relations of physicians to their patients and the community, deserve special consideration.

There is another class of critics from which legal medicine suffers. It is sometimes said that the student or practitioner of medicine as a matter of fact requires no special training in medicolegal matters. The assertion is made that if one is well trained in the general science of medicine; if he knows as he

ought, his anatomy, his chemistry, surgery, and midwifery; and if he is honest and means to tell the truth, he need not fear to meet any crisis in which his services will be needed by the court. Forensic medicine, it is declared, is not an independent part in medical science, but a pretender without valid right to recognition. The assertion is made that it offers nothing new in medical knowledge, nothing in addition to what is or ought to be within the knowledge of every educated and properly equipped practitioner. That this is an unreasonable position, it requires but a moment's reflection to show. The knowledge is the same, no doubt, in general and in forensic medicine; but in the latter it has novel relations and applications out of the common course. "Medical questions," says a high authority, "assume a very different aspect and reflect very novel hues when viewed in the glare of the court of justice from what they do in the mild light of the sick-room or the hospital ward."

Special Training Required of a Medical Jurist.— It is quite true that a physician can not be a witness of the first rate unless he is well educated; it is also true that he may be a cultivated and successful practitioner, well versed in medical science and fully informed in its latest advances, and still, for lack of some technical knowledge in legal medicine, may find himself a very poor witness at a trial. There is little sympathy to be had for a man who, not having had the inclination to give due attention to medical jurisprudence as a study, glibly talks of his ability, on the score of his success in practice, to step into court and show bench, bar, and jury that he knows the whole subject and can set them right on all questions. There are snares and pitfalls for that man that are little suspected. A great many instances might be cited of physicians retiring from the witness-stand overwhelmed with mortification over the sorry exhibition which they had made, the result, not so much of conceit, as of a deplorable indifference to the need of preparation. Let anyone who doubts ponder the case of John Hunter. He stood, in his generation, at the very head of his profession. If sound and comprehensive medical knowledge could qualify any man to act well the part of a witness, we should certainly be justified in pointing to him as an example; and yet this accomplished man, when summoned in 1781 to give evidence at a memorable trial for poisoning, was obliged to confess that he could not give a satisfactory answer to the questions put to him. He was the only medical witness called by the prisoner to rebut the charge of poisoning. The final proposition put by the Court was: "Give your

opinion, in the best manner you can, one way or the other, whether, upon the whole of the symptoms described, the death proceeded from the medicine (laurel water) or from some other causes." And John Hunter's reply was: "I do not wish to equivocate, but I am unable to give a satisfactory answer."

Medical men, as a class, are unsatisfactory witnesses at trials at law, so the lawyers say; and they also have a wholesome dread and disinclination with regard to appearing in a court-room in any capacity whatever. This is the result, in some measure, of a misapprehension of the real scope and importance of a knowledge of forensic medicine as a part of a physician's outfit; and also of an indifference to a proper elementary preparation in its principles. But it is well to remember that there are occasions in the course of every professional man's career when he will have to step beyond the sphere and routine of his ordinary vocation, and will be *obliged*, whether he is well or ill prepared, to practise legal medicine. It will depend mainly on himself whether his success or failure in that function is the more conspicuous.

The Exacting Nature of the Calls upon a Medical Witness.—It will be worth while to remember this, that forensic medicine, of all the departments of practical medicine, has this peculiarity: that it is the only one which the physician is compelled to practise whether he is willing or unwilling. It is essential that every physician should have a tolerably full knowledge of medicine, surgery, and obstetrics before he can secure a diploma and undertake the duties of a practitioner. But the diploma does not oblige him to attempt the practice of medicine, surgery, and obstetrics, if he is not so inclined. He may follow either one and abjure the others. Indeed, he may decline to see any case of any sort. But here mark the difference. If, as a surgeon, an obstetrician, a general practitioner, or a specialist, he becomes acquainted with a case presenting some element of suspicion in the eye of the law, he will be summoned, under penalties for negligence, to tell in court what he knows of the case, and so be forced under circumstances which are not of his own choosing to practise legal medicine. His sign may not have been displayed a single day before he is called to attend a man already moribund from some act of violence, a pistol-shot wound, a stab, or a blow. Any day may bring him the occasion for the exercise of his best judgment in such an emergency. His observations and his method of stating them may make or mar the completeness of a capital trial. He may be called, no matter where he is located, even if he live and practises in a quiet country village,

to attend a person suffering from the effects of poison administered with criminal intent. In spite of the best management death ensues. Here the functions of the medical man and those of the medical witness blend and overlap. It is utterly impossible that he can avoid giving evidence, except by leaving the country. He can not shift the responsibility upon another. The law will insist on his appearance and testimony. It will be assumed at the trial that, as a duly qualified member of the medical profession, he is fully competent to answer every question relative to poisons. In behalf of the accused prisoner an attempt may be made to raise a doubt whether the patient did not die from disease, instead of from poison; in that case the questioning will lead to a searching inquiry into his knowledge of all those diseases which resemble poisoning in their symptoms and post-mortem appearances. It can not escape conviction that the position of a physician under such relations is a most responsible one. Unless he is able to answer all questions on the witness-stand convincingly, intelligibly, honestly, a guilty man may escape punishment, or an innocent man may be unjustly condemned.

Legal Medicine does not Admit of Specialism.— This is peculiarly a matter of importance to the *general* practitioner. The calls to attend cases which may prove to be medicolegal in their character come mostly to the physician who has no specialty; and he can not turn these cases off as he can others. He may send his case of cataract to the ophthalmologist, his case of chronic eczema to the dermatologist, his case of aphonia to the laryngologist, his case of leucorrhea to the gynecologist, but he must depend on his own resources when he is called to attend the girl who has been raped, the man who has been poisoned, the child who has been suffocated; he can not transfer these cases to a specialist; and even if he attempted to do so, he can not avoid telling in open court his entire connection with the affair, what he observed and did, and what his conclusions were. And this which he gives as his testimony, may be reported in many newspapers to be read, discussed, and criticised. "If his evidence is one-sided, his judgment biassed, his opinions not founded on knowledge, or swayed by popular sentiment, friendship, or his own ignorance, that single case may injure his whole career; as it may, on the other hand, if he brings thought, learning, power, judgment, and common sense to bear upon it, aid in establishing a reputation." A striking example of this experience is found in the primary career of Koch, the distinguished Berlin professor. During his early professional experience, he was an obscure country

physician in the little German town of Wollstein, and his practice and reputation did not extend beyond that village. While here his name came before the public as an expert in the Speichert poisoning affair. It is asserted that the prisoner's conviction in this celebrated case was almost entirely to be credited to the remarkable chemical analysis and medical testimony of Koch, which attracted such general attention by their profound erudition that he was summoned presently to Berlin as a member of the Sanitary Commission and as a professor in the School of Medicine. It is useful, also, to remember this—that the moment a case assumes medicolegal relations a train of observations is required which the mere cure of disease, simple clinical study, would not demand. The cultivation of the faculty of minute detailed observation, and the training of the mind in analyzing and arranging data—these are of more consequence in this department of science than the technical knowledge of abstruse chemical formulæ or of fine anatomic enigmas. Sir Astley Cooper was once summoned to a man who, while sitting in a chair in his private room, had been mortally wounded by a pistol-shot from the hands of an unseen person. Sir Astley, having done what was necessary for the immediate needs of the patient, compared carefully the direction from which the bullet came with the position of the wounded man, and he reached the conclusion that, in view of all the data, the pistol must have been fired by a left-handed man. Now, the only left-handed person on the premises at the time was an intimate friend of the wounded party, and against him there had been up to that moment no suspicion; but this acute observation on the part of the attending surgeon was the starting-point of the inquiry which led to the arrest, trial, and conviction of the left-handed murderer.

The Scope of Forensic Medicine.—If physicians as a class were asked as to the occasions which supply opportunity for medical men to exhibit the skill, tact, and ability whereby they may acquire a reputation in this department of their profession, the majority of them would say at once that murder trials supply the chief, if not the only chance for distinction; and they would naturally remark further that these, though too numerous for the public peace, are too few for the acquisition of a great reputation on the part of medical witnesses; and the inference follows that it is hardly worth while for a busy medical man, student or practitioner, to spend much time upon matters about which he will be called to act at long and uncertain intervals. It is true that capital trials afford the crowning chance to display attainments in legal medicine, and that

these trials are infrequent.   But these comprise only an insignificant part of the field in which to exercise medicolegal talent. There are a great number of deaths by violence which are not homicidal, but which may involve suits at law, such as fatal railroad accidents, machinery casualties, and the like, to which any one of the neighboring practitioners may be called, and concerning which he may be summoned to testify at a later period.   Then there is the numerous class of sudden deaths; the first and most natural thing to do in such instances on the part of friends is to summon a doctor; and each one of such cases will demand from him the exercise of a certain amount of medicolegal knowledge to enable him to eliminate the element of criminality from the cause of the death, or, in the presence of suspicious circumstances, to do exactly the right thing, so that justice may not miscarry through neglect of due care in this preliminary business.

But it is not with the dead body alone, or perhaps mainly, that forensic medicine has to deal.   No doubt, cases involving a death are relatively of the most impressive character because they may lead to the taking of another life on the scaffold at the end of a capital trial; but there are needed the same kind of skill, the same correctness of observation, the same aptitude in sifting relevant from irrelevant facts when the issue concerns other matters besides homicidal death; to determine, for example, whether the injuries on a living person were due to an accident on his part or to an assault by another.   One needs the same logical analysis of symptoms and signs, and, it may be, the same delicacy of chemical research, to decide that there has been an unsuccessful attempt to poison, that he requires to put in force when the attempt has been successful and has resulted fatally.   Indeed, in many instances where the injured party is alive a special element of difficulty is added, which does not exist when the investigation refers to a death.   A dead body tells no tales save those which it imparts to the alert intelligence of the scientific observer, by him to be reported to the proper quarter.   A living body has a living tongue in its mouth, and that tongue may be a lying one, ready either from vindictive feeling to have recourse to exaggeration or even to a suggestion of falsehood, or, from fear of consequences, to adopt the method of concealing the truth; and it requires certainly no less, rather it demands more acuteness and discernment on the part of the authority who investigates, or of the medical witness who testifies, to follow the scent of the truth when a spirit of untruth obstructs the way.

The number and variety of subjects concerning which the

text-books of medical jurisprudence treat show at once that the field of medicolegal literature is not a restricted one. Questions of age-determination; of doubtful sex; of personal identity; of impotence and sterility; of rape; of pregnancy and delivery; of criminal abortion; of infanticide; of death in all its medicolegal relations; of wounds and injuries; of asphyxia in its various forms; and of medical evidence—all these come specifically within the scope of forensic medicine, not to mention the important subjects of toxicology and of insanity, both of which, in their medicolegal relations, deserve special treatment.

The Wide Variety of Questions Relative to a Homicide Affair.—A somewhat recent instance may be mentioned illustrating the wide scope which a medicolegal inquiry may assume: the Borden affair in 1892, in Fall River, Massachusetts, in which a man and his wife were murdered by hatchet-blows on the head. At the preliminary hearing, to determine whether the accused daughter should be held for the grand jury, the medical witnesses were questioned upon more than forty distinct topics, all relevant to the case and having a clear relationship to it. Here are some of the points raised: Besides the testimony as to anatomical appearances, and inquiries as to facts outside the purely medical field, the lawyers questioned the medical witnesses regarding their conclusions from a study of the wounds; the precise number of the wounds; the weapon which probably made them; the force required to produce them; whether the weapon was wielded with one hand or with two hands; if with one hand, was it the right or the left; which was the first blow; was a certain wound observed at the autopsy the result of a miss-blow; what was the position of the victims when they were struck; what was the position of the assailant in striking; the gravity of the wounds as to their effect in causing instant death; the cause of death in wounds of the brain; peculiarities of bony lesions made with sharp or with dull weapons; the effect of blows on bone on an edged weapon; the thickness of the human skull in different subjects. The absolute and relative time of death of the two parties killed; the value of evidence as to this question derived from the stage of digestion, from the temperature of the two bodies, and from the appearance of the blood around the wounds. Modifications in the process of digestion wrought by excess or lack of gastric juice; by recent gastro-enteric irritation; by the presence of other matters than food in the stomach; by the nutrition of the body, whether stout or lean.

The amount of hemorrhage from incised and contused scalp wounds; the arterial supply in the way of the wounds observed; the behavior of arteries when wounded; the character of arterial blood spurts; the character of drops and spatters of arterial blood on walls and other flat surfaces; the determination of the direction and force of arterial blood thrown on walls from wounds; the effect on hemorrhage of a cessation of the heart's action; the ratio between the weight of the body and the weight of its blood; the exact weight of a pint of blood; the cause of the coagulation of human blood; the time of drying of blood on steel surfaces; the identification of suspected stains as human blood; the differentiation of blood and rust on metal surfaces; the appearance of flea-stains and mosquito-stains on clothing; the identification of human and of animal hairs; the correct use of medical notes in court. Correct answers to all these imply a tolerably liberal medical education.

Medicolegal Matters Independent of Legal Elements.—Much of the indifference, if not positive unwillingness, of medical students and physicians about undertaking medicolegal studies grows out of an impression that somehow purely medical matters in legal medicine are intimately mingled with legal elements, as the term medicolegal would seem to imply. There is a notion that a good medical witness ought to know a great deal of medicine and considerable law in order to fit him to appear creditably on the witness-stand; to enable him to bear successfully the overhauling to which a cross-examination is supposed inevitably to expose him; to endow him with ability to parry sharp questioning and to answer intelligently the confusing interrogatories which may come from both sides. There is much excuse for this feeling. The medical man goes to court, generally, with a feeling of personal self-sacrifice. Knowing by tradition, if not through actual experience, the kind of treatment he may receive there, he does not look upon medicolegal service as a holiday recreation or like reading a paper before medical friends. He goes within the portals of the so-called temple of justice because he has been summoned there by an authority which every citizen must heed and obey; but his response to this call is mingled with a dread lest the lawyers will manage to transform his best endeavors into a pitiable performance of confusion and contradiction. And, somehow, he entertains the idea that his lack of success grows out of an unfamiliarity with legal rules and customs, which might have been greatly lessened if he had known more law as well as medicine.

But the medical jurist is not a hybrid, half doctor and half lawyer. If he comprehends his true position, he never forgets that forensic medicine is an essential department of general medicine, and that the practitioner of it is a physician always, nothing more, nothing less, nothing else. He is not a lawyer, nor will erudition in the law give him much advantage. As any craftsman, artist, or expert in any department of activity holds his knowledge and experience at the service of justice, under proper and well-understood limitations, so must the physician, and nothing else is required of him.

In this manual the author will endeavor to keep strictly within the limits which he has marked out, and will simply try to exemplify in what directions medical knowledge may be of service in the administration of the law. And he would not leave the impression that this service of medical men in court is a service so unsatisfactory and ungracious that it is to be shunned as one would shun wrongdoing. It has its compensations, not so much of the material kind, in the form of fees, as of the more intangible sort which are yet real and valuable. There is no more useful training than that which is generally required of the medical witness in his preparation for an important trial. He will be surprised by the new and hitherto unexplored paths into which his researches will lead him. And the knowledge thus gained under a new sort of stimulus will add much to his outfit and to his ability to meet the ordinary emergencies of his professional life.

Self-reliance as a Result of Medicolegal Training. —Another compensation coming out of medicolegal experience is self-reliance. To stand in a court-room, before an audience representing all grades of intelligence, to be obliged to make medical matters readily comprehensible to less cultivated minds, to speak in a language about technical things that will enlighten and not simply show learning, to keep one's temper, to be apt and ready in answering questions not always stated clearly—these conditions promote, when rightly appreciated and utilized, a high degree of self-reliance that could not be attained in any better way.

Legal business in the courts comes under two generic heads, criminal practice and civil practice. In the former, the State is the complainant and prosecutes the complaint against some individual defendant or defendants. Jurisdiction here relates, so far as the subject of legal medicine is concerned, to crimes of all degrees against the person. These crimes range all the way from the gravest known to the law (murder in the first degree) down to simple assaults. They include all grades of

homicide, together with criminal abortion, rape, and various other forms of violence.

Civil practice (at least that form of civil practice in which physicians are interested) has to do with actions brought by one individual against another, the State having no part except to supply the judicial machinery for the orderly conduct of the litigation. The usual basis of the trials coming in this class is an alleged negligence on the part of the defendant whereby the plaintiff in the suit has suffered bodily injury and has experienced pain and loss, for which he seeks relief in damages. Besides these suits, actions of tort as they are called, civil jurisprudence, so far as it concerns physicians, comprises also divorce proceedings, probate of wills, and appeals from probate judgments.

These two classes, then, criminal and civil, include all the occasions when the law needs the aid of medical knowledge in the public administration of the judicial department of the government. And, inasmuch as criminal law procedure is somewhat more complex and formal than are the rules of civil practice, the author will describe, first, the course which a criminal prosecution would take and the relation of medical men to it.

Proceedings in a Criminal Prosecution.—The first stage in the order of judicial business in criminal proceedings where the investigation relates to a homicide, for example, is the inquest. In most of the United States it would be a coroner's inquest, but in Massachusetts and some other States, since 1877, coroners' juries and coroners' inquests have been abolished. A system of inquiry into the cause and manner of violent deaths which had been inherited from England (dating from the reign of Edward I.) has been replaced by a new method offering manifest advantages. There were so many faults inherent in the antiquated and clumsy inquest proceedings conducted by coroners, so many abuses had become attached to the coroner's office, that it is extraordinary how long this out-worn method held its place. But after many years of discussion, chiefly among medical journals and in medical societies, certain gross blunders on the part of two or three incapable coroners called sharp attention to the system and led shortly to its displacement.

At present the course of procedure in Massachusetts, Rhode Island, and Connecticut in a criminal prosecution for homicide is as follows: A person is found dead. Certain facts and appearances excite suspicion of violence, or perhaps there is an absolute lack of knowledge of the circumstances of the death.

Notice is conveyed to the medical examiner appointed to serve in the district in which the dead body has been found. Who is this officer? He is a State official, a physician, appointed by the Governor and confirmed by his Council, and placed under bonds to discharge his duty faithfully. He is obliged to respond forthwith when notified, and *any* person may give him notice of the discovery of the dead body. The business and duty of the medical examiner are to determine the cause and the manner of the death. To accomplish this, he has at his service several methods. An inspection of the body may be sufficient or he may deem it necessary to perform an autopsy under proper authority, and in the presence of witnesses. Moreover, he may invoke the aid of others, chemists or microscopists, to enable him to reach conclusions. He goes far enough in his investigations to determine the fact of violence or, negatively, the absence of such an element in the cause of death. If the medical examiner determines from his inquiry and observations that the person found dead came to his death by the act or neglect of some other person, he reports his conclusions, with a formal statement of the anatomical appearances, to the judge presiding over the court of lowest grade in the county, and by him an inquest is held. The witnesses summoned according to legal form are obliged to respond, as in other court proceedings. This obligation applies to medical witnesses as well as to others. The object of this inquest is to ascertain the criminal accountability if possible. The medical examiner answers the question, What was the cause of the death? The question for the judge at his inquest is, Who caused it? To determine this, the judge interrogates the witnesses in turn. It is in the course of this inquiry that medical men may be summoned, either because of actual professional and clinical relations to the case, or to help the judge in interpreting facts of scientific character. It is plain that the manner in which the physician meets this initial demand may be of vital consequence to the issue. Therefore the medical witness should not regard the inquest as a trivial or informal matter. The evidence there given is recorded and forms the basis for subsequent proceedings, so that the medical witness at the inquest may, in effect, be giving testimony before the highest court, since the same facts and opinions may be called for at a subsequent capital trial, as upon this earliest primary inquiry. It is important, then, that the physician's testimony, whether of fact or of interpretation, should be as carefully prepared, as guardedly stated, and as impartially and accurately given at the inquest as on any later and more formal occasion.

The inquest and its findings are introductory to proceedings against the perpetrator of the crime. The accused, having been arrested and charged in due form with the alleged felony, is brought before the same court usually at which the inquest was held. Here he undergoes what is called the " preliminary examination." He may waive this examination, as it is called, and submit his case for direct inquiry by the grand jury; but if he submits to an examination, he is present in court, and the witnesses who know anything of the act with which he is charged are summoned to give their testimony. The questions are asked and the answers thereto are recorded by the judge or by some one representing the State, the accused, or his counsel, being permitted to cross-examine. Usually the same evidence is submitted here as at the inquest. The judge may, if he thinks proper, dismiss the case and discharge the prisoner, if the evidence fails to substantiate the accusation. But the common course is to commit the accused to jail, or if he is permitted to remain at large, his freedom is subject to bail obligations pending the action of the grand jury, to which body the charge is transmitted from the lower court.

The grand jury is of English origin, and was inaugurated in the reign of Ethelred. It consists of twenty-three men, who hold a session at regular intervals during their six months' term and investigate all complaints brought before them. The witnesses are examined by the district attorney representing the State as a public prosecutor. The same evidence is submitted here as in the previous stages of the process, the same obligation to answer summons by subpena attaches, the same oath, and the same necessity for exact deportment on the part of the medical as of the other witnesses.

The subject which the grand jury considers is: Is the guilt of the accused probable (provable), and is the testimony likely to result in conviction? If, after hearing the evidence in any case, a majority of the twenty-three jurors votes that the proof is sufficient to show that the accused is probably guilty, an indictment is drawn setting forth the character, time, and other data of the crime. It is to be observed that the accused has no defence before the grand jury; he is not present at the hearing, and is not represented there by counsel. The proceedings are wholly *ex parte*, and are for the sole and simple purpose of establishing a basis for further action. If the grand jury fails to find an indictment, the accused person goes free at once; but if an indictment is found, he becomes forthwith a defendant, and must make his fight at a trial.

The formalities at a trial are well understood. The witnesses

are summoned by subpena and are obliged to obey the summons. The prisoner is arraigned, hears the indictment at length, and makes his plea. A plea of "guilty" is followed by sentence without a trial, but the witnesses are paid their fees for attendance just as if there had been a trial. If the plea is "not guilty," a jury of twelve is impanelled, to whom the attorney for the Commonwealth explains the points which he expects to prove and the character of the crime which is charged. The witnesses are then sworn and examined, each one being cross-examined by the counsel for the defendant, the cross-examination being conducted in such fashion as, if possible, to make the witness contradict himself, and so to invalidate his testimony. The evidence on the part of the State being concluded, the prisoner's lawyer introduces his evidence in behalf of the accused. These witnesses are in their turn cross-examined by the State's attorney. If, on the defendant's part, new evidence has been brought forward, that is to say, new as regards the testimony of the prosecution, then the State has the privilege of presenting rebutting evidence. Then follow the arguments of counsel, the defendant's counsel leading, then the charge to the jury, and the jury deliberations and verdict.

To recapitulate: a medical witness may be called upon, in criminal proceedings relating to a homicide, to testify before all of the following: 1. The inquest. 2. The preliminary examination in the police or district court. 3. The grand jury. 4. The trial before the jury in the upper court.

This is the course of procedure which the law takes in handling a case based upon the alleged unlawful destruction of human life. But suppose the death of a victim of crime is not involved. There are many medicolegal cases before the criminal courts without any element of fatal violence. Rape, simple assault, assault with intent to kill, and so on, cases in which medical men are obliged to perform a most responsible part as witnesses regarding injuries received. In these instances the proceedings follow the same lines through the court, with the exception that the inquest has no place in the programme. The accused has his preliminary examination in the lower court, and the victim of his unlawful acts is present to testify against him. Then follow the grand jury investigation and the trial, as in the more serious class of cases.

Proceedings in a Civil Prosecution.—In the foregoing outline attention has been directed to criminal proceedings in courts of law with which chiefly, though not exclusively, the physician has to do as a witness. But in

civil suits the forms of law are so comparatively simple and involve so little comparative responsibility on the part of the medical witness that they need not be described. Each party to a civil suit summons his own witnesses and pays their fees; but witnesses are under obligations to obey the summons as in criminal cases. Civil suits usually take the form of actions for damages, and occur in cases of alleged bodily harm through the neglect of another party, individual or municipal; the services of physicians are required to testify to the original injury if any occurred, and at or just before the trial to examine the plaintiff for the purpose of determining the exact present physical condition with reference to the alleged injury and the probable duration of those effects. It is in civil suits especially that opportunity offers for those deplorable exhibitions of medical contradiction wherein, on the one side and on the other, the medical witnesses, being retained to give as favorable aspect as may be to their employer's case, forget the obligation of their oath to tell "the truth and the whole truth," and indulge in statements which make them medical advocates rather than medical witnesses.

CHAPTER II.

MEDICAL EVIDENCE AND THE MEDICAL WITNESS.

REPEATED allusions in the preceding chapter to the part performed by medical men as witnesses in court lead naturally to a more detailed consideration of their rights and duties in that relationship, together with some remarks on personal demeanor in the delivery of personal testimony, and these matters will be the topic of the present chapter.

It is the object of evidence in its legal sense "to establish facts for judicial determination." Such evidence is derived from two sources:

1. Written documents, so-called documentary evidence.

2. Depositions, sworn oral statements, delivered in court by living witnesses, the so-called parole testimony.

A distinction is to be made between testimony and evidence. The former includes the latter and is its basis. The former is the declaration of a witness; the latter is the effect of that declaration on the mind and judgment of the hearer; it is the resulting degree of light which it affords to illuminate the question at issue. All evidence, therefore, must be testimony, for the greater includes the less; but all testimony is not evidence. Parole or oral evidence is derived from two kinds of witnesses, namely, ordinary witnesses, who state facts, who depose to matters which have been under their personal observation; and expert or skilled witnesses, who interpret those facts in the light of their experience and knowledge. The former tell what they know, as facts; the latter, what they believe, as opinions.

Physicians, like other individuals, are called to court in both of these relations, to discharge the functions of ordinary and of expert witnesses, often to discharge them both in the same trial concurrently. They are liable to be summoned as ordinary witnesses because they may have been, at some time, observers of acts or of the *effects* of acts of an unlawful character. They are subject to requisition as skilled witnesses by virtue of their professional experience and their acknowledged acquaintance with matters of which court, counsel, and jury are presumably ignorant.

Ordinary Testimony.—It is obvious that as an ordinary witness a medical man is in the same position as any individual who speaks of facts within his own knowledge or observation. Of course, the occasions on which he may find himself in the position of such a witness are as varied as is human experience. A physician does not carry with him such an existence that he can move through the world wholly oblivious or unobservant of what is going on around him. He is not the less a citizen because he is a physician, and his profession affords him no exemption from such civil duties as promote good order and public morality. His vocation, indeed, exposes him in a special and relatively frequent fashion to the chances of a willing or unwilling knowledge of unlawful acts or, at least of their effects. A person is shot or stabbed in a quarrel, and a physician is straightway called, and becomes a very material witness in the case. Poison has been feloniously given; rape has been committed; a spine has been injured in a railway collision; a femur has been broken because of a defect in a highway. A physician is called in each instance and, having obeyed this summons, he can not evade the subsequent summons which requires him to tell, under oath, the truth and the whole truth in the cause now made the subject of judicial decision.

Dying Declarations.—There is one kind of testimony to which the physician and surgeon is intimately related by virtue of his office as an attendant on those who have been injured. As is well known, courts reject as inadmissible all so-called "hearsay" evidence. That is, the witness is to confine himself to what he himself saw or did, and he can not testify of what came to his knowledge of the case through third parties. He can not repeat conversations about the crime alleged unless the accused person was also present at the time of the conversation and had an opportunity to hear and to contradict the statements. An important exception to this principle is made in the dying declarations of the victims of unlawful violence. The general principle on which this kind of evidence is admitted is derived from the Roman law. It rests on the fact that these declarations are made in extremity, when the patient is at the point of death, when every motive to falsehood is silenced, and the mind is induced by the most powerful and solemn considerations to declare the truth. Shakespeare well expresses the situation in these words :[1]

> " Have I not hideous death within my view ?
> What in the world should make me now deceive,
> Since I must lose the use of all deceit ?"

[1] *Richard II.* Act II.

A situation of such a character is considered by the law as creating an obligation to which an oath can give no additional force. But in order that such dying declarations may be admissible as evidence in court it is essential that several conditions relating to them shall have been rigidly observed:

1. It must be proved that the declarant was *fully aware* that he was about to die; that his case was without hope of recovery. It is in this connection that the medical attendant becomes important; and it is from this attendant's lips that the words come which tell of the impending shadow. It is then by the testimony of the physician mainly that the state of the dying patient's mind at the time of the declaration is to be proved.

2. In this connection something more is required than proof that the person *fears* death as the result of the injuries, or apprehends it as a *probability*. He must be aware that it is impending at the time. If the medical attendant informs him that he can not recover, and he (the patient) obviously believes it, then his statements are taken as evidence; and it is this state of the patient's mind which is to be proved by medical testimony. How narrow the line is is illustrated in a case which occurred in 1894 in Essex County, Massachusetts:

In the case of the Commonwealth *v.* Annie A. M. Brewer, the full bench of the Supreme Court overruled the defendant's exceptions. She was convicted of manslaughter in killing Gideon W. Lattimer, in Lynn, December 13, 1894. They were engaged to be married, and she shot him in her room. The principal exception was the admission in evidence of dying declarations made by the deceased. Upon this part of the case the Court said:

"The dying declarations of Lattimer were admissible. The evidence was clear that they were made under a sense of impending death. Just before they were made both the attending doctors had told Lattimer that there was no chance of his recovering. His exclamation in answer, 'Oh, my God, must I die!' and his request, 'Give me some water if I have got to die,' imply an acceptance of the fact. The rebellion suggested by the words is not against the truth, but against the hardship of the fact."

Now, statements made under these exacting conditions, by a patient who is the victim of a homicide, or of abortion, in Massachusetts, whether made to a lawyer or to the attending physician, or to anyone else, become evidence affecting the one charged with the crime. Such statements *may* be elicited by

leading questions. But the great objection to that method of getting facts is that it may be misinterpreted in court as a show of zeal savoring of bias. So it is better to receive whatever the dying patient cares to impart without using any persuasion or coercive means. If a cross-examination of the dying man or woman is to be had, let it be conducted by a lawyer. The physician will do better to be a passive reporter of what his patient imparts, carefully observing and making a memorandum of his patient's mental state, and the latter's recognition of approaching death. Let the physician note every word said to or by the declarant relative to the crime, giving the order of the conversation or declaration with great exactness in memoranda written on the spot, always remembering, as a preliminary matter, to inform the patient of his incurable condition, and to obtain from him an express admission that he believes this statement.

The Value of Notes.—It is necessary for the physician to bear in mind that one of the most important aids to a medical witness lies in the *notes* taken on the spot, at the time or immediately after, in any case that is likely to come into court. The habit of note-taking is an excellent one in the ordinary routine of clinical work. But in all cases the facts pertaining to which may some time become the subject-matter of a legal inquiry, however remotely, the possession of memoranda is of the highest assistance. Therefore the habit of detailed observation, in the first place, and the no less important habit of accurate note-taking, should be cultivated. Carefully note dates, as a memorandum of the hour, day, or month of the witness's part in any transaction is frequently of great consequence. If the notes can not be written at the time and location of the occurrence to which they refer, write them as soon as possible afterward, for they lose their value in proportion to their remoteness. *Save* the original notes. In this way any errors in the process of copying may be avoided, as these first drafts may serve as special reminders of the time and circumstances under which they were made. Do not be afraid of noting down too many matters; even apparent trivialities are not superfluous. It is often of the greatest assistance to the memory to make a rough sketch of rooms or premises in which dead bodies are found, or in which a homicide or other crime has been committed. Failure to observe the exact condition of the undisturbed surroundings has resulted in the acquittal of murderers. It is one of the arts of counsel who defend persons charged with crime to endeavor to discover wherein the medical witness has made errors of omission.

The omission may really be of not the slightest consequence medically, but it is usually placed before the jury in such a light that the accused person gets much benefit from it, and the witness wishes he had been a little more observant.

Summarizing in a few words the qualities of a successful and creditable medical witness—that is, the ordinary witness to facts—he should possess the following:

1. The faculty of accurately observing all things about him, and of making full notes of what he sees.

2. A retentive memory.

3. Sincerity, candor, and a mind unprejudiced.

4. A well-balanced temper that will remain unmoved under provocation.

5. A gift of expressing tersely and intelligibly what is in his mind.

Some of these qualities are the inherent and valuable possession of fortunate individuals, but they may all be acquired. How they are to be exhibited practically, in court, will be treated of more fully.

Expert Testimony.—It is in the discharge of duty as an ordinary witness that the physician most frequently finds himself obeying a summons to court. It is right, however, that he should have an adequate idea of the true function of medical men as skilled or *expert* witnesses, and of the easy transition, on the part of the physician, from testimony regarding facts to testimony regarding opinion. Exactly where this point of transition lies is a question of some moment to medical men. What are matters of fact, and what are matters of opinion? The answers to these questions comprehend the distinction between ordinary and skilled testimony. It is the distinction between observation and interpretation. If a physician sees A strike B with a club, and B falls immediately and A runs away, it will require no special skill to observe the facts and to tell them in court. If he attends B and gives him surgical care after his injury; if he finds a scalp wound or a fracture of the skull; if he notices that the man has paralysis of one side, and observes that he steadily fails and presently dies—all this is within his ordinary observation as a medical man, and it becomes a matter of ordinary testimony in a trial for homicide. But if he has been called to attend court as an expert; if he has listened to the testimony in the case, and that, having heard this testimony, he is called upon, under oath, to interpret the medical data brought before the jury, to throw light out of his medical experience upon medical and other facts, to give his opinion,

belief, and conviction as to what those facts represent with reference to the question, then he is a skilled witness and is giving expert testimony. Such being, in *theory*, the important and dignified function of the expert, what qualities ought he to have? In the first place, the very term " expert " implies the possession of *special* qualifications in point of knowledge and experience. The expert's claim is one of superior and special attainments. He is not presumed to know everything in medical science, however convenient such omniscience might be. But he is supposed to be fully acquainted with the latest and most exact knowledge of the scientific matters of which he testifies in the case now pending. But the ideal expert witness not only has wide knowledge; he has also special aptitude in formulating correct conclusions from available data in the light of that knowledge. He has a judicial mind; he will think deliberately and accurately; he will not reach his conclusions by jumping, or form his opinion on an incomplete statement of facts. A really honest purpose will lead him to avoid dogmatism, recognizing that medicine is a progressive science; that medical theories which were held as orthodox truth fifty years ago are obsolete to-day; that many of the articles of our own medical creed to-day will be rated as rejected medical rubbish by our grandchildren; and he will always remember the difference between the absolute, the probable, and the possible.

Finally, without exhausting the catalogue of the qualifications of the true medical expert, strict impartiality, which is another name for rugged honesty, should be one of his chief virtues. Properly considered, an expert is superior to partisanship; he is not concerned with the result of the litigation. When he has stated candidly what certain facts in evidence indicate to his mind with reference to the issue between the litigants, his office ends. He is not called on to answer the questions : Is the accusation proved? Is the complaint established? Those questions are for the jury. The expert is to say whether, assuming certain facts to be shown, they as a matter of medical science indicate a logical or probable connection with each other and with the allegations under investigation at the trial. " Every witness," says Lord Justice Hatherly, " should eschew altogether the notion of partisanship. He should be ready to give his opinion frankly and unreservedly, regardless how it may tell. He is there not as an advocate, but in order to inform the Court and jury to the best of his judgment." Now in practice the performances of many, if not most, physicians in court, are deplorably below this

standard of conduct. The usual course which expert testimony takes before a jury has a distinct tendency to produce this result. Sometimes before a trial is to occur the complainant or defendant asks some physician to come to court and testify as an expert ; the invitation is a complimentary one and the fees are attractive. If the physician assents, he is forthwith made acquainted with the facts and views relied upon to establish the contention of the side which he has taken. The facts on the other side are not his to have. So, *inevitably*, he becomes to a greater or less degree a partisan witness, an advocate for the party on whose side he is acting and by whose money he is rewarded. However upright and honest his intentions may be, he can not help a certain degree of self-surrender to bias. He can not avoid the notion that he is bound to regard his professional opinions as so far elastic as to permit him to mould and stretch them in the interests of his own side and as much as possible against the interests of the opposing side. This is loyalty to his employer. As the distinguished Attorney-General of Massachusetts, the Honorable H. M. Knowlton, well expressed it :[1] " The defect of medical expert testimony is the almost inevitable and often unconscious tendency of experts to help the side that calls them." But the same principle, or lack of principle, is met, as a matter of course, on the opposing side of the case. A medical expert for that party is ready with his elastic opinions to rebut, annul, and neutralize the opinions previously advanced for the enlightenment of the jury.

And so it happens, not always, but very frequently, that medical expert testimony comes to be a tilt at contradictions, to the scandal of the medical profession and the amusement of the court audience, and the very purpose for which the testimony is introduced at all is largely subverted. Many physicians feel it to be a reproach and not an honorable privilege to appear as experts, to be abused by counsel, contradicted by adverse testimony, and made to appear ridiculous before all in the court-room, not to mention the larger audience which reads the newspapers in the world outside. The legal authorities themselves, influenced in their opinions by current observations, show scant appreciation of medical men in court. Greenleaf, in his classical work on *Evidence* says : " That the testimony of experts in many, if not in most, cases is of little value is universally agreed." Another writer declares that " within the last ten years trials have taken place in which the

[1] *Transactions of the Massachusetts Medicolegal Society*, 1897, p. 323.

SAUNDERS' BOOKS FOR NURSES

DE LEE'S OBSTETRICS FOR NURSES

In this new book Dr. De Lee presents a work of the greatest value not alone to the nurse, but also to the practitioner, upon whom the duties of a nurse often devolve in the early years of his practice. **Dr. J. Clifton Edgar,** Professor of Obstetrics and of Clinical Midwifery in Cornell University, New York, says: "It is far and away the best that has come to my notice, and I shall take great pleasure in recommending it to my nurses and students as well." There are really two subjects considered—obstetrics for nurses and the actual obstetric nursing—the author having so combined them that the relations of one to the other are natural and mutually helpful. The text represents the result of the author's eight years' experience in lecturing to the nurses of five different training schools.

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suggestions of a practical sort contained
therein, are timely and valuable;" while the
Trained Nurse and Hospital Review says
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up to date, without the superfluous reading
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will find this book of the greatest value, both during their hospital course and in private practice." Cloth, $1.25 net.

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The second edition of this useful and practical work has just been issued, and Dr. Grafstrom has made the revision complete. He has added two new chapters, one on Massage of the Eye, Ear, Nose, and Throat, and the other on Pelvic Massage. The **New York Medical Journal** in reviewing the first edition of this work said: "It certainly fills its mission in rendering comprehensive the subject of massage and medical gymnastics," and the second edition will be found even more useful to the trained nurse, medical gymnast, and physician. The illustrative feature has been enhanced by the addition of seventeen new illustrations. Cloth, $1.25 net.

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This work, the new sixth edition of which has just been issued, has met with a remarkable reception by both nurses and practitioners. The New York **Medical News** says it is "an up-to-date hand book conveniently arranged for ready reference;" while the **Medical World** says "the work covers completely the ground gone over by the student, special stress being laid on diagnosis, differential diagnosis, and treatment." Owing to the rapid advance in the science of medicine, Dr. Stevens found it necessary to rewrite

many of the chapters, so that the work has been entirely reset and much enlarged.

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FOUR EPOCHS OF WOMAN'S LIFE

Two editions of this work in less than two years is sufficient proof that such a book was needed. The New York **Medical Record** says: " This little volume was so well received when it first appeared that it is not surprising that a second edition should have been needed in less than two years." The **Johns Hopkins Hospital Bulletin** thinks it " seems well calculated to instruct young women, especially young wives and mothers, in matters which they ought to know." A comprehensive glossary has been appended. The second edition has just been issued.

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POCKET MEDICAL DICTIONARY

The new fourth edition of this handy dictionary has just been issued and contains over twenty-five hundred new terms that have appeared in recent medical literature. It is an absolutely new book, defining all the terms of modern medicine and forming an unusually

full vocabulary. **Dr. James W. Holland**, Professor of Medical Chemistry and Toxicology, and Dean, Jefferson Medical College, Philadelphia, says: "I am struck at once with admiration at the compact size and the attractive exterior. I can recommend it to our students without reserve." The **Trained Nurse and Hospital Review** says: "We have had many occasions to refer to this dictionary, and in every instance we have found the desired information." There are also included sixty-four extensive and valuable tables of great practical use to nurses and students of medicine.   Flexible Morocco, $1.00 net.

GRIFFITH'S CARE OF THE BABY

In the third edition of this work, recently issued, Dr. Griffith furnishes a reliable guide for caring for children in sickness and in health. He has made his statements clear and easily understood, so that the work will be of service, not only to mothers and nurses, but also to medical students and practitioners. The **Johns Hopkins Hospital Bulletin** says "it is a clear exposition of the knowledge that comes from large personal experience," and that it " will go far to counteract the ignorance, neglect, and bad management accountable for

medical witnesses did more harm than good—did more to mislead the jury than to instruct them."

In the Maybrick case, tried at Liverpool in the summer of 1889, Mr. Justice Stephen addressed the jury in these terms:

" The jury," he said, "would use what knowledge of medicine they, like other men, might have picked up in their general experience, and he could not give them any rules or directions on the subject. . . . . The great controversy in this case was in the medical evidence. No doubt the jury had noticed the different peculiarities of manner and expression on the part of the medical witnesses, and had formed their own opinion as to their impartiality or partisanship and their understanding and judgment. There was no imputation on the good faith of these gentlemen, but they certainly *did* differ very widely in their conclusions. In forensic medicine there was a kind of subtle partisanship which very much diminished the value of the evidence given. . . . . The mere fact of a man going into the witness-box and saying he was this, that, or the other did not by any means qualify him to receive unhesitating belief. A good deal of what he might call the scum had to be taken off the testimony of skilled witnesses, for (of course, probably insensibly to themselves) they were apt to become advocates rather than witnesses. . . . . The jury must form their own judgment and must treat the evidence in a discreet and rational way, not being influenced by unnecessary respect for the opinions of men specially skilled in these matters. . . . . A doctor has been defined as a man who passes his time in putting drugs of which he knows little, into a body of which he knows less. This was one of those pointed sayings which were convenient because they *were* pointed, but at the same time there was a degree of truth in it, and it should remind all persons, especially those who were employed for the time being in the tremendous functions confided to medical men, to be very modest in their opinions."

A leading lawyer, in an argument in court recently, used these words: " Now, what is an expert? An expert sees nothing; he hears nothing; he smells nothing; he does not use any of his senses; but he comes on the stand and assumes. He generally writes out for counsel, too, all that he wishes to have assumed, so that it comes down to this, ' Assuming this and assuming that, what do you think?' The expert must be a good talker, a quick thinker, and a great assumer. Isn't that a great thing for a corporation? And is it any wonder that no matter what it costs, you can always get experts to testify the way you want. It is a pretty tough question for

the courts, this expert question, and it would be a good deal tougher if juries took much stock in expert testimony."

Such are the opinions of some of the highest representatives of the legal profession concerning the usefulness of medical experts. They point out incisively, not to use a harsher term, the evils and abuses which attend the employment of scientific witnesses, and of all the evils, partisanship is the crowning one.

Now, many remedies have been proposed for this, both in England and in the United States. We hear of no such great abuses and reproaches in Germany, where judicial matters connected with medical science are submitted to an impartial commission of experts appointed by the Government, and where the opinions are given in writing and are submitted in that form as evidence. It thus happens that Germany has, as has been stated, "the best corps of experts the world has ever seen." For practice in our own country various suggestions have been made. A plan which has found favor with many is to have the judge before whom the trial is to be held select a proper number of experts of established reputation, and to have them called to testify after a proper hearing of the full testimony. The effect of this would be that the evidence of witnesses so appointed would carry a weight with a jury altogether greater than is possible under the present one-sided system. It would add a dignity and importance to the office of an expert which is really merited. It would go far toward excluding a class of incapable and mercenary physicians from a service which they have done much to discredit. To some such method they must come sooner or later.

The use of medical men as auditors or masters to examine cases in which medical issues are involved, and to report their findings in court, is another way of relief which has much to recommend it. The chief obstacle to reform is the set purpose of the lawyers not to surrender any advantage which present rules give them. This is very natural, since lawyers desire to bring forward all proofs favorable to their clients, and they are unwilling to surrender their full control of such proofs or to work in the dark.

One evil practice should, at all events, be avoided—the practice of medical men who combine the functions of medical witnesses and medical advisers or advocates. A medical witness should not sit at the elbow of counsel to suggest questions to be asked of another medical man on the stand. It is a practice which is open to the severest criticism, and it frequently elicits very uncomplimentary comments by opposing counsel and by the judge sitting in the case.

Rights and Demeanor of Medical Witnesses.—We pass now to matters of more immediate practical concern, namely, to some of the rights of physicians as medical witnesses, and to some rules of conduct which will be of service to those attending court. First, of the summons: Every witness, ordinary and expert, medical and non-medical, is entitled to a formal written summons before he is obliged to appear at a trial. This summons, technically called a subpena, is issued in the name of the Commonwealth by any court clerk or by any justice of the peace. If the witness is expected to produce any books or papers relating to the litigation (for these are no more* safe than the witness's person from the demands of the law), a clause to that effect is inserted and the summons is then called a *subpœna duces tecum.* This summons is to be left either with the witness in person or at his place of abode, and within a reasonable interval before the trial. A summons in the morning to attend court in the afternoon of · the same day has been held by the courts to be insufficient, although the witness lived near the place of trial. There is a slight difference between civil and criminal trials in the matter of the summons. It is a rule of the common law that, in order to secure the witness's presence and testimony at a civil suit, the fees allowed by law for one day's attendance and for travel to and from the place of the trial shall be paid or tendered with the summons. In a criminal trial no offer of the fees on the part of the Government is held to be necessary to secure the witness's attendance, as it is considered the duty of every citizen to obey a call to court, since he is himself, in a certain sense and to a certain degree, a party. But if the *defendant* in a criminal trial wants a witness, he must send to the witness the one day's fee, just as if the case were a *civil* suit. (General Statutes of Massachusetts, chapter 120.)

But if the witness is entitled to receive a formal call to court, he is by the same token under obligation to obey the call. A question has arisen as to whether a medical man can be compelled to appear in court as a skilled witness against his will. There is some difference of opinion in this matter, some judicial rulings having been recorded to the effect that an expert is not bound to attend court upon a subpena. Thus, Lord Campbell is reported to the effect that " A scientific witness was not obliged to appear upon being served with a subpena; and that he ought not to be subpenaed. If the witness knew any matters of *fact*, he might be compelled to attend; but he could not be compelled to give his attendance to speak of matters of *opinion.*" And Mr. Justice Sprague, of

the United States District Court, is on record as reaffirming the same view. But the most logical, as it is also the most general view is that the subpena is a peremptory command, not to be construed by the expert or by anyone else according to any hypothesis of his own. It is an order for personal attendance at court, and must be obeyed if within the range of physical ability. But once the witness is put upon the stand, if he knows no *facts* relative to the case in progress, his obligation to the public ceases. He owes no duty which requires him to state his opinions on any subject. It is evident that the professional experience and skill of a medical man are so far his personal property, his capital in his vocation, that he can not be compelled to dispose of its fruits in court to the first person who wants them. On the witness-stand, precisely as in his office, the physician's *opinions* may be given or withheld at his pleasure, for it has been repeatedly ruled that refusal to give a medical opinion and to testify as a medical expert is not punishable as a contempt of court.

But such a contingency is a rare one. A reluctant or unwilling witness is of poor service; and a physician forced to leave his ordinary work and against his will and without preparation to go to court to give his opinion, even under the expectation or promise of remuneration, would not in general prove a very useful ally to a cause, or a useful aid to justice; and lawyers know this, and do not risk the results growing out of such reluctant service. Therefore, engagements with experts are made generally some time before the time set for the trial, and opportunity for preparation is thus afforded and the matter of compensation is fully understood.

A much more common experience with physicians than compulsory attendance in court as experts is the attempt to use them as *experts* when they are on the stand as *ordinary* witnesses, and when no intimation has been given that the testimony desired will be other than testimony relating to facts. For example: A surgeon has attended a wounded man who has died, and a trial for manslaughter ensues. The surgeon is summoned as an *ordinary* witness, and he testifies to what he did; how the patient appeared; the character of the injuries—all matters of fact. Then follows such a question as this: In your opinion, was the deceased able to move or to make resistance after he was struck?

This is a very natural question, but if it is answered as candidly as it is apparently asked, the witness will find that he has opened the gate widely to an unlimited amount of questioning on matters of *opinion* purely. If he values his com-

fort as well as the rewards of his profession, to both of which he is entitled, he will manage the emergency in this way: When a question, the **first** question, is asked, the answer to which involves the expression of a medical opinion, and he has no previous understanding that he will be used as a medical expert in the case, he will say, " I have not formed an opinion ; I am not in the case as an expert, but as an ordinary witness only " ; or, " Do you wish me to understand that I shall answer questions as a medical expert ?" The *response* will establish the relationship at once.

Fees.—It is a source of much annoyance to physicians that they are obliged to interrupt their business and submit, sometimes for days together, to the inconvenience and delays and miseries of a trial in court; and that they are allowed such inadequate recompense, based as it is on the pay of day laborers and graded according to the degree of the court. It may be argued that a loyal and patriotic citizen ought to be willing freely to give his time and service in behalf of public morality and good order. That will answer measurably with regard to criminal proceedings, but the civil litigations which often summon the physician to court, and which are frequently based on the least honorable of human motives, such as the hope of gain, revenge, retaliation, and the like, are in a different relation.

Fees for *expert* testimony vary according to the witness's skill in making a shrewd bargain ; according to the importance of the case ; the fulness of the employer's purse ; and the value which the expert places on his services. The usual rate is from twenty-five to fifty dollars for each day's attendance. Chemists charge also for time spent in preparatory work in a laboratory ; these fees are established by custom, and are expressed in fee-tables.

Now, once in court as a witness, what rights has the physician on the witness-stand ? He has the right before answering a question, to *understand* fully the question. If he does *not* understand it, he has the right, and it is his duty, to ask its repetition. Some men are lacking in the ability to ask a question connectedly, simply, and intelligibly ; and legal counsel are not above criticism in this respect. The most absurd and inconsequent questions are propounded to physicians by lawyers in court, not, perhaps, with the intention to mislead or confuse, but solely from a lack of acquaintance with medical matters. For example, in a recent capital trial, the defendant's counsel asked the expert this question : " Have you an opinion as to what effect upon forming an

opinion as to the time of coagulation of the blood has, provided it is out of the body and found near it."

Some counsel adopt the ingenious plan of compressing two or three questions into one. A witness unthinkingly answers the last, or the one which most fixes his attention. The same answer may not apply to all, but the witness may find, when it is too late, that it is made to do so, to his disadvantage.

A medical witness has the right, within certain well-defined limits, to refer to *notes* or *memoranda* on the witness-stand. On this subject the rule of law is that notes made by the witness or by anyone else at the moment of or just after the fact to which they refer may be used by him to " refresh the memory." It is not necessary that the memorandum shall have been made by the witness himself, in his own handwriting; any bit of writing relating to the affair is admitted as a mnemonic. But if the transaction or fact noted has completely escaped the witness's memory so that, although he may believe the note to be true, he can not recall that to which it refers, such note would not be admitted.

The general rule as to the inadmissibility of such written evidence is further departed from in the case of medical or other scientific detailed reports; these the witness is sometimes allowed to read as his deposition, the same being affirmed as true by the witness, under oath. The reason for this exception is founded on the obvious consideration that the medical or other facts in the report are generally so detailed and minute that they could not with safety be entrusted to the witness's memory; but that much more reliance may be placed on a report made out by him when the matter was fresh in his recollection, while the witness himself is presumed to have no personal interest in the issue of the case, and so would be regarded as above suspicion. Both the reports above referred to and the memoranda previously mentioned should be the originals and not copies, in order to render them valid; they must have remained unaltered and uninterpolated.

But a medical expert is not permitted to quote opinions from *professional books* in substitution or support of his own sworn opinion. The author is not under oath as the witness is, and, while the latter may and ought to help himself in shaping his opinions by studying standard works before going on the stand, he can not quote from or use such works in giving his testimony. Moreover, books deal with general or universal propositions, while the witness is called upon to

apply his knowledge and experience in unravelling or explaining certain medical or scientific features of a *particular* case which wears a complexion of its own, and which must be interpreted on its own merits. But in cross-examination counsel is sometimes permitted by the Court to ask the witness if he accepts such and such an author as a standard, and a quotation may be made which appears to contradict the expressed opinion of the witness. Before answering, the witness should ask to see the book, in order to be sure that the quotation is correctly made, and that the context is not overlooked.

Professor Taylor says [1] that, in his opinion, any advice respecting the **manner** in which a medical witness should give his evidence is quite superfluous, since experience shows that rules of this sort, like those given to prevent drowning, are invariably forgotten at the very moment when the individual is in the situation in which he most requires them. Of course, very much of a medical witness's success depends on his natural individual temper, as well as on his preparation for the ordeal. Some are diffident and reserved, a misfortune they can never conquer; others have difficulty in controlling their speech—before they know it, their tongues have outrun their prudence, and they have talked too much and too fast; others have an irritable temper which they can not control. But to all these, and to all others who are, in spite of themselves, compelled to stand and deliver in court under trying and novel circumstances, a few practical hints may be offered.

Of course, it goes without saying that a witness should be well prepared beforehand on all parts of the subject on which he is to give evidence. He should study authorities with exhaustive care, acting as if he were himself prompting counsel in his own cross-examination. This is the only safe way in detecting his weak points. It should be assumed that the cross-examining lawyer has fully instructed himself as to these easy places of assault, and the witness will do wisely to exaggerate his difficulties in advance. He should not trust to luck that they will remain undetected, for sometimes these matters will come upon him unawares and very inconveniently. No man, however, can be expected to know everything, so he can never be hanged for ignorance. Therefore, when the witness is clear that he can not answer a question without guessing, he should not hesitate to say, " I do not know." He will lose nothing by his evident candor, and nothing so baffles a troublesome counsel as such sincerity. But having once replied, " I

[1] *Principles and Practice of Medical Jurisprudence*, i., p. 20.

do not know," to a question, he should never allow himself to be *further* drawn out by the skill of counsel.

All questions should be answered directly and decidedly without ambiguity or evasion. The nearer the replies come to the monosyllabic " yes " or " no " the better for the comfort of the witness. He who says, " I think," or " my impression is," or makes qualified statements, will soon find himself in difficulty and open to the imputation that he belongs to the " guessing profession." If by a proper study of all the facts (and the witness ought not to give an opinion unless he has all the facts) he reaches a conclusion for which he can give reasons, he should announce the conclusion at the proper time in answer to questions, and stick to it. He should avoid expressing opinions manufactured hastily, on the spot. " To be accurate is a thousand times better than to appear brilliant." In the development of conclusions the witness should keep in mind, and in readiness for use, the distinction between the absolute, the probable, and the possible, as already suggested. It is a distinction admitted by lawyers and frequently used by them in examinations.

Physicians should avoid the use of exaggerated language. There is a tendency among medical men in general to express their notions and observations in the superlative degree; to say a part is " intensely inflamed " or " exceedingly swollen," or that hemorrhage was " enormous." The cross-examining lawyer will be likely to compel the witness to explain his notion of these terms, if he uses them. Especially should the witness use language which can readily be understood. He should recollect that he is speaking, not to physicians, but to men who are wholly ignorant of the meaning of the most ordinary medical terms. To the Court and the bar such terms are presumably unintelligible; to the jury they are worse than a dead language. If any one thing more than another has served to render physicians ridiculous and uncomfortable under the fire of a cross-examination it is their misfortune in an unconscious tendency to use scientific terms. Advantage is inevitably taken to get some fun out of it for the amusement of the court. A thousand anecdotes might be told of the mistakes which medical witnesses have made in this direction. For instance, the following one from Taylor:[1] " At a trial for an assault several years ago a medical witness informed the court that, on examining the patient (the plaintiff), he found him suffering from a severe contusion of the integument under the left orbit, with great extravasation of blood and ecchymosis in

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[1] Taylor, *loc. cit.*, i., p. 30.

the surrounding cellular tissue which was in a tumefied state; there was also considerable abrasion of the cuticle." "You mean, I suppose," said the Judge, "that the man had a bad black eye?" "Yes," replied the witness. "Then," said His Honor, "why not say so at once?"

Therefore, all technical terms should be translated into plain English to suit the comprehension of the simplest auditors. If the witness means skull, he should say so, and not cranium; if he means belly, he should say so, and not abdomen; he should say gullet, and not esophagus; blood-clot, and not apoplectic extravasation; bruise, and not contusion, and so on through the chapter. It was a horse doctor who was asked what he meant by "suspensory ligament"; if he meant "hangman's noose"; but horse doctors are not the only ones who sin. Save, therefore, the long words for medical meetings, where they will be understood, and avoid the charge of affectation and pedantry, if not of ignorance, by talking so that you can be understood.

The witness should be on his guard, too, about being cunningly drawn into a discussion while on the stand, because he will almost invariably be at a disadvantage in the controversy. Such a scene can not do him, or the case, any good, and the chances are that it will result to the discredit and discomfiture of the witness. The counsel, being at home in the presence of the Court, and the witness being in a new and, to him, perhaps an embarrassing or awkward position, the former will have every advantage. Attempts at smart repartee are risky. In repeating conversations the witness should give as nearly as possible the exact words used by both the parties in the talk. For example, instead of saying, "I asked the prisoner whether he knew anything about the murder and he denied any knowledge"—say, "I said to the prisoner, do you know anything about this murder?" and he replied, "I do not know anything whatever about it."

Finally, he should tell the truth with entire indifference as to its effects or bearing on the case. It is right that he should know, in this connection, that in most States physicians have no legal privileges by virtue of their professional relations with their patients; therefore, outrageous as it seems to the medical man's sense of honor, he is bound, if asked in his examination in court, to disclose all he knows of any case in question, even to the divulging of secrets imparted to him in the course of his professional attendance. An appeal to the Bench is the only safeguard to the physician's sense of honor in such circumstances, and by its decision alone can he be guided

as to how much of the information thus acquired is to be revealed.

As a conclusion to these remarks on medical evidence, the following sensible advice by an old writer on legal medicine, Sir William Blizard,[1] may be quoted: " Be the plainest of men in the world in a court of justice. Never harbor the thought that if you do not appear positive you must appear little or mean. Give your evidence in as concise, plain, and clear a manner as possible. Be intelligent, candid, and just, but never aim at appearing unnecessarily scientific. If you can, make your evidence a self-evident truth. Thus, though the Court may at the time have too poor or too mean an opinion of your judgment, they must deem you an honest man."

[1] Tidy, *Legal Medicine*, i., p. 27.

CHAPTER III.

IDENTITY IN ITS GENERAL RELATIONS.

AGE, as a medicolegal topic, is to be studied under two aspects: 1. Legal relations, or the periods of human life which the law recognizes for certain purposes. 2. Means and data for determining the question of age in the living and the dead. Under the first head, questions with regard to age may arise in connection with prosecutions for abortion, infanticide (age of the child), and rape (the age of the victim). In civil practice questions of marriage and of citizenship come up for solution. Incidentally, employment of minors in factories and compulsory attendance at school become occasions for determining age. Most important of all it is an essential element in the determination of personal identity.

As to the legal relations of age during the fetal period, the law makes no distinction such as medicine recognizes in the different stages of fetal development. There is in the statutes no occasion to differentiate an ovum or embryo and a fetus. Abortion and premature birth are terms peculiar to obstetrics, and they have no place in legal treatises. In the latter the general term " miscarriage " is used. Thus, the statute relating to criminal abortion prohibits " causing or procuring the miscarriage of any woman pregnant with child." And again, the law has a penalty for any person who, " with intent to procure a miscarriage of any woman," does certain specified acts which are prohibited. So the law makes no distinction as to viability with regard to the criminality of procuring miscarriage; the crime is equally great at any stage.

There is one apparent exception to this; the word " quickening " is used in one connection. An old Massachusetts statute, still in force, says: " If a female convict under sentence of death is quick with child, the Governor and Council shall forbear to issue a warrant for her execution; or if such warrant has been issued, the execution thereof shall be respited until it appears to the satisfaction of the Governor and Council that she is no longer quick with child."

Is an Unborn Child a Person?—Is a dead fetus the

dead body of a person ?   Physiologically and anatomically we answer, yes.   According to law, it is doubtful.   Although the common law declares that an unborn child, whether viable or not, may inherit property, may be appointed executor, and may receive property under a marriage settlement, if subsequently born alive and surviving its birth, it is nevertheless unsatisfactory concerning the question presented, because it is not explicit.   The common law principle is that a dead-born child is to be considered as if it had never been conceived or born.   *Mortuus exitus, non est exitus.*   Greenleaf says :   " If a child is born dead, it can not be regarded as having been the subject of violence, even though it were destroyed by human agency, no matter at what age . . .   To support an indictment for infanticide it must be clearly proved that the child was fully born and born alive, having an independent circulation and existence."   It would clearly appear from this that however civil or ecclesiastical law may regard the matter, the law, as it relates to crime, does not recognize as a victim of crime, in other words as a person, a fetus which has not sustained an existence of its own ; or when born dead, as the dead body of a person.   That is, it must not only have been able to live, but it must have been born alive and wholly born.   The German rule asks :   " Could the child have maintained an independent existence ?   Is it viable and not a monster ?"   Thus, a child born at the fourth or fifth month of pregnancy, or an acephalous or an anencephalous anomaly, incapable of living, could not be regarded as human persons under the law. The British law requires proof of at least seven months' development of the fetus (whose birth has been concealed) in order to convict the alleged mother of the crime of concealment.

With ages after birth the law is more explicit, and has established arbitrary limitations which may require medical evidence to determine.   Under seven years of age a child is, in law, an infant and incapable of crime.   At fourteen years the age of " discretion " is reached.   Between seven and fourteen it is a matter of evidence as to intelligence and crime.   Witnesses may be of any age ; the matter rests in the discretion of the Court, and the usual custom is to test the child's mental growth by questions before testimony is allowed.   In other words, the competency of a witness of tender years does not depend on age, but on the understanding.   Some Massachusetts statutes provide for the protection of minors : children under ten are not to be employed in factories ; nor between ten and fourteen unless they have attended school a certain

number of weeks. If under fifteen, not more than sixty hours
of work a week can be required. If under sixteen and unpro-
tected, the child may be provided for by town regulations or
sent to an institution. At ages between eight and fourteen the
child must be sent to school at least twelve weeks in the year.
The law with regard to rape establishes an age of consent. A
boy under fourteen, according to English law, can not commit
a rape, being regarded as sexually incapable. The marriage
of males under twenty-one and of females under eighteen
without consent is forbidden in some States. Fraudulent and
deceitful enticement of an unmarried female under sixteen for
clandestine marriage may be punished by fine and imprison-
ment. Male citizens (certain classes being exempt) are liable
to militia duty between the ages of eighteen and forty-five; at
twenty-one they attain their majority and the privilege of vot-
ing, they may serve on a jury, or make a will, or execute a
deed or contract. A person is twenty-one the first instant of
the day before the twenty-first anniversary of the birthday;
this may be forty-seven hours and fifty-nine minutes short of
the actual time counting by hours. The principle is, that, in
law, a part of the day is equal to the whole of the day.
Hence, it is important to note exactly the day and hour of
the child's birth, for much legal quibbling may thus be pre-
vented.

The periods of human life popularly relied on are too inexact
for scientific use. Aristotle considered life to be made up of
three stages, growth, maturity, and decline. Shakespeare
allotted to human life seven ages: the infant, schoolboy, lover,
soldier, justice, the lean and slippered pantaloon, and the old
man in his second childhood. This will do for poetry, but is
not available for legal medicine. The ancient divisions were
by septenniads: at seven months of gestation the fetus was
viable; at seven months of a child's life the primary teeth
appeared; at seven years the permanent teeth; at fourteen
years puberty was reached; at twenty-one the age of ma-
jority; between twenty-eight and forty-nine was the age of
maturity; at sixty-three the grand climacteric was reached;
and at seventy the age limit, according to the Scriptures, was
attained.

At and before fetal maturity three classes of data for scien-
tific observation are available: 1. The weight of the body as
a whole. 2. Measurement of the entire body or of its parts.
3. A progressive ossification of the bones. All of these may
be observed in the dead subject; the first two alone in the
living.

The **weight** and **length** of the fetus at different stages of the fetal life are as follows :

Age in months.	Weight.	Length in inches.
2		1
3	460 grains.	2¾ to 3½
4	1 ounce.	4 " 6¾
5	8 ounces.	7 " 10½
6	23½ "	11 " 13½
7	41¼ "	13¾ " 15
8	3½ pounds.	15¼ " 16
9	4¼ to 5½ pounds.	16½ " 17¼
At birth.	6 to 9 "	18 " 21

The average weight of children born at full term in England, according to Tidy, is 6 pounds and 8 ounces. The diversity among authorities grows out of the scarcity of material and the difficulty in fixing the stage of pregnancy at which the observations are made. A rough rule may be stated in these terms : After the fourth month of pregnancy the length of the fetus in inches represents twice the age in months. Thus, a fetus twelve inches long is approximately in its sixth month of development. Casper puts the rule in these terms : "After the fifth month of pregnancy the length in centimeters is five times the age in months."

The relative development of the upper and lower parts of the fetal body gives another evidence of the stage of growth in the progressive lowering of the central point between the crown of the head and the soles of the feet ; at six months we find it at the lower end of the sternum ; at seven months, a little below the ensiform cartilage ; at eight months, nearer to the navel than to the end of the sternum ; and at maturity, close down to the navel. Other data are that the pupillary membrane is distinct to the end of the seventh month, then gradually disappears and is absent at term. Maturity, too, is indicated by full growth of the nails beyond the tips of the toes and fingers, by growth of the hair on the scalp, by the formation of vernix caseosa, by descent of the testes into the scrotum in boy babies, and by the presence of meconium in the colon.

Centers of Ossification.—In the dead body of the new-born child we may learn much concerning its fetal age and stage of development by a study of the centers of ossification and their relative progress. These centers appear in the second month, in the ribs, ulna, radius, fibula, ilium, and vertebræ ; in the third month, in the cranial bones and ischia ; in the fourth month, in the upper bones of the sacrum ; in the fifth month,

in the pubes and os calcis; in the sixth month, in the sternum; in the eighth month, in the lower end of the sacrum; in the ninth month, at the lower extremity of the femur. This last is of special medicolegal value; it is found by making a transverse incision below the patella and throwing open the knee-joint; then by making thin sections of the end of the femur until the center of ossification is revealed as a red, dense, circumscribed spot in the bone, which at its fullest is about the size of a pea. There is no trace of it before the thirty-sixth or thirty-seventh week of gestation; in the thirty-eighth week it is 1 mm. in diameter; at the fortieth week it measures from 6 to 8 mm. If it is found to measure 6 or more mm., one may assume that the fetus is at or near maturity. One great advantage of this sign is that it defies putrefaction.

It is interesting to note with regard to ossification that it begins earliest and progresses fastest in bones inclosing vital
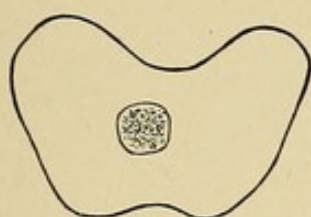
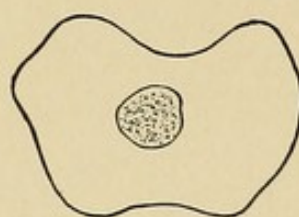FIG. 1.—A transverse section of inferior epiphysis of the left femur at maturity.

FIG. 2.—Section of inferior epiphysis of the left femur at age of two weeks.

organs—the thorax, vertebræ, and cranium. Ossification of bones employed in locomotion is delayed.

The Funis.—The determination of the age of the newborn infant, reckoned in days from birth, rests mostly on observation of changes which occur in fetal structures no longer useful. Externally the changes in the umbilical cord are of service in this direction. At birth, and for a few hours after, the funis is of a bluish, pearl-white color, spiral, plump, moist, bright, and glistening, and of the size of the finger of an adult. In from twelve to twenty-four hours the luster disappears, the cord becomes flaccid and transparent, its color changes to yellow, and the vessels are seen within. The process of desiccation goes forward, and is complete at the end of the fifth day. Meanwhile the skin at the base of the funis becomes red and swollen, and is pushed up along the cord like a cone. Presently, as early as the second or third day, suppuration begins around and at the navel. A line of demarcation shows the process of separation of the no longer useful cord. In the course of

a week the process is complete and a small ulceration remains to be healed. The extreme limits of age of the infant within which this occurs vary from the fourth to the ninth day; in the majority of instances it is observed on the fifth or the sixth day. Cicatrization of the navel is usually complete before the end of the second week. Observation of the navel, then, and of the state of the cord, will aid in determining the child's age. With the navel fully healed, the age must be at least ten days; with the cord dry but not detached, we infer an age of from four to nine days.

As already observed, the weight of children at birth and soon after is subject to considerable variety, and the extremes are quite striking because of the great diversity in prenatal conditions: the height and constitutional vigor of the parents; the health and nutrition of the pregnant mother. For example, a syphilitic taint, excessive vomiting, and repeated hemorrhages would naturally reduce the weight of the child. In most cases, under normal conditions there is some loss of weight in the newborn child during the first days after its birth. This is the rule for healthy babies born of healthy mothers. Occasionally it may happen that the weight appears to remain stationary because of the retention of meconium. In such a case the loss of weight will be postponed for a few days; this loss is greatest in the first-born and in boys. The tide turns and increase of weight begins at about the fourth day, and all loss will have been made up on the tenth day, if conditions are normal. The cause of this temporary loss seems to depend on the inability of the child to assimilate food, and there is a temporary partial starvation although the food may be sufficient and of good quality. The increase in a child's weight after the primary loss should be progressive. During the first five months the gain should be such that the weight is double the weight at birth; and at sixteen months the child should weigh twice as much as at five months. It is evident that the assistance to be derived from a study of the weight of the child is of secondary value in determining its age; it is one of the aids that enable us to approximate in our estimate, but it has no controlling importance in solving the question.

Dentition.—In the living child an examination of the mouth and a census of the teeth will tell us the age after this fashion: If we find the two lower middle incisors only, we say the child is under seven months of age. If, with these, the four upper incisors are also through the gums, it indicates that the age is nine months at least, and ten months and a half at the oldest. If, with these six, we find the two lower

lateral incisors and four anterior molars, we say the child is a year old. If, with these twelve, the mouth shows the four canine teeth, we assume an age of a year and a half, but not above twenty-one months. And if, with these sixteen, the four posterior molars are present, and the child shows all the temporary set, we conclude that the age is between twenty-six and thirty months. These observations are the result of a great number of cases. Saunders inspected 1046 children. Before the appearance of the permanent teeth and the loss of the temporary or primary set the child's jaws contain
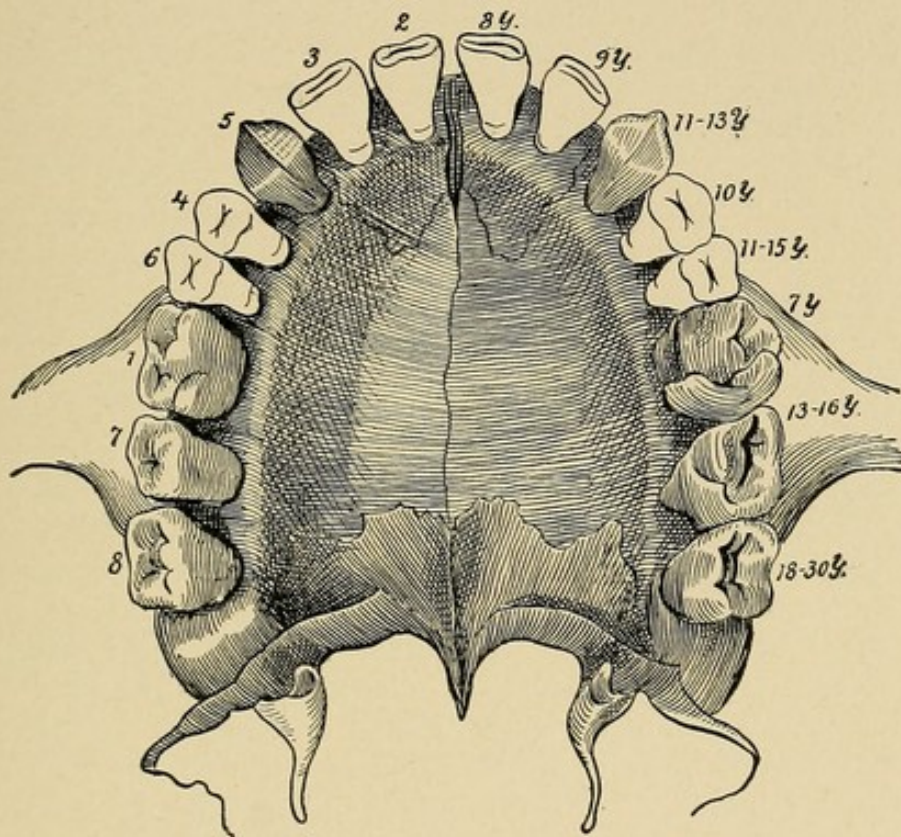
Fig. 3.—Diagram from Welcker, showing on the left side the order, and on the right side the time (in years), of appearance of the permanent teeth of the upper jaw (Rauber).

forty-eight teeth, twenty fully developed and twenty-eight in the process of development. The discovery, then, of forty-eight teeth in the alveoli of the jaws of a child's skeleton head would fix the age at between six and seven years.

The permanent teeth number thirty-two, which appear in the following order:

1. Anterior permanent molars, six to eight years.

2. Four middle incisors (upper and lower), seven to eight years.

3. Four lateral incisors, eight to nine years.

4. Bicuspids, ten years.
5. Canines, eleven to thirteen years.
6. Second molars, thirteen to sixteen years.

7. The last molars (wisdom teeth) are exceedingly irregular, and, as has been said of them, they are due when they arrive; approximately, they come about the twenty-first year.

Dentition determines some interesting changes in the shape of the lower jaw. At birth, owing to the absence of teeth, the angle formed by the rami and body of the jaw is obtuse, being about 140 degrees. The body is almost semicircular in form; it is shallow and chiefly alveolar rather than basal. But when the teeth come additional space is needed. This is provided by a growth of the body of the jaw posteriorly. The angle between the rami and the body becomes less obtuse, and at puberty approaches a right angle. The shape of the body of the jaw also, observed from above, changes from a semicircular form to that of a horseshoe. All this is to accommodate the teeth and to make the jaw better adapted to its functions.

Regarding the period of adolescence, as puberty approaches additional evidences of growth appear. In the boy the voice changes, the genitals develop, hair grows on the pubes, and a beard appears on the face. The girl shows fulness of the chest; there are pelvic changes; hair grows on the pubes and in the axillæ; and menstruation appears, subject to well-known modifications. In the female cadaver post-mortem conditions of the ovaries are characteristic. But there are quite wide differences in different individuals with reference to the arrival of puberty. If the child is precocious, these changes may appear at thirteen or even at twelve years of age; if adolescence is delayed, the age may be eighteen before the voice changes in the boy, or menstruation occurs in the girl. The manifestations of puberty are not dependent on health so much as on individual peculiarity.

Full stature is rarely attained in either sex before the age of twenty-five years. Before that time it will be unsafe to place much reliance on the height as an evidence of age, because so many conditions and variations modify growth in young persons.

At ages beyond the stage of maturity, which we place at twenty-five in the male and twenty-two in the female, the data for answering the question, " How old is the subject ?" are increasingly uncertain and unsatisfactory, especially in the living subject. It is reduced to an exercise in shrewd guessing. In any event there should be a study of all available

data. Hard work, mental worry, disease, and dissipation make people prematurely old. On the contrary, prosperity, robust health, regular habits, and easy living postpone the evil day.

Senility.—In general it is to be noted that, as age advances, toward the decline of life, the muscles grow flabby, atrophied, slow to respond to the will; the joints are stiffer owing to the progressive hardening and drying of the cartilages; the teeth decay and are lost and their crowns are worn; the hair changes its color, and its amount diminishes; the arcus senilis appears in the cornea; the skin loses its elasticity and becomes wrinkled; the mammæ in the female subject are either atrophied or much increased; and the body in general shows progressive feebleness. In other words, changes in the circulation lead to nutritive modifications which make all the mischief. It should not be forgotten that these
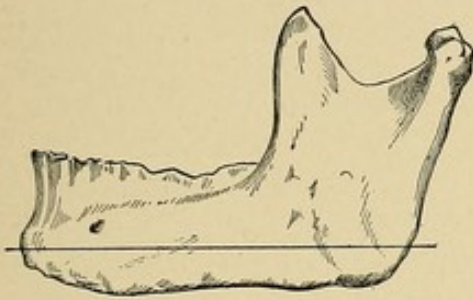

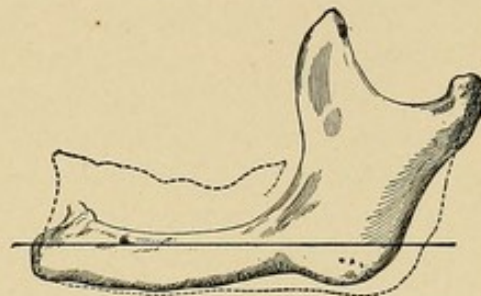Fig. 4.—Lower jaw in the adult (Chapman).   Fig. 5.—Lower jaw in the aged (Chapman).

changes are in turn modified by arts of the toilet, condition of life, habits, and the like.

If we have the skeleton only for our material, we may find some data enabling us to approximate accuracy, without permitting us to be dogmatically sure. For example, a skeleton which shows all the important epiphyses firmly united, but some of the secondary epiphyses still distinct, and union of the first sacral vertebræ with its fellows delayed, probably belonged to a person under thirty and over twenty. If the epiphyses of any of the long bones still show a want of ossification, the skeleton is of one under twenty. Between thirty and sixty changes in the bones are not easy to follow. In a general way the ensiform cartilage of the sternum becomes firm at and after twenty; the coccyx is ossified and is united to the sacrum; the ribs and costal cartilages effect a strong union; the cranial sutures are closed and the pieces of the sacrum are united. If the teeth are in place in the jaws, we shall derive some assistance in determining questions of age

by a careful examination of them. The presence of wisdom teeth will aid. Other data of adult maturity are in the firm and solid texture of the bones; their rough surfaces for the insertion of muscles; and their well-marked processes, grooves, and foramina.

In old age the changes in the bones are quite characteristic; they become yellow from the deposit of fat, lighter and brittle from the excess of earthy matter; their arterial grooves are deeper and their processes and ridges are less pronounced; the depressions for Pacchionian bodies in the skull are well defined. The costal and other cartilages are ossified; the pelvic bones are united in a single piece. The diploë of the cranial bones is sometimes absorbed, leaving them thinner. The marrow-cavities in the long bones are larger. Marked atrophy of the facial bones is observed. There is one special peculiarity: the angle of the body and rami of the lower jaw is greater than in earlier maturity.

CHAPTER IV.

SEX AND DOUBTFUL SEX.

THE question of the sex of an individual sometimes arises in legal medicine, and from the earliest period of fetal growth at which life may be maintained this question may arise for settlement, either as an independent problem or in connection with other inquiries. For example, it may occur in cases of doubtful identity; in the settlement of inheritance problems; in determining the validity of certain marriages; in establishing the legal status of an individual and the right to vote.

These questions touching the determination of sex are sufficiently easy to solve, as a general rule, when the body is living and structural anomalies are not extreme. They are easy, too, on the *dead* body, when all the parts are present; but they are difficult and sometimes insoluble when they relate to: 1. Mutilated remains of a dead body. 2. Puzzling abnormalities growing out of developmental aberrations. 3. Bony remnants only. The subject may profitably be studied under two heads: 1. The means of determining the sex when the conformation and characteristics of the sexual organs are naturally, but perhaps imperfectly, developed. 2. When these organs and the functions and habits pertaining to them are *abnormal*.

Normal Conditions Giving Rise to Doubt.—Velpeau tells us that during the first fifty-five days of embryonic life it is impossible to determine the sex of the fetus; it is the neuter gender at the start for us all. The clitoris or the penis is distinguishable between the second and the third month, but which of the two organs it is, one can not say unhesitatingly before the end of the fourth month. Indeed, it is easy to make a mistake in this matter in some cases of *seven month* fetuses, owing to the disproportionate development of the clitoris and its resemblance to the penis. Even at birth, if, with this disproportion, the testicles are not in their normal place in the scrotum, as they ought to be, at the end of the eighth or during the ninth month, an erroneous decision is not unlikely in some instances.

After *birth*, in the intervals between *birth and puberty*, the genitals are the only parts whose inspection enables us to

decide the sex. These being absent from any cause, we have no guide. The skeleton even is of no service to determine the question. Even if the organs of reproduction are present, they must be normal, else great difficulty may arise. After puberty, as adult maturity comes on, the normally formed male and female show distinctive anatomical differences in addition to differences in the sexual apparatus. The proportions of the body differ; the male is taller; the upper part of his body is less developed relatively; the middle point of the stature is at the *lower* part of the symphysis pubis. The female is shorter; her body outline is oval; the trunk is more fully developed than in males; the middle point of the stature is at the *upper* part of the symphysis pubis. It thus happens that in the male the lower limbs are relatively longer and the trunk is relatively shorter than in females.

In the male the distance from the pubes to the umbilicus is *shorter* than the distance from the umbilicus to the ensiform cartilage. A man's foot is one-seventh the length of his body (Gould); a man's shoulders are broader than his hips. In the female the distance from the pubes to the umbilicus is *longer* than that from the umbilicus to the ensiform cartilage. A woman's foot is one-ninth ·her full height. Her full development of the pelvic region gives a greater obliquity to her thighs, so that when the knees are together the upper parts of the thighs show a considerable separation. The development of the thorax makes it narrow at the base, with a larger antero-posterior and a smaller bicostal diameter. The mammary glands are, of course, distinctive.

The muscles in women are smaller than in men; the hair is finer and longer; the individual hairs are between $\frac{1}{1300}$ and $\frac{1}{1250}$ of an inch less in diameter; the tissues of the integument are more delicately organized; her nails are smooth and semitransparent. The arrangement of the hairy growth on the mons veneris is distinctive in the two sexes—in women its growth stops at a transverse line just above the pubes; in men it is extended well up toward the umbilicus. It is stated that the blood of women is less rich in red corpuscles than the blood of men.

Certain incidental or secondary contrasts ought not to escape mention: The larynx, and so the voice, has distinct differences; the facial development offers contrasts; the beard is essentially masculine; the lineæ albicantes are usually the result of pregnancy and are essentially feminine; their usefulness even in dead bodies is apparent. In the dead body, too, the pelvic organs may be of special importance to study with

reference to sexual identity. As will be pointed out, the uterus resists putrefaction to a marked degree, and it may be of the highest service as evidence when other soft parts have disappeared.

Sexual Characteristics of the Skeleton.—Let us suppose that we have only the skeleton for our material, and we are required to say whether it is that of a male or of a female subject, What points do we seek, what data do we require about the bones to solve this question? This problem is by no means a hypothetical one. For satisfactory results we need an adult skeleton, one that has well outgrown the age of puberty. Under such conditions the following points of difference may help us: The weight of the skeleton as a whole differs in the two sexes. The average results given for the male are 10 pounds and 6 ounces, and for the female 8 pounds and 13 ounces. The bones of the *female* skeleton are, in general, more delicately formed than those of the male; their development is less rugged; the ridges for muscular attachment are smaller. She is the "lesser man." Her flat bones are thinner; her round bones are more spongy; her joints are smaller. On the other hand, the bones of the *male* are larger, stronger, more curved, and more rugged; their ridges and projections are greater and rougher, and their articular surfaces are larger. This point is of great significance and has the widest application.

The Skull.—In *females* the skull is, in general, smaller; the facial development is less marked; the jaws are less prominent; the frontal sinuses are smaller. The anteroposterior diameter offers no marked contrasts in the sexes, but the other diameters are less; then, too, the small size of the superciliary eminences, occipital protuberances and ridges, and mastoid processes are suggestive.

The Thorax.—Should all be in place for satisfactory study; individual parts are of little value. Thus, taking the thoracic cage as a whole, we find the thorax of the *female* short in length and narrow at the base; in general shape it is oval in the female and conical in the male; dress modifies the shape of the female thorax. The spine is relatively longer in the female; the ribs are lighter and more sharply inclined downward than in the male, and the bodies of the vertebræ are smaller.

The Sternum.—In the female this is lighter and smaller than in the male. Hyrtl formulated the rule that the manubrium of the female sternum exceeds in length that of *half* of the middle piece (body), while in males it is less than that. This

is called by him an infallible evidence of sex. Henle confirms this. Luschka says : " The body of the sternum is usually *twice* as long as the manubrium in females, and it is two and a half times as long in men." This is the same rule in another form. Professor Thomas Dwight has looked carefully into this observation, and finds many exceptions to the rule, although the averages of all his measurements confirmed the law as stated. Strauch found as an additional sexual difference that female sterna are relatively broader than male.

The Clavicle.—In females the clavicle is shorter, straighter, and lighter than in males. In the latter, in form, it resembles the letter S ; it is flatter ; it is larger in all its dimensions ; it is directed backward ; and it has larger articular surfaces.

The Scapula.—This is relatively lighter in females ; its angles are sharper ; it is, in general, thinner and shorter ; and its glenoid cavity is smaller and narrower.

The Femur.—The femur has always been studied with much interest to determine its characteristics in the two sexes. The female femur is more slender ; looked at from the front, the shaft narrows gradually from the condyles up, until at or above its middle point the narrowest part is reached. The typical male femur narrows more suddenly lower down, so that the stout, strong shaft is nearly uniform. Formerly it was taught that the angle of neck and shaft in the *female* femur is less than in males ; that it was due to the shorter shaft and the broader pelvis.

Recent studies [1] show that this doctrine must be modified, if not abandoned. Many accurate measurements have been made by anatomists, the result of which is that, on the whole, the angle alluded to is of little value as a sign of sex.

One difference between male and female femora ascertained by recent studies is interesting. This relates to the diameter of the head of the bone. In females it is, on the average, 4.15 cm. ; in males, 4.8 cm. In females, again, there is a fairly regular increase in the size of the head of the femur as the length of the bone increases. This does not hold true with male femora.

The Pelvis.—More, perhaps, than all other parts together, the pelvis affords the most reliable evidence for the sexual identification of the skeleton. Studied in its entirety, with all its parts in place, it presents characteristics of great interest and value. Taken as a whole, as one bone, it is larger and heavier in the male ; its ridges for muscles are prominent ; and its development is masculine. It is, however, when we come

[1] Dwight, *Shattuck Lecture*, 1894.
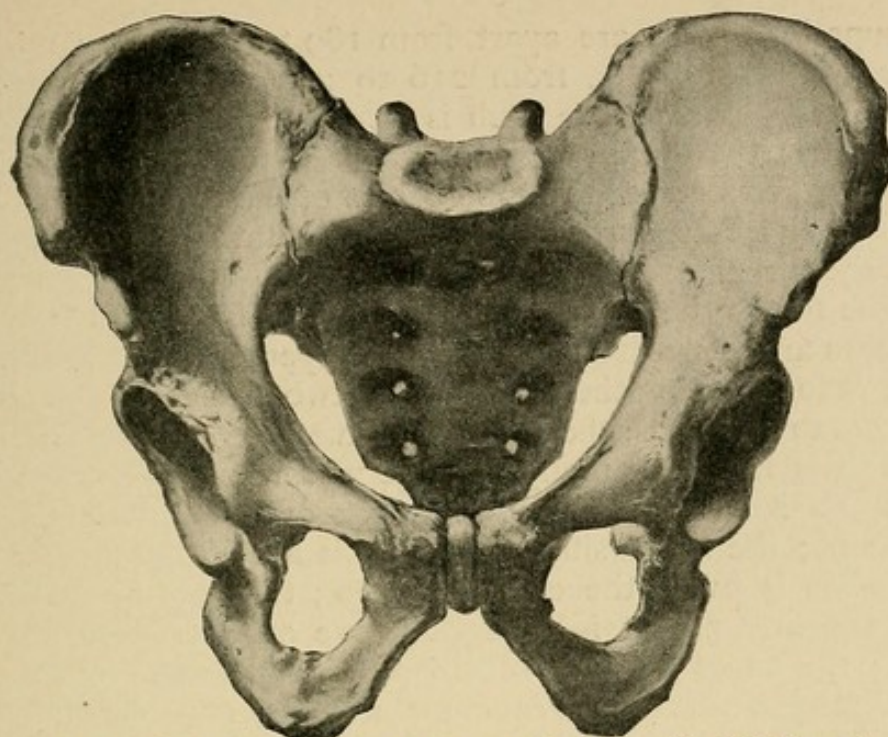
FIG. 6.—Male pelvis (slightly less than one-third natural size) (Dickinson).

to examine the pelvis in its detailed characteristics that differences between the male and the female appear conspicuously, and these grow out of the differences in purpose and function.
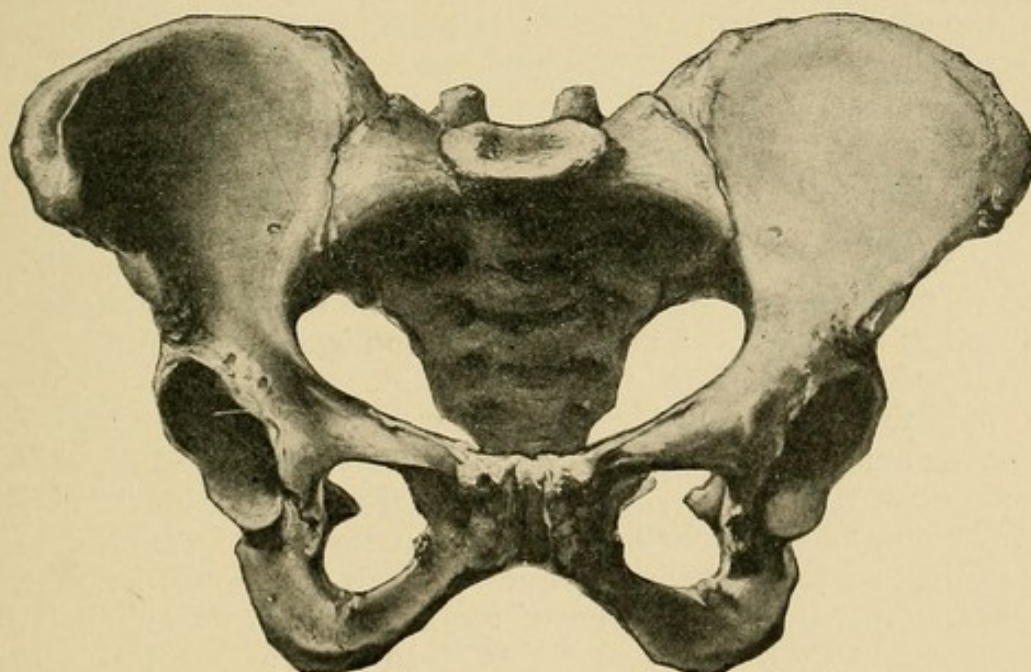

FIG. 7.—Female pelvis (one-third natural size) (Dickinson).

Sexual Peculiarities of the Pelvis.—In the **male** it is deep and narrow; the ilia have a vertical direction; the ante-

rior superior spines are apart, from 189 to 216 mm.; middle of the two iliac crests, from 216 to 243 mm.; the greatest diameter is bilateral; the arch is perpendicular; the width is 80 degrees; the symphysis is high; the promontory of the sacrum projects more; the tuberosities of the ischia are closer; the true pelvis is round; the cavity is shallow; the sacrum is regularly curved.

In the **female** the pelvis is broad; the ilia flare outward; the diameters are all greater; the anterior superior spines are apart, from 255 to 260 mm.; the middle of the two iliac crests measures from 270 to 297 mm.; the greatest diameter is anteroposterior; the arch is more overhanging; the width is 90 degrees; the symphysis is lower; the promontory of the sacrum is not prominent; the tuberosities of the ischia are farther apart; the true pelvis is oval; the cavity is deep; the sacrum is broad and triangular, and it is straight above and strongly curved below; the bones of the os coccygis are light and movable.

Hermaphrodites.—We come now to consider another class of cases, namely, those in which the organs of generation are malformed, and in which therefore the determination of the question of sex is often difficult and sometimes impossible. An additional element of difficulty lies in the fact that the medical examiner can not be guided wholly by the anatomic departures from the normal standard; but he is met by changes in the conformation of the body in general, by modified mental faculties, and by altered, absent, or aberrant sexual desires, the male considering himself as a female and the female as a male, and behaving accordingly. It has occasionally happened that examination of such unfortunate creatures during life has wholly failed to decide the question of their sex, and that dissection was the only means for an unequivocal decision. To these malformed human beings the generic term hermaphrodites has been applied, and the condition is called hermaphrodism or hermaphroditism.

According to English common law, if a child is born " without the shape of mankind," he can not inherit. The law, however, does not define the phrase " shape of mankind," but it implies undoubtedly far more than mere bodily deformity. The question, therefore, becomes one of much medicolegal importance, namely, What degree of monstrosity or unshapeliness must exist to prevent legal rights? In such a case the duty of the medical man would be best performed by describing with the greatest detailed accuracy in what respect the individual in question differs from the normal, leaving to the Court to say whether it is " without the shape of mankind." But

supposing this question answered, and that the Court decides the individual to be capable of inheriting, the further question arises (and this is what is of immediate concern in its relation to the subject), Is the being male or female, or both in one? This question is of great importance in law; for example, in the inheritance of property and in the inheritance of titles in countries where titles exist. So, too, in deciding the choice of a business or profession; for instance, a girl can not be admitted to holy orders.

In a suit for divorce it may be urged by a husband that his supposed wife, or by a wife that her supposed husband, is so constituted as to be incapable of fulfilling the marriage contract. As early as 1654 a divorce was granted on this ground because the wife was a reputed hermaphrodite.

In **doubtful paternity** the question arises, Can an hermaphrodite beget children? The rights of citizenship and voting may be founded on the matter of sex; a charge of rape may set up the defence of doubtful sex. Thus the question of hermaphrodism resolves itself practically into three subordinate questions:

1. Has this individual the "shape of mankind"?
2. Is it male or female, or a mingling of both sexes?
3. If male or female, is it capable of procreating its kind?

The second of these questions is the one of most immediate concern. The ancients considered these things as monsters and entertained a cruel prejudice against them. This is reflected in their laws and historical writings. Diodorus says that the Romans and Athenians burned them soon after birth if the sex was a matter of doubt. According to an early Roman law, every child of this description was to be put into a box and thrown into the sea. Livy gives an instance in which a child was thus disposed of on the occasion of doubt as to its sex: "Tanquam fœdum et turpe prodigium." The canon law forbade the promotion of hermaphrodites to holy orders; nor could they be made judges. They were ranked with "infamous persons to whom the gates of dignity should not be opened." An old French law enacted that an hermaphrodite should choose one sex and keep to it irrevocably in all matters of behavior. A Hindoo legal provision is to the effect, that the inheritance of an only son being, by their law, the entirety of an estate, and that of an only daughter being half, the proper portion of an hermaphrodite should be half of one and half of the other, or three-fourths of the inheritance. But all these legal limitations and prohibitions, some of them more monstrous than the subjects or human

beings to which they refer, have faded before the advance of science and of scientific methods of investigation. We have just as many and just as great deviations from the normal type as ever, but these may all be referred to distinct and well-recognized classes of malformations.

The Embryology of Hermaphrodites.—Anatomists tell us that early in the development of the fetus the cloaca divides, the posterior portion becoming the outlet of the alimentary canal, and the anterior division being the genital division or fissure. In the female the anterior fissure remains fissured, and constitutes the labia majora. In the male, coalescence takes place, and the scrotum is thus formed to receive the testicles. From the front of the fissure a bud-like projection with a furrow is formed; this is the penis in the male, and the clitoris in the female. About the fourteenth week of fetal growth the sides of this furrow close in, in the male, to make the urethra; in the female the inferior surface simply remains grooved, the non-coalescing margins forming the labia minora. Occasionally, in the female, canals have been found post mortem, passing from an ovary to an enlarged clitoris. This was the analogue of the male vasa deferentia. These canals are persistent Wolffian ducts, present in the embryos of both male and female, but physiologically belonging to the male.

On the other hand, one sometimes finds in the male cadaver an enlargement or growth resembling the womb and occupying the position of the sinus pocularis in the prostatic portion of the urethra. This is the result of abnormally developed Müllerian ducts, embryonic structures, destined normally to become the vagina, the uterus, and the Fallopian tubes of the female, but in the male to shrink into mere rudimentary remnants of embryonic life. Thus it appears that in many aspects males and females are alike at the start—they both have Wolffian and Müllerian canals and a divided cloaca. The sex in after-life depends on the turn that takes place as development proceeds; and abnormal types are determined by aberrations in the course of this development. And if, in any case, we can ascertain exactly the nature of the genital gland, whether it is a testicle or an ovary, wherever it is situated— that fact determines for us the sex of the individual. This is the ultimate and controlling anatomic proof to which we appeal.

Following the teaching of some of the latest and best authorities on this subject of hermaphrodism, we shall consider these imperfect beings (imperfect from defect of development on the one hand, and excess of parts on the other) under *two* specific classes:

1. Pseudo or *spurious* hermaphrodites—in whom the genital organs and the general sexual conformation of one sex simulate, from imperfect or abnormal development, those of the opposite sex.

2. *True* hermaphrodites—in whom in the body of the same individual, more or less of the sexual organs and distinctive characters actually coexist.

Concerning the former class, there is no controversy as to the question of their existence. Concerning the latter, there is some disposition to dispute the propriety of the title "true," because it involves questions of function as well as structure. Thus, Brouardel says that a genuine hermaphrodite is a myth. Hermaphrodism, so far as it relates to the internal sexual organs, has been found, but its coexistence with the external attributes of *both* sexes is, he says, impossible. Internally, by parallelism of development, we may find coincident formation of a rudimentary ovary and testicle in the same body. But externally we can not have at once, in the same person, both closure and non-closure of the genital cleft of the cloaca ; there can not be at once a true scrotum and true labia minora. Complete hermaphrodism can not, therefore, exist, according to Brouardel.

Spurious Hermaphrodism in Males (Androgyni or Woman-like Men).—Concerning this class, we find the following illustrations. The diagnosis is generally more obscure than in the analogous class of women—the so-called androgynæ :

1. **Exstrophy of the Bladder.**—This is easy of recognition generally ; it is of more consequence in the study of impotence. In these cases the anterior wall of the bladder and the abdomen is lacking ; the ureters open externally, and a disgusting leakage of urine results ; the urethra is lacking, or is a mere furrow ; the penis is rudimentary ; the testes are present.

2. **Congenital Adhesion of the Penis to the Scrotum.**—The parents of a child so formed might be deceived, and the error is made more easy by the deviation of the stream of urine. Cases are related by Livy, Montaigne, Ambroise Paré, and others. Christopher[1] reports the instance of a child of thirteen months, in whom the penis was rudimentary and bound to the scrotum in the median line ; no testicles were found ; a punctiform meatus was located a quarter of an inch behind the glans ; the urine passed easily.

3. **Immaturity of the Sexual Organs.**—There are many cases

[1] Sajous, *Annual of the Universal Medical Sciences*, 1889, vol. v., sect. F., p. 30.

of delayed puberty and adolescence, and the subjects are vul-
garly called hermaphrodites, but without reason. In these
persons there is nothing wrong anatomically; there is simply
a lack of normal development correlative with age. The geni-
tals are small; there is no pubic hair; the voice is a high tenor;
the skin and muscles are soft; the manner is nervous and
effeminate; and the sexual desires are latent. To a medical
man such a case presents no difficulty.

4. **Non-descent of the Testes.**—This defect may cause an
effeminate manner. Castration in early life has similar results.
The Turkish method of making eunuchs by a clean, sweeping
removal of all the genital organs might suggest a doubt on
superficial examination.

5. **Hypospadia.**—This is a much more common form of ab-
normality than those previously described. It depends on an
unusual opening of the urethra, the meatus being behind its
normal place in the glans, and being carried more or less near
to the bladder on the inferior surface of the penis. When the
meatus is near the glans, the deformity, of course, is slight
and the diagnosis is easy. It is only the *extreme* cases which
can give rise to doubt as to the sex of the individual. In these
extreme cases the orifice is far back of, near, or in the peri-
neum. It is not a mere foramen, but a fissure of some length,
thus resembling the vaginal outlet. The scrotum is cleft, like
the labia; the penis is small, imperforate, and like the clitoris.
Sometimes, the skin lining the cleft is thin and red, like the
vulva. If the testicles have not descended, doubt is still
greater.

Dupuytren[1] gives an instance of a person with hypospadia
who had been married fifteen or twenty years, and all this time
had been regarded as a female. Sexual intercourse had been
regularly effected by the urethra, and it was not until the
period mentioned that it was discovered that the individual
was a *man.*

St. Hilaire mentions a similar case: an individual called
Adelaide Preville lived for a long time with a man as a
husband.

Ogston[2] relates that an individual was exhibited in Aberdeen
several years ago, in whom the scrotum was cleft; the testicles
were present; and the urethral fissure was lined with mucous
membrane of a red color. This fissure admitted one or two
fingers for a distance of half an inch. The penis was small,
the glans was imperforate, and the body was masculine.

An abnormal individual, assuming the name of Duplex de

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[1] *Leçons orales.*   [2] *Lectures on Medical Jurisprudence,* p. 52.

Balzac, gave exhibitions in 1885 to favored persons in various cities of the United States. The clothing, voice, hair, and manner were those of a female; there was no beard; the age was twenty-three. Among other female characteristics, the neck, upper arms, breasts, and thighs were distinctive. *Male* peculiarities were observed in the forearms and hands; the presence of hair on the forearms; the size of the waist and of the legs and feet were also noted. The *genitals* showed either a small penis or a large clitoris; either a cleft scrotum or full labia; no indurated body was felt in either side; no exploration

FIG. 8.—Perineal hypospadia (Curtis).

of the cavities was allowed; menstruation was denied; sexual desire with regard to both sexes was asserted.

Now, the *male* sex is to be determined in *these* cases by the presence of testicles in the scrotal fold or in the groin; by communication of the opening in an imperforate penis in the perineum, or with the bladder; by the absence of any organ suggesting the uterus; and by the absence of menstruation. The conformation of the body, the tone of the voice, and the tastes and habit correspond.

Spurious Female Hermaphrodism (Androgynæ).— Two abnormalities of the sexual organs give rise to this class

of cases. Both occasion doubt through resemblance to the penis:

1. **Unnaturally Enlarged Clitoris.**—This may come from natural causes or it may arise from climatic conditions. In tropical countries it is habitually larger. In some tribes (travellers say) enlargement is the rule, and establishes for that locality a normal type. Most commonly it is caused in temperate climates by masturbation.

Sir Everard Home[1] reports the case of a negress, twenty-four years old, in whom the breasts were flat, the voice rough, and the face masculine. The clitoris was two inches long and
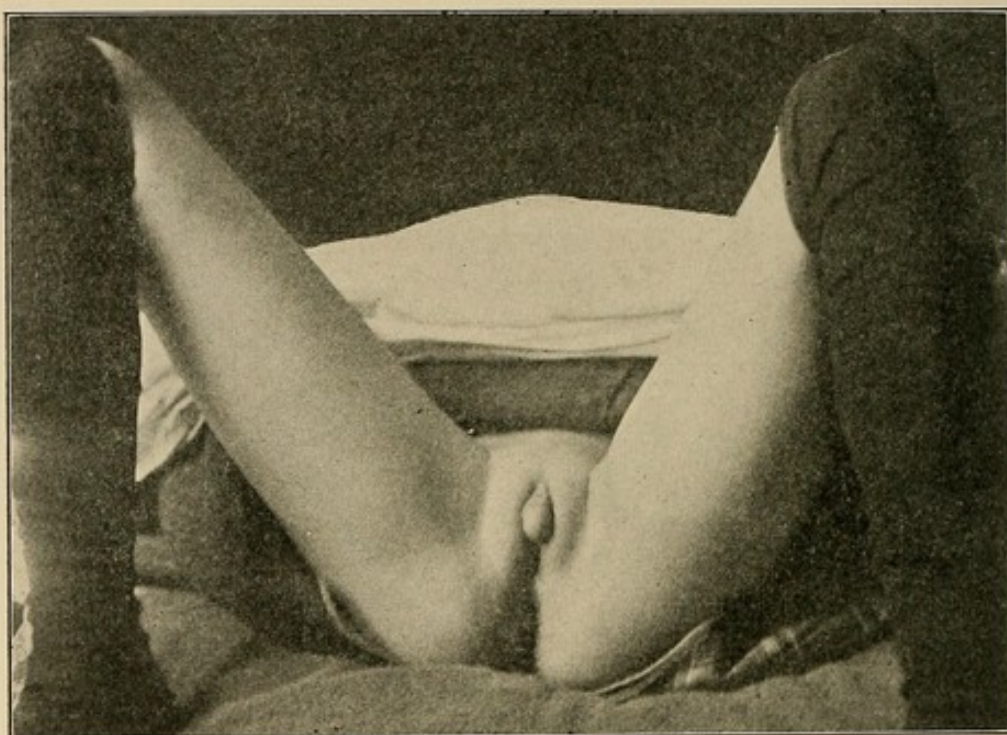

FIG. 9.—Hypertrophy of the clitoris (Hirst).

as large as a thumb. On close inspection it was found to be without urethra or prepuce, and it was more pointed than a penis; it was lifted for purposes of urination. Manipulation caused engorgement. The other genital organs were all normal.

Beck[2] cites the following case: In 1814, an individual, calling herself Mary Madeline Lefort, exhibited herself in Paris and London as an hermaphrodite. She was examined by a committee of the French Faculty of Medicine. The mammæ were developed and their areolæ were distinct; the upper lip and chin were covered with a beard; the clitoris resembled a

[1] Beck, *Medical Jurisprudence*, i., p. 176.　　　[2] *Loc. cit.*, i., p. 177.

small penis and was an inch and a half long, with a prepuce; the glans was imperforate; at its root was an opening for urine and menses; a thick membrane closed the ostium vaginæ. Parent Duchatelet mentions a case in which the clitoris of a prostitute was three inches long and of the thickness of the ring finger.

2. A **prolapsed uterus** would hardly seem capable of giving rise to doubt as to sexual distinctions; certainly not in these days. Yet such a dilemma has occurred. Beck[1] relates the case of Margaret Malaure, who came to Paris in 1693, dressed as a man. She considered herself as possessing the organs of
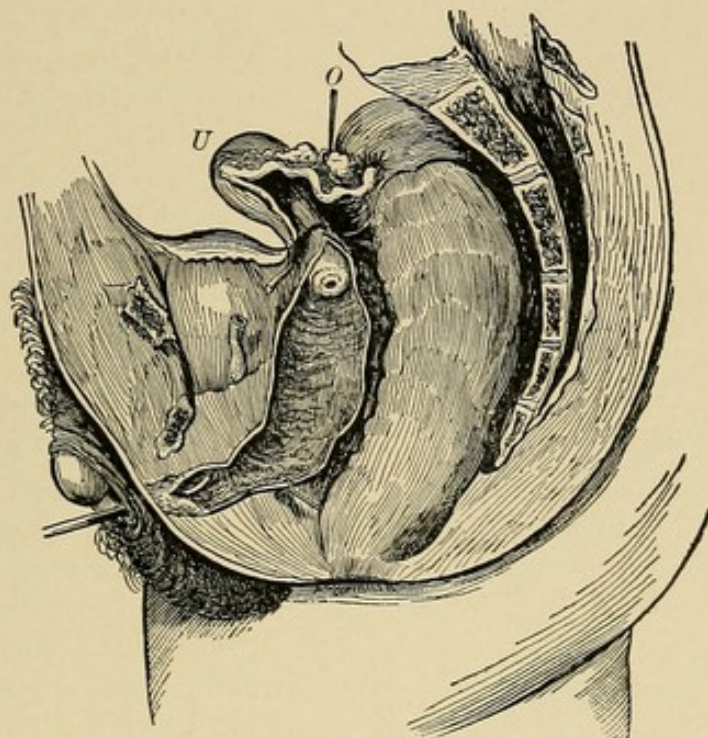

Fig. 16.—Mesial section showing the generative organs of Marie-Madeline Lefort. The sound is introduced into the vagina, and thence into the orifice of the urethra; *U*, the uterus; *O*, the ovary and Fallopian tube (Gould and Pyle).

both sexes, and stated that she was endowed with double functions, male and female. Her genitals were examined by able physicians and surgeons, and several gave a certificate to the effect that Margaret was an hermaphrodite. Saviard, however, an eminent surgeon, was incredulous; he examined her and diagnosticated procidentia uteri; he reduced the organ and exposed the fraud.

Sir Everard Home mentions a similar case, in which the woman, it is stated, made two thousand dollars in a few weeks by exhibiting a prolapsed womb. She pretended to be a male

[1] *Loc. cit.*, i., p. 177.

of extraordinary formation, not that she had double functions.

Such are some of the instances of **spurious hermaphrodism.** It is a condition fully recognized by medical authorities, and one about which there is no dispute.

As to the other general variety called **true hermaphrodism,** there is not the same unanimity. If, however, the designation is limited to *structural* relations and does not include function; if it implies that the same individual may present in his or her body genital organs and some of the distinctive sexual characteristics of both male and female, without any implication of the coexistence of *functional* powers of both, there will be few to object to the term. It is never pretended nowadays that a true hermaphrodite, a being capable of self-impregnation, of begetting and bearing children by means of a compound apparatus, is to be thought of as for a moment possible. But there are many recorded illustrations of the coexistence of essential generative organs in the same person, with some aptitude for partial complex sexual relations, and to these the majority of medical jurists agree in applying the name "real," "genuine," or "true hermaphrodism," in distinction from the class just considered. Without stopping, then, to quarrel with the name, or to indulge in embryologic speculations as to the way in which these abnormal deviations come in the course of fetal life, we confine our attention to the usual forms in which these deviations occur. Even in this direction we shall find the subject somewhat limited in its medicolegal importance; for it is obvious that the medical man in establishing the question of sex in a disputed case will generally have his attention
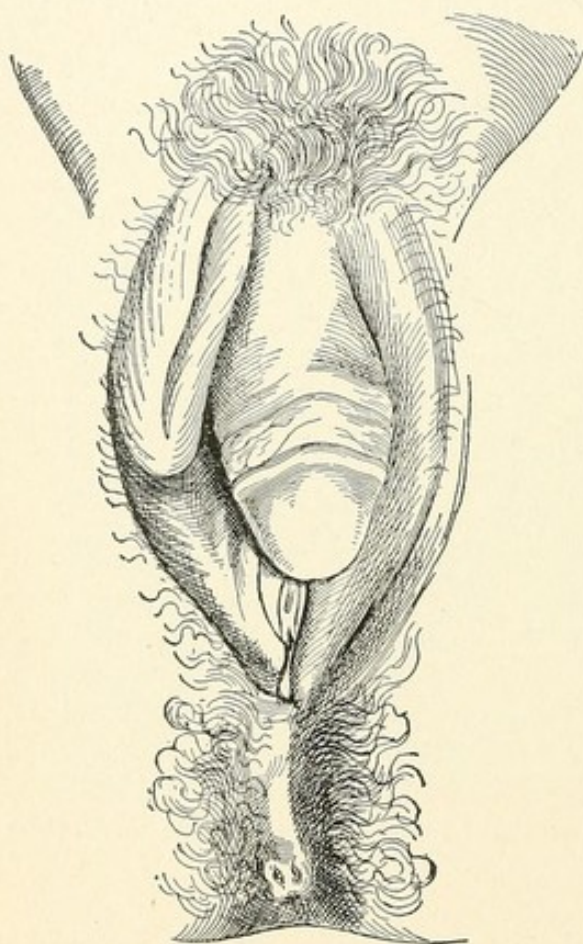
FIG. 11.—Feminine pseudohermaphrodism : the right labium contained an ovary (Fehling).

directed to the living individual, in whom only the *external* parts are available for examination, so that some of the forms and varieties of true hermaphrodism recognized by the authorities really come outside of his jurisdiction, as we shall presently see. Moreover, it is difficult, if not impossible, to assign all cases that may occur to one or another of the classes which Simpson and others have established. There are many cases of a mixed character in which the type is not apparent, and in which the determination of the sex is very difficult and requires exhaustive investigation and a judicial balancing of probabilities.

The **first** variety is called *lateral*. On one side of the median line is the testicle with its appendages; on the other side are an ovary and its belongings. The ovary is most frequently on the **left** side. In such cases there is usually an imperfectly developed uterus. The external parts and conformation differ—sometimes the male and sometimes the female predominating. Sometimes, again, they are mixed or indeterminate, as will be illustrated by the following cases:

Levi Suydam [1] lived, in 1843, in Salisbury, Connecticut. A hot election campaign was on and every voter was wanted. Suydam had passed for a man, without a question; he was twenty-three years old. An examination was made by Dr. Barry to settle the question of sex before Suydam could take the initial steps of citizenship. The external genitals only were inspected. Barry found a mons veneris; an imperforate penis, two inches and a half long; a glans and prepuce; an imperfect scrotum half the usual size; in the right side a *testicle* of the size of a filbert, and a spermatic cord leading from it; micturition was through a hole in the perineum. The penis and testicle satisfied Barry, and he so reported. At election Suydam was challenged, and another examination was made by Dr. Ticknor with Barry. Both agreed that Suydam was a man. Later, it leaked out that Suydam had menstruated for years, regularly but scantily. He was then re-examined, for the first time thoroughly, in the nude, and a complete feminine figure was found. Breasts were present; there were full hips; a perineal opening led into a vagina (*not* bladder) three-fourths of an inch deep. Inclination for the male sex was observed; also a fondness for dress.

In another case [2] the individual, a German fifty-two years old, exhibited herself as a woman. The breasts and upper part of the trunk were feminine. The generative organs were mixed in character. The right side was male; in the center

[1] Taylor, *Principles and Practice of Medical Jurisprudence*, ii., p. 279.
[2] *Lancet*, August 22, 1874.

was a rudimentary penis with a furrowed glans; the urethra opened at the base of the penis in a scrotal slit; the prepuce was large and loose, simulating nymphæ. On the right side a testicle was in the scrotum; none was found on the left side. The whole scrotum resembled labia majora. A finger introduced into the cleft under the penis found a cavity like a vagina, but ending in a cul-de-sac. A catheter entered at the meatus came against a body having a resisting feeling like a uterus. When directed upward, the catheter entered the bladder. Menstruation through the meatus had been regular up to the forty-fourth year. Spermatozoa were found in a discharge from the penis. The propensities of both sexes were thus suggested. The voice was masculine, and the chin had some beard and was regularly shaved. Formerly the individual was known as Catherine Hohman and had dressed as a woman; later in life male attire was used.

The **second** variety of true hermaphrodism is called *transverse*, with the internal organs of one sex and the external organs of the other sex. External organs are those which have a common integument, mucous or dermal. The uterus and vagina as well as the vulva are thus external. The testicles, though more exposed, are internal. It is readily seen that, to the medical jurist, cases of this kind are of remote consequence so far as the living subject is concerned. Nothing short of a dissection would enable one to decide the sex in such cases with authority; shrewd guessing only is available otherwise as to the character of a body (testes) in the groin and labia.

Kiwisch and Kölliker[1] report the following case: The individual died at the age of thirty-three. The external generative organs were a perfectly normal penis with a rugose but empty scrotum. The uterus was perfect and somewhat longer than usual, but in its normal position. The vagina was rudimentary and opened into the prostatic portion of the urethra. The Fallopian tubes were three and three-quarters inches in length, with imperfectly developed fimbriæ. The round ligaments were normal. In place of ovaries were found testes, each with epididymis and an efferent duct which led to the inguinal ring and, turning to the uterus, followed its sides, and finally opened into the prostate, which was of normal size and had vesiculæ seminales on either side.

The **third** variety of true hermaphrodism is called *vertical* or *double*. Such cases are rare to the last degree. They belong rather in the province of the pathologist than in that

[1] Wharton and Stillé, ii., p. 158; or Ackermann-Beck, i., p. 168.

of the medical jurist. Their diagnosis can be guessed during the life of the subject, but not demonstrated.

Ceccherelli[1] gives the following good illustrative case: The subject was fourteen years old and, on examination, presented well-developed mammæ; the penis was hypospadic; the scrotum was divided and contained one testicle. Between the folds of the cleft scrotum or labia the neck of the uterus could be felt. The female pelvic organs appeared to be complete. Menstruation had occurred regularly from the twelfth year, and the individual had had intercourse as a woman. From the opening of the penis semen was ejected, and spermatozoa were found by Virchow in this fluid.

Finally, there are some cases so complex, so mixed in character, that they would puzzle the most expert examiner to assign them to *any* class, or, indeed, so to interpret appearances that the question of sex could be absolutely determined. They may be called of the neuter gender.

The study of this subject of doubtful sex may best be concluded by quoting the following rules for the medical investigation of cases of this sort. These rules are given by Marc in his article on "Hermaphroditism," in the *Dictionnaire des sciences médicales*, and are approved by Orfila:

1. "The examination of *all* the external organs of generation must be performed with exactitude and caution. Every opening is to be sounded to ascertain its depth and direction, taking care not to use force.

2. "The inspection of the whole surface of the body is no less essential, with a view to determine the prevailing characteristics. We should also strive to make ourselves acquainted with the tastes, habits, and propensities of the individual under examination. This, however, will require time, and care must be taken not to confound the habits which may have originated in the artificial position assumed by the individual with those which took their origin in organic structure and development.

3. "Ascertain whether from any opening, especially any opening about the genital parts, there is any periodical sexual discharge—a circumstance of great importance, and one which will of itself *almost* decide as to the femininity of the person.

4. "When the individual examined is *very young*—a newborn child, for example—nothing is worse than precipitation. We must avoid haste above all things. Perhaps the most we can do, or ought to do, in the first instance, is to give a formal notice of the dubious nature of the case, and to take time,

[1] *Lo Sperimentale*, 1874.

years if need be, in order to be able to observe the progressive development of the physical and moral characteristics.

5. "Lastly, no attention should be paid to the declarations of the individual examined, or to those of his relatives and friends; at all events, if received, they should be carefully weighed in order that a correct judgment be formed as to the motives dictating them."

It will be useful also to bear in mind, in this connection, some or all of the following summary observations which Woodman and Tidy set forth:[1]

1. "An analysis of recorded cases shows that, in infants, the probabilities are greatly in favor of the *male* sex in doubtful cases. And there are obvious reasons which urge the rearing of the child in the ways of a male rather than in those of a female in cases of question.

2. "In adults regard should be had to general anatomic peculiarities aside from the genital organs, the endeavor being made to ascertain sexual peculiarities of structure.

3. "If a body of small size and unknown character is felt in one labium or in half of a cleft scrotum, Virchow's statement may be usefully recalled—that the ovary, being largely composed of a fibrous stroma, is harder than the *testicles*.

4. "As regards the mammæ, the development of the gland or nipple is of more importance than mere size due to adipose growth."

Tidy[2] concludes his discussion of hermaphrodism with these propositions:

1. "Given the presence of testicles, or of *a* testicle—wherever they or it is placed—and of a single opening communicating with the bladder and *not* with the uterus, more particularly if there are seminal emissions containing spermatozoa, and an absence of periodical hemorrhages, the individual in question is to be accounted as belonging to the male sex, and that independently altogether of anatomic malformations, such as the presence of an imperforate penis, or the existence of feminine configurations and instincts.

2. "Given the presence of ovaries, or of an ovary, more particularly if there are periodic hemorrhages, the individual in question is to be accounted a female; and that independently altogether of anatomic formation.

3. "Given the presence of glands which may be either ovaries or testicles—and the precise nature of which there is a difficulty of deciding—or, given the absence of both ovaries and testicles, together with, in either case, the absence of semi-

[1] *Forensic Medicine*, p. 678.   [2] *Legal Medicine*, p. 333.

nal emissions and periodic hemorrhages, then the presence of a uterus and a second opening below and distinct from the opening to the bladder must be sought for. If a uterus or a second opening of the nature described is found, the individual is to be accounted a female, and that independently of anatomic malformations, or of male configurations or instincts. *But*, if *per contra*, there should be *no* uterus and *no* second opening below and distinct from the opening to the bladder, then the *male* sex is strongly indicated.

4. "When the anatomic conditions are so evenly balanced that neither sex seems to prevail, the existence of periodic hemorrhages is to be regarded as strongly indicative of the sex being female; while on the other hand, the occurrence of emissions is strongly indicative of the sex being male; and if spermatozoa should be detected in such emissions, the proof of the *male* sex is complete.

5. "The sexual inclinations, habits, and tastes, and the general conformation of the body should in all cases be considered. If they support the conclusions based on the principles laid down in the preceding paragraphs, they may be regarded as valuable confirmatory evidence; but if, on the contrary, they *fail* to confirm, or even appear at variance with such conclusions, they may then be entirely disregarded.

CHAPTER V.

PERSONAL IDENTITY.

IDENTIFICATION of the living, when in doubt, is settled in the majority of cases by the evidence of kindred or acquaintances. If this evidence fails to be conclusive, then medical testimony is sought concerning physiologic conditions and changes which may enlighten the problem. The occasions for such inquiry are various. For example: The reappearance of a person after a long absence or after abduction in infancy, the individual returning in adult life to claim property and rights; suspicion rests on a person that he has committed a crime, and he sets up the defence that there is a mistake in the identity; when false claims are made to the estate and rights of another person; when habitual criminals are re-arrested and it is important to be certain of their true identity; when a person is missing from home and every effort is exerted to find him.

Hardly a day passes in a great city without the necessity for using all available means to establish personal identity in one or the other of these directions. Take the last mentioned, for instance. Think of the great number of missing people who have dropped out of sight of home and kindred and have left no trace. In 1898 the dead body of a woman, greatly mutilated, was found on the flats near a city in a neighboring State. For many days it remained a matter of doubt as to who she was, and before the mystery was cleared up the chief of police of that city received more than three hundred letters of inquiry—ninety-two of them from the parents of missing daughters in that one State alone. What widespread and sore distress such an incident uncovers!

In determining this question, when doubt has arisen in any case, we have to study, in addition to the obvious general considerations as to age, sex, height, and complexion, certain *special* data, such as the presence of defects and physical peculiarities; marks on the skin, congenital or acquired; traces of former disease or injury; and, in the living subject, mental accomplishments, deficiencies, and eccentricities.

Inquiries concerning identity are frequently complicated by

the fact that the great majority of people are untrained in accurate and minute observation. Thus, one part of a family will describe an absent relative as having very dark hair, while others of the same family, with equally good faith, will assert that, when last seen, his hair was brown. They will differ as to his features, his mode of wearing whiskers, and the fashion and color of his clothes.

Sometimes criminals, attempting to escape arrest, or convicts eloping from prison, seek to prevent identification and capture by various means of disguise—not only by change of dress, but by altering their natural clothing ; by removing the hair from surfaces where it was previously growing, or by allowing it to grow where it had hitherto been shaved, or by artificially altering its color. The readiest agent for effecting a change from dark to light, for bleaching the hair, is chlorine. The hair is washed first with ammonia to remove fatty or oily matter, then the chlorine is applied. According to Orfila, 1 part of a strong solution of chlorine in 4 parts of water will change black hair to dark chestnut in two hours. By successive immersions in such a solution the hair will be brought to a bright chestnut, a bright yellow, and, finally, to a yellowish-white color. Devergie made some confirmatory experiments, and found that the time required for bleaching the hair was longer, and consumed from twelve to twenty hours. He found, too, that the decolorization was not uniform, a fact that is of service in detecting the fraud. Discovery is easy, also, by other evidences. The color is unnatural which bleached hair displays, and chlorine leaves a characteristic odor. Hair on other parts of the body is ordinarily left in its normal state in contrast with that on the head. New growth proclaims the deceit also. Besides chlorine, other agents, such as nitric acid, muriatic acid, or hydrogen peroxide are sometimes used.

As for the means of *darkening* the hair, it may be stated, as a rule, that the individuals generally depend on the formation of a metallic sulphide. A common method of changing the hair from light to dark is to use a mixture of lime and oxide of lead in equal parts, or 3 parts of lead oxide to 2 parts of lime, the litharge being sometimes replaced by lead carbonate. This mixture, made into a paste with hot water, is applied to the hair for four or five hours, The lime combines with the fat and the lead with the sulphur of the hair to make a black lead sulphide. Bismuth was at one time used for this purpose. Silver nitrate is also resorted to. Chevallier describes a mixture sold by Parisian dealers as a hair dye, in which 1 part of

silver nitrate is dissolved in 9 parts of water, a solution of the same strength of potassium sulphide being used first.

Detection is Easy.—The general appearance is suspicious, and a solution of nitric acid applied to the hair would decompose the metallic sulphide; and new growth is apparent near the roots. Then, again, hair on other parts of the body than the face or head is normal. There are certain other interesting points relating to the hair and having medicolegal significance. The natural color is a composite of many shades. All hairs of the same head are not uniform in color; the shade taken as a whole is determined by this blending in masses, and care should be taken not to place too much value on the color of single hairs.

Hairs that have never been cut or broken are *tapering* and pointed at their end, Human hairs differ from those of the majority of animals in their being smaller. Animal hairs taper toward their outer end; their medullary cavity is uniform and large; there are alternations in the pigmentation of individual hairs; and the scales of the cuticle of the hair are coarser.

Sometimes Nature plays tricks with the hair, and by omitting to provide pigment for a band or lock leaves an ineffaceable and significant piece of evidence. The author was once connected as a witness with a case in which a woman was accused of killing her newborn child. She denied her connection with the child or its death. The case resolved itself into one of identity, and the fact that, although a young woman, she had a lock of *white* hair in the left frontal part of a head of dark-brown hair had a very prominent place in the evidence.

What Scars are Indelible?—Scars have an important part in determining identity. Taylor[1] gives the case of a man who was tried at the Old Bailey in London, in *1834*, for returning unlawfully to England, after a sentence in *1817* to transportation for life. The man sentenced in 1817 was *Stuart;* the man on trial gave his name as *Stipler*, and several persons swore that Stuart and Stipler were one and the same. Among those who testified was the jailer who had had Stuart in his keeping. But it transpired, according to the testimony of this man, that Stuart had a small tumor or wen on his hand in 1817, so well marked that it entered into the details of his description. The case was going to the jury, and, as it seemed, adversely to the defendant, when it occurred to his advocate to go a little further with the wen matter. To this end, he called to the witness-stand a surgeon who was in court, a Mr. Carpue, who testified that it was impossible to remove such a

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[1] *Principles and Practice of Medical Jurisprudence*, i., p. 624.

growth as had been described without leaving a visible cicatrix. Both hands of the prisoner were then examined, but no wen or any mark indicating a surgical operation was found, and the prisoner was acquitted.

Was this testimony correct? Casper has formulated our knowledge on this subject as follows: Scars occasioned by actual loss of substance or by any wound healed by granulation never disappear. That is to say, any lesion which involves loss of the tissue of the true skin leaves in its healing an indelible scar.

Besides the indelible character of scars under certain conditions, other questions arise concerning them: How accurately can the period at which a wound was inflicted be inferred from the appearance presented by a scar? To what degree can the nature and size of a wound be inferred from the size and shape of a cicatrix? Of course, when *no* scar is in evidence, the medical witness will be safe in testifying that no wound of importance was at any time inflicted. But when a scar *is* exhibited, these and other similar inquiries arise.

As to the age of scars, it is always a difficult and frequently an unanswerable inquiry. A wound in healing passes through three stages to the final cicatrix:

1. A recent scar is tender, soft, and pink.

2. After one or two months it is harder, no longer tender, and becomes brownish-white.

3. Finally, it becomes hard and thick, white and shiny; thenceforward it undergoes little change, except to tend toward a linear shape.

A scar of this last variety, then, hard, white, glistening, and non-sensitive, although it does not permit the observer to say affirmatively how old it is, whether six years or six months, does permit the *negative* statement that the wound which it represents was *not* received within the previous month; while a scar of the first variety, tender, soft, and pink, enables us to say confidently that it is a *recent* formation, but beyond that it is impossible to be exact.

How far can the nature of a wound be inferred from the cicatrix? In a general way, it may be said that cicatrices afford only an approximate index of the wound which formed them, and that as much or more depends on the structure of the part wounded than on the character of the wound. Straight incised wounds leave a rectilinear scar, more or less wide at the center if the skin wounded was tense, or if healing was not by first intention. Oblique incised wounds leave a semilunar scar. A stab leaves a triangular scar, commonly; bullet-wound scars

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are much depressed, with irregular edges—with tattoo-marks of unexploded powder-grains around the entrance wound; the wound of exit is generally larger and more irregular than the wound of entrance.

Flogging is shown by faint white lines extending between little circular pits made by knots. Venesection leaves white linear cicatrices in the direction of the vein. Cupping is declared by a regular series of parallel, small, white, symmetric scars. Blisters leave no scars. Vaccination is known by irregular, flat, depressed, cribriform, honeycombed scars. Syphilitic and scrofulous ulcers are very irregular, depressed white cicatrices.

The cicatrix of a wound in an adult is smaller than the wound which caused it; in a growing child it is larger. Scars of wounds involving loss of the true skin, though they may be indelible, may yet become obscured by lapse of time and other conditions, such as growing stoutness, for example. They are brought to view by friction or cold. The tissue of a scar is dense, white, and fibrous. There is no true derma with vessels or hair-follicles; hence, rubbing makes the surrounding skin red, leaving this part white.

Tattoo-marks.—In close relation with the subject of scars is the question whether tattoo-marks are indelible. Uninterfered with they are indelible, if well made in the first place. Much depends on the agent used for coloring. Cinnabar, vermilion, blue ink, and black ink disappear with comparative readiness; while China ink, India ink, indigo, soot, and gunpowder, well pricked in, are indelible.

Sometimes a portion, or indeed the whole of the pigment, appears to have vanished; under such circumstances the coloring-matter may still be found in adjacent lymphatic glands.

Can tattoo-marks, once established, be *artificially* obliterated? Tardieu reports the case of a man in a French prison, who, in six days, removed some marks from his skin for the purpose of raising a question as to his identity if occasion should arise. He first applied a paste of pure *acetic acid and lard* to the colored part; he then rubbed it with *potash*, and finally with *hydrochloric acid*. A crust fell off at the end of the operation, leaving no trace of the tattoo, but, instead, a white area with an ill-defined outline. Of course, if an eschar is formed, the cicatrix of the operation is indelible.

Variot, a French medicolegal writer, recently proposed another method of removing tattoo-marks and, as he claims, without leaving a scar. He pricked in a *concentrated solution of tannic acid* all over the design; then rubbed *silver nitrate*

over the same surface. An eschar was formed, but it is represented as a superficial one, leaving no permanent trace.

Ohmann-Dumesnil, of St. Louis, devised the following method: The region of skin showing the tattooed design is thoroughly washed with soap and water; then a bunch of from six to ten fine cambric needles, secured with silk thread, is dipped in glycerole of papoid. The needles so charged are driven with a sharp blow into the tattooed design. This is repeated until the entire design has received this obliterating tattooing. It is of consequence to force the needles quite deeply in order to get results. The rationale of the method is stated thus: The digestive principle of the papoid is disseminated about the deposit of pigment, liberating it from the tissues. A portion is absorbed by the lymphatics, and another part finds its way to the upper layers of the epidermis and so to the surface. There is no swelling or inflammatory action.

Congenital marks and anomalies comprise another class of useful data for the determination of personal identity in the *living* subject. There can hardly be any fallacy of the memory touching the variety, form, and location of these appearances, and they differ from cicatrices in that they can not be artificially produced or imitated. If they are removed by surgical art, they leave a scar which, involving, as it must, the deeper dermal layers, must be indelible. Among these appearances on the skin, having a congenital origin, we may enumerate: moles, nevi, port-wine marks, and certain examples of ichthyosis and of scleroderma. Certain pigmentary freaks, like the "leopard children," should also be mentioned.

The case of the girl Salome Müller, as related at length by Beck and made romantic by the literary skill of Cable, is an illustration.[1] This girl was brought from Germany to Louisiana in her infancy. Both her parents died and by some mishap or fraud the child was sold as a slave. Twenty years later, the likeness of the girl to her parents attracted the notice of some of her fellow immigrants by accident; but it was at first found to be impossible to trace her identity through her varied career from infancy. She was induced, however, to sue for her freedom, and her identity was established mainly by the presence on the thighs of two moles of about the size of coffee beans. These were proved to have existed in the same location in the baby immigrant, and they were allowed, after tedious litigation, to establish her claims to her freedom.

Foderé relates an instance in which a man named Baronet returned to his native village, after twenty-two years' absence,

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[1] *Century Magazine*, May, 1889.

to reclaim his property from the fraudulent possession of a spendthrift sister. She denied his identity and had him sent to the galleys as an impostor. After two years of misery, he procured a new trial, and Louis was commissioned to examine the question of his identity. Here, again, the presence of a nevus on the thigh had great weight in the decision of the question.

If a missing individual had among the items of his description certain physical defects or deformities still more pronounced than these congenital marks, they naturally would be of the greatest service in determining his identity. Lameness from hip disease; ankylosis from old disease of a joint; angular curvature of the spine; clubfoot; harelip or the scars of a plastic operation to cure it; albinism;—all these, it is hardly necessary to remark, would need no medical interpreter to make them valuable.

The subject of the character of the impression left by the human foot, either naked or shod, on various surfaces, has received much attention among Continental observers. This is really a police question, but occasionally it becomes a medicolegal one. It is a very general popular idea that the print of the foot is always of the same size as the foot which made it. It is pretty well established, however, that the foot and its print in soft earth or other impressible material do not accurately correspond, and that sometimes the one is smaller and sometimes larger than the other.

Many ingenious plans have been proposed for taking a permanent *record*, as it were, of the footprints for future comparison with the shoes or other foot-clothing of a suspected criminal. The most ingenious of these methods is that proposed by M. Hougolin. It consists in heating earth to a temperature of 220° F. over incandescent charcoal in a warming-pan, and with stearic acid making a cast for a mould.[1] The same author suggests that footprints in the *snow* may be preserved by sprinkling the track with salt to intensify the coldness, then filling the track with gelatin melted just so that it will flow. Thus a cast may be obtained.

Although footprints are subject to some limitations with regard to their identification, they may nevertheless be useful in showing the kind of shoe worn; the sort of nails used; the arrangement of the nails; and the wear of the shoe, whether on the side of the heel, or on the sole.

Polydactylism, hypospadia, and other such peculiarities are frequently transmitted through several generations, and may

[1] Ogston, *Lectures on Medical Jurisprudence*, p. 62.

serve to aid in establishing identity. The rare circumstance of *one iris* having a different tint from the other proved to be of importance in a case of disputed identity. *Wens* and *warts* have also been made useful as evidence.

Galton has stated the ingenious proposition that the papillary ridges in the skin at the bulbs of the fingers afford a good means of personal identification. These ridges, in their arrangement, differ in individuals to such an extent that each one may be said to carry his identity at his finger-tips. Moreover, in general character and in minute structure they are *unchangeable* from youth up. If then, at any time, one takes an impression of the finger-bulbs on paper properly prepared, that record will be of permanent utility, according to Galton, no matter how the person may change in other ways. The main utility of this is in the identification of habitual criminals.

| Thumb. | Index-finger. | Middle finger. | Ring finger. | Little finger. |

FIG. 12.—Finger-prints from one hand, showing five distinct patterns (Ewing).

In course of transit between New York and New Orleans a packet of paper money had been opened and its contents considerably reduced. Two of the seals had been broken and one had been resealed by thumb pressure. Mr. Carvalho, an expert in matters of identification, endeavored to find out the thief, and, with this view, obtained wax impressions of the thumbs of all the officials of the express company through whose hands the packet was known to have passed. The impressions were photographed and enlarged, and one of them clearly agreed with an enlarged photograph of the thumb-impressed seal. The thief was thus detected.

Habitual criminals are also identified by recorded and accurately detailed measurements, according to the Bertillon method.

Occupation leaves its impress on the physique and often aids in establishing identity. The tailor, the shoemaker, the

coal-heaver, the sailor, and the photographer, all have distinguishing marks.   Laundry women, dressmakers' fingers showing needle punctures, drivers' fingers, violinists' fingers with a callus at the tips, and tanners with the stains of their trade, illustrate the same fact.

Sometimes the hair shows chemical changes resulting from exposure to certain atmospheric conditions.   The blue hair of workers in cobalt mines and indigo factories, the green hair of copper-smelters, and the deep red-brown hair of handlers of crude anilin afford examples.

The literature of forensic medicine gives many illustrations of the importance of small matters in deciding identity.   Thus, in Sir Astley Cooper's case of left-handed homicide, referred to in the first chapter, the prisoner stoutly protested that he was not left-handed.   But when he was called on in court to hold up his **right** hand to take an oath, he unconsciously raised his **left** hand.   In another case, a thief whose teeth were defective was made to bite an apple, and the impression left was identical with that on an apple found at the scene of the crime.

Identification of the Dead.—There is, unfortunately, a not infrequent necessity of clearing away doubts as to personal identity in cases of individuals found dead away from home, the victims of homicide, suicide, accident, or sudden death.   As there is no limit to the time at which such identification may be required, so there is no occasion when the medical jurist, if he has an official relation to these cases, can decline an investigation on the plea that it is unnecessary and probably fruitless.   The subject may be considered profitably under four heads :

1. Identification of the recently dead, before putrefaction has begun.

2. Identification after decomposition, but before the soft parts have disappeared.

3. Identification of mutilated human remains.

4. Identification of the human skeleton.

With reference to the first of these classes, it is obvious that most of the measures available for recognition of the living can be used in identifying the recently dead.   The dress, scars, tattoo-marks, congenital defects, peculiar marks, and the effects of disease or injury, all these, in addition or in confirmation of the recognition of the features, are, of course, of great assistance.   It is scarcely necessary, however, to remind the reader that these latter aids (the features) undergo marked and rapid changes, wrought by death simply, and before putre-

faction has begun. No one familiar with the aspect of dead bodies will deny these changes—they are often very striking. But even in the presence of such difficulties we are often aided by what seem to be *trifles*. In the author's experience some curious instances have occurred. A woman was found drowned. Her body was taken to the mortuary, and among the items of her description was a belladonna plaster on her back with the mystic and unintelligible characters "G—14" on it. A little detective work traced the woman to Ward G, bed 14, in Boston City Hospital, and quickly discovered her identity. In another case, a man's shoes were found tied with different colored strings, and this fact being published led to his recognition by his kindred, who had missed him for several days. Another unidentified victim of accident was traced by means of the buttons on his trousers, which bore the stamped impress of the tailoring firm with whom he had traded.

The Hair in Identification.—In criminal jurisprudence the hair has often assumed very great importance in the study of identity of the dead in homicide cases. For example, hairs found on weapons used in homicide; on fragments of skull bones; on remains erroneously supposed to be human; clutched in the hand of the deceased; on a prisoner's clothes; all these may require careful microscopical research to identify them.

The value of microscopic evidence relating to hair is well illustrated in a case that occurred many years ago in Norwich, England[1]: A little girl, nine years old, was found dead in a field. There was a gash in her throat, and suspicion fell on the mother, who was arrested. It was observed that she was very cool. She stated that she had been out with her little girl near where the body was found, and had been separated while looking for flowers. She denied all knowledge of the manner of the child's death. A long sharp knife was found in her possession, and this was examined carefully and nothing was found on it, except a few small hairs adhering to the handle and scarcely to be seen. When her attention was called to this hair, she said at once: "Yes, I dare say there is hair on the knife, and very likely blood, for as I came along home I found a rabbit caught in a snare, and I cut its throat with my knife." The knife was sent to an expert in microscopy to determine the origin of the hairs and their identity. Without any knowledge of the facts, he said that the hairs were from a squirrel. And they corresponded with those of the *squirrel* fur victorina tippet on the child's neck. The woman confessed her guilt.

[1] Wharton and Stillé, *Medical Jurisprudence*, section 768.

At the Gilbert trial in Boston for murder, June, 1895, the identity of certain hairs assumed some importance with reference to a weapon supposed to have been used. A little girl had been the subject of lustful manipulations by Gilbert, and as she was successful in preventing him from the full accomplishment of his purpose, he lost control of himself and killed her by repeated blows on her head. An *axe* was found on the premises. Caught in the crevice where the wood of the handle projected through the eye of the blade were five short, fine hairs of a light color. These were accurately observed under the microscope, their anatomic structure was studied, and at the trial the testimony was that those five hairs corresponded in color, in diameter, in the medullary canal, and in pigmentation with hairs taken from the girl's head for purposes of comparison. These observations served to establish the connection of the axe with the homicide.

Incidentally in identification the question may arise whether the *hair* or *beard grows* after death. Authorities differ somewhat, but the weight of authority favors the view that the hair, including the beard, *ceases* to grow at death. Haller explains *apparent* growth by the shrinking of the soft tissues around each individual hair. That growth of the hair after burial of the body may and does occur in exceptional cases appears to be demonstrated by authentic cases on record. Dr. Caldwell, of Iowa, was present at the exhumation of a man who had been buried for four years.[1] The joints of the coffin had yielded, and hair protruded. The hair on the head was found to be eighteen inches long ; on the face, eight inches ; and on the breast, from four to six inches. The man had been shaved before his burial. The same authors state that an exhumation occurred at Washington, D. C., the body being that of a girl, between twelve and thirteen years of age. The duration of burial was unknown. Her hair reached to her feet. Bartholinus relates the case of a man who had short black hair and beard at the time of his burial, who, some time after death, was found to have long and yellowish hair.

The Teeth as Witnesses.—As in the living, so in the dead also, the teeth may be of great help in solving a doubt as to identity. Their shape, regularity, integrity as to disease, number, what they show as to dental operations, what fillings they have—these are data of consequence. But even with the help of the teeth as witnesses, it is quite possible to go astray and reach a wrong conclusion.

In the early summer of 1898, the mutilated remnants of a

[1] Witthaus and Becker, i., p. 407.

young woman's body were found at a lonely place not far from Bridgeport, Connecticut. Enough of the body remained to show that death had resulted from criminal abortion, but the head had been severed from the body and the lower limbs had been roughly amputated. News of this discovery reached a family from whose home an adult daughter had a few days previously ran away. At the same time the young woman's lover disappeared. The girl's father went to Bridgeport, and after inspecting the head identified it as a part of his daughter's body. He was greatly influenced in this decision by the fact that the undertaker found several teeth filled just as the dentist of his daughter declared that his dental charts and records showed them to be filled. The remains of the body were delivered to the father and he started for his home with them for their burial. On his way he was intercepted by a telegram which stated that his missing daughter had just reached home, safe, well, and married.

An older case is on record in which the teeth were important features.[1] A woman in London, named Caroline Walsh, was missing, and another woman named Ross was arrested on the suspicion that she had secretly murdered her and sold her body for dissection. Both direct and circumstantial evidence brought the crime home to the accused. But it happened that, on the day after the Walsh woman had disappeared, a woman calling herself Caroline Welsh was found, badly injured, in the street, and not far from the place of the alleged murder. She was carried to the nearest hospital, where she presently died. The Ross woman insisted that Welsh and Walsh were one and the same person, and thus tried to relieve herself of the charge of murder. Various points of resemblance and of difference were brought out, but the chief and convincing fact was that the missing Walsh had very good *incisor teeth* (a remarkable incident at eighty-four years of age), while the injured woman (Welsh) had *no front teeth* at all, and their alveolar cavities were obliterated. The case is really an extraordinary instance of disputed identity, the coincidence of name, time, age, and occupation, the origin and circumstances being all upset by the medical evidence as to teeth and jaws.

The dead body may have to be **identified after putrefaction** has begun its work of changing and destroying the soft parts. Of course, medical men are often essential aids in this work. Some historic cases of identification many years after the death and burial of the body lose some of their interest in this connection because the date and other circumstances of the

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[1] Taylor, *Principles and Practice of Medical Jurisprudence*, i., p. 150.

death are known, and the difficulties attending purely negative cases are removed. Thus the examination and identification of the body of Charles I. at St. George's Chapel, Windsor Castle, by Sir Henry Halford, one hundred and sixty-five years after the King's execution, was an interesting, but not very difficult problem. The royal cadaver, after the King's beheading, was embalmed and interred in a lead coffin encasing a wooden inner shell. At the exhumation, this lead coffin was intact, but the wooden lining had gone to pieces. The King's body showed remarkable details. The skin of the face was dark; the forehead and temples were well preserved; the pointed beard so well known from Van Dyke's pictures was entire; the occipital scalp was entire and had a remarkably fresh aspect. The muscles of the neck were retracted but quite fully preserved; the smooth surface upon the fourth cervical vertebra told of its section by the headsman's axe. The hair of the head was of a dark brown; that of the beard was redder. It does not appear that the hair upon either part had increased in length.

Again, the question of identity sometimes arises in connection with the finding of **mutilated remains,** or where only fragments of a human body are the subject of inquiry. Some very noteworthy cases of this kind have been recorded. It is scarcely necessary to remark that the proper elaboration of these cases in their preparation for presentation at a trial for murder taxes the highest anatomic skill and knowledge. A well-known example of this sort of thing is presented in the case of Dr. Parkman, a case whose scene was in the old medical school building in North Grove Street in Boston, in the chemical lecture-room and in the laboratory and basement below.

The extraordinary features of this affair excited the most intense interest, and the report of the trial of Professor Webster for the killing of Dr. Parkman is considered as a classic in criminal jurisprudence. Dr. Parkman was last seen alive in the afternoon of Friday, November 23, 1849, entering the front door of the medical school building. It was subsequently shown that he came there by appointment to receive some money which Professor Webster had long owed him. Dr. Parkman did not return that night to his dinner, and his family and friends began an anxious search. Suspicion gradually turned toward Professor Webster, but a whole week passed before any active detective work in the school building was begun. Then a systematic search was instituted, which was rewarded by finding a naked human pelvis with its soft parts, a right

thigh, and a left leg in a privy vault on the premises. Some fragments of bone, a few broken pieces of mineral teeth, and some bits of gold from artificial teeth were discovered in the ash pit of a laboratory furnace. The entire trunk (with a wound in the side) and the left thigh were in an old tea chest with tan and mineral waste. The head, arms, forearms, both feet, and the right leg from the knee down were the missing parts. The various fragments were submitted to Dr. Jeffries Wyman, whose anatomic knowledge made him a recognized expert able, if anyone was able, to establish the identity of these human remains. His first question was, Were the fragments part of a dissected body? It was a natural question, as the remains were found in a medical school and near the dissecting-room. His answer was negative. There was no sign of dissection, and there was no evidence of a preservative. Were they parts of the same human body? The answer was that the different portions fitted accurately; there were no *duplicate* parts. The various sections had been made by one skilled and not a bungler. What was the height? When the parts were in position they measured exactly the height of Dr. Parkman as shown by his passport, proper allowance being made for the missing head. What was the age? The state of the skin, the color of the hair on the breast, the general aspect, and the " ossification " of the arteries (so-called) indicated an age of about sixty. The question of sex was not raised, as the sexual organs had not been mutilated or disturbed. The greatest interest, however, centered in the teeth. Three fragments of the thirty-five pieces of bone found made up a greater part of the right half of the lower jaw, and Dr. Wyman found from this that all the molar teeth on that side were missing. The artificial teeth found in the cinders fitted this space, and these were identified by a dentist as having been made for Dr. Parkman, the identification being determined not only by their own appearance, but also because they accurately corresponded with the cast which the dentist had taken of Dr. Parkman's very peculiarly shaped jaw. In this case the teeth did not lead to any wrong conclusions, because the work of investigation was most carefully done.

The medical expert, called upon to help in solving a question of personal identity, may have as his material for study only what is left when putrefaction has done its full work upon the soft parts. Frequently, indeed, he will be aided by adventitious matters, a piece of the dress or clothing, an article of ornament, or a document of any sort, found upon or with the skeleton when all parts except the bones have disappeared in

the course of nature or by felonious design.   Metallic buttons, gold rings, and other like articles are practically imperishable under ordinary processes and should be sought for near the bony remains.   For example, the gold rings and corset irons in the Luetgert case in Chicago in May, 1897, where the sausage-maker was accused of killing his wife and disposing of her body in a great vat with potash, assumed much importance. In 1847, an Englishman was tried for the murder of a man whose skeleton was found in a cesspool, and whose identity was determined by garters on the leg bones ; one of these was white and the other was red.   The woman who made the garters recognized them and swore she had given them to the deceased.

But all these fortunate discoveries may be lacking ; then the expert has only human bones or parts of bones as his material for study.   In such cases identification becomes a purely scientific medicolegal problem to be solved by anatomic knowledge only.   The medical inspector is required to show whether or not the bony remnants probably belonged to a person in life whose sex, height, and age were those of the person missing.   In a question of this kind, affecting a normal skeleton, the difficulties are very great.   The most that one can do in general is to declare that what he has had under his study is, or is not, consistent with the assumed details.   If there were imperfections or malformations, these would help. Talipes, palate fissure, even fractures, would facilitate his work greatly.   But the best that he can do is to *approximate* exactitude—he can never say he is absolutely sure of the identity, even under favorable conditions, if the bones are his only material.   It will be prudent to declare that what he has been studying is consistent with certain supposed facts rather than to affect a dogmatic certainty about the matter.   He sometimes has it in his power to be negatively sure.

Taylor[1] gives the following as the usual questions likely to arise in connection with the identification of bones :

1. Are they the bones of a human subject or are they the remains of an animal ?   With the whole skeleton before one, the answer is not difficult.   But, having decided that the bones are not human remains, that is enough for the expert ; he will do wisely not to particularize the animal which is represented unless he is himself an expert naturalist.

2, If the bones are human, what is the *sex ?*   This question has been discussed in a previous chapter.

3. How long since the bones were buried ?   What is the

[1] *Principles and Practice of Medical Jurisprudence,* i., p. 139.

interval since death? This is exceedingly difficult to answer even approximately. The conditions of decay vary widely. We know that bones are very slow to decay. King Dagobert's skeleton was exhumed after twelve hundred years, and King William Rufus' royal bones lay undisturbed seven hundred and eighty years before they were inspected.

4. What was the probable *age* of the person? In settling this query, the condition of the teeth is helpful.

5. What was the probable height? This is not an easy problem, but one may approximate. If the skeleton is entire, add one inch and a half for the soft parts, and from five inches and a half to six inches for the vertebral cartilages. One should remember that the middle point is at the pubes. When the arms are outstretched the distance from the end of one middle finger to the end of the other represents the height. If only one arm is available for study, double its length and add twelve inches for the clavicle and one inch and a half for the sternum. But the most exact way, because it is the scientific way, is to measure the parts present, accurately, to supply the missing parts by estimating their relative size from the bones at hand, and to make proper allowance for the soft parts.[1] The application of this method to a specific case is related in Dr. Robert Burns' report of the Gray case.[2]

6. What was the race of the individual? For this the type of the skull is to be studied, whether Caucasian, Mongolian or negro.

7. Did the bones belong to the same person or to more than one individual? This is determined by careful adaptation of the parts.

8. Was there any mechanical or other injury to the bones—any fracture, old or recent?

9. Were there any deformities—that is, supernumerary fingers or toes, curvature of the spine, curvature of the bones from mollities ossium or ankylosis?

10. Had the bones been subjected to any save the natural processes of decay since the person's death—had they been calcined or otherwise treated?

The author quotes with approval Tidy's[3] scheme of the details to be noted in the examination of persons, of dead bodies, or of bones for identification:

[1] Dwight, *Identification of the Human Skeleton*, Massachusetts Medical Society *Prize Essay*, 1878.

[2] *Transactions of the Massachusetts Medicolegal Society*, ii., p. 294.

[3] *Legal Medicine*, i., p. 252.

GENERAL EXAMINATION OF THE RECENTLY DEAD BODY.

Surroundings of the Body.—Clothes; jewelry; all articles on the body or in the coffin; hairs grasped in the hand or free about the body.

Probable Business or Trade at which the Person Worked.—Hands; injuries to the nails; stains.

Height.

Weight.

Age.—Amount and color of the hair; teeth; the alveolar processes; the fontanelles; the points of ossification; condition of the epiphyses; the size of the bones.

Sex.—Genital organs; breasts; general conformation; length of hair, especially the back hair; the pelvis; markings on the bones.

Deformities.—Hip disease shortening; spinal disease curvature; talipes; wens, etc.

Marks, Growths, etc., on the Skin.—From disease—scrofula, syphilis, smallpox, skin diseases; surgical operations; tatooing; natural causes—moles, nævi, warts, pigmentations; from violence; from stains of blood, etc.

Injuries—Fractures; dislocations; wounds—their origin, position, extent.

DETAILED EXAMINATION OF THE VARIOUS PARTS OF THE BODY.

Head.—Note complexion, whether fair, dark, or sallow; shape and race type; the forehead, whether low, high, or prominent; eyes—large, small, color of iris, sunk, or prominent; nose—short or long, flat, state of nostrils; ears—lobules, if pierced; mouth—large or small, and if scarred in the roof; lips — large, small, or scarred; teeth—number, regularity, decay, false; chin—full, round, double, pointed, or receding; hair—amount, color, length, if natural or artificially colored, if recently cut.

Neck.—Whether short or long, thin or fat; scars.

Chest.—Formation; shoulders; sternum.

Pelvis.—Genitals, if normal or otherwise; in females, the question of pregnancy; if a skeleton only, whether male or female.

Extremities.—Arms—size and length; hands—roughened or hardened by work, or stained; fingers—short or long; nails; legs, if equal in length; ankylosis of joints; bowed; in-kneed; the ankles and feet.

Mutilated Remains.—Note the degree of accuracy with which the parts fit together—bones, muscles, blood-vessels.

Nature of the Mutilation.—Whether the muscles were hacked or were divided by a sharp knife; whether the bones were chopped or were divided with a fine or a coarse saw.

After-treatment of the Parts.—Whether by time or by chemicals; by burning (examine ashes for phosphate of lime); or by boiling.

Discovery of a Skeleton or of Individual Bones.—Note the extent of the disappearance of the soft parts; the extent of the separation of the bones; the color of the bones; their state of preservation; are they human; sex—note the pelvis especially; do the bones belong to the same body, or to more than one body; are any fetal bones in or near the pelvis; have any remnants of disease been left on the bones; were there any injuries of recent occurrence before death.

CHAPTER VI.

IMPOTENCE AND STERILITY.

SEXUAL disability is a subject of considerable importance in medical jurisprudence, and its determination and diagnosis are sometimes matters of great difficulty and delicacy. This disability appears under two principal forms: impotence and sterility. These forms are sufficiently distinguished by their definition. Impotence is incapacity for sexual intercourse; sterility is incapacity for procreation or conception.

Both conditions apply to *both* sexes, although it is more common to speak of impotence as a disability of the male sex, and sterility as belonging to women only. This is an error. Again, a sterile person is not necessarily impotent, but while the impotency lasts an impotent person is sterile.

The law makes no distinction between the two conditions, but refers to impotence as the single disability which excuses in certain emergencies. Thus, the Massachusetts statute [1] concerning divorce says: " A divorce from the bond of matrimony may be decreed for—among other causes—impotency of either party." The English and German law is to the same purport: " Any incurable cause of complete inability to perform the matrimonial duty . . . . any incurable bodily infirmity which excites loathing and disgust or wholly prevents the attainment of the objects of matrimony."

Impotence is used as a plea in defence in trials for rape, bastardy, and adultery or incest. Especially in divorce suits does it have an important relation.

In private practice, a husband or wife desiring heirs may consult the family physician as to the sexual capacity of either party. A mother, whose daughter has some real or fancied malformation of the sexual organs, seeks advice as to whether she should marry; or a man, engaged to be married, asks if he should fulfil his engagement; or a couple in advanced life are anxious to learn if they are too late for the parentage of children.

Most frequently medical counsel is sought by young men who have read vile books about " manhood restored "; they have entertained the worst prognosis because a normal evacua-

[1] *Revised Laws*, Chapter 152.

tion of the vesiculæ seminales, at intervals, has frightened them unreasonably.

Casper speaks of the frequent attempts at deceit which used to come to his notice in this class of cases, and lays down a caution.[1] He says, " There is no department of forensic medicine in which such incredible lies and shameless assertions will be made to the practitioner in order to obtain a favorable opinion as in this. And very naturally, since the result in cases of pregnancy, paternity, divorce, etc., frequently affects for life the future position of the parties concerned. And, also, because the most ignorant non-professional person is conscious that in a matter which never permits any witnesses, no third party, not even a physician, can come forward either for or against him. I might fill volumes with the shameless and absurd declarations which have been brought to me. In one case a former operation on the genitals was said to have rendered impotent, for a long time, a man accused of the paternity of an illegitimate child. He showed, as the still visible cicatrix of the operation, the natural raphe of the scrotum. In another case a shameless fellow had shaved all the hair from his pubes, and dared to present himself as imperfectly formed and impotent."

The author had a case in October, 1885, of a prisoner about to be tried for adultery. He was a married man, forty-five years old, who had been detected in bed on three occasions with a woman, also married, but not his wife. His defence was impotence. Some two years before, he had fallen in a boat astride a thwart and had injured his scrotum and one testicle. Some acute inflammatory condition had followed, preventing him from working temporarily; subsequently, atrophy or softening of the injured testicle supervened. At the time of the trial he declared that he had never had or attempted sexual intercourse since the accident; that he had no sexual desires when with women, and that he considered himself impotent. He admitted occasional partial erections when in bed. When he presented himself for examination his genitals were swathed in a napkin worn like a T-bandage, for the purpose, he stated, of relieving a sensation of chill or numbness in the parts. The organs of generation were of normal size on inspection; but on palpation, the left testicle was found to be small, pulpy, and shapeless. The right testicle and the penis were apparently in good and useful condition. The report was: " The examination revealed nothing to establish clearly the fact that the defendant was sexually

[1] *Forensic Medicine,* iii., p. 239.

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disabled by his injury." One testicle was surely normal, and the presumption was established by his unlawful actions. He entered a plea of "guilty."

Legal questions relating to sexual capacity arise now and then in connection with divorce suits. The marriage contract is sought to be annulled, because one party or the other is unable to fulfil an essential obligation imposed by the matrimonial contract, the procreation of children. This principle has been recognized since the twelfth century, and it is lawful ground for divorce in all civilized countries. It is the same in China also. But the impotence must be absolute and irremediable; it must have existed at the time of the marriage; and it must be incontestably established at the trial. Hence, examination of both parties is often necessary. Taylor says that divorce suits on the ground of impotence are usually brought by the wife against the husband, because of the difficulty of proving the condition in women and the relative ease with which, in marked cases, physical causes may be demonstrated in men.

The causes and conditions whose presence determines impotence in the male, and leaves no manner of doubt about the matter, may be classified as: Absolute or relative; irremediable or curable; permanent or temporary; natural or accidental; physical or mental or psychical. Adopting the last classification and mentioning those *physical* defects first which result in impotence in men, we may regard them as either (1) irremediably, permanently, and absolutely impotent, or (2) temporarily impotent with a chance of relief:

Absence of the Penis.—It will at once occur to the mind that this condition should take precedence in the list of incurable causes of impotence. This lack may be congenital, or due to accident, mutilation, or disease. But the deficiency must be complete. Cases are recorded in which, with only a small remnant of the penis left after surgical operation or accidental loss, fertile intercourse has been accomplished.

Absence of the Testicles by Congenital Defect.—The defect must be entire. The organs must be entirely missing. The testicles may not be in the scrotum; they may be undescended, and the patient may be a cryptorchid. How can we distinguish them from men in whom there is either congenital atrophy or entire absence of the testes?

Men without testicles or with very inert ones show other genital organs imperfectly developed. The mons veneris is well supplied with fat; there is slight mental or physical vigor; there is absence of sexual desire; there are a softness of skin, and a figure approaching the feminine type. A scanty

beard, a shrill, feminine voice, large breasts, small hands and feet, and slender limbs are other objective evidences of this condition.

On the other hand, cryptorchids, with rare exceptions, have the usual mental and physical development of men in normal conditions. They may be sterile, but they are not impotent. The rarity of this anomaly is confessed. Marshall found only 1 case in 10,800 recruits.

Monorchids, men who have but one testicle, are not on that account alone either impotent or sterile. The Parliament of France, in 1665, decreed that a man must show two testicles in order to establish his claim that he was normal. It is now known that a single testis is sufficient; the loss of its fellow by natural defect, accident, or surgical interference does not produce sexual incapacity.

Exstrophy of the Bladder.—This is clearly an instance of defective formation. Its cause is an arrest in the development of the anterior wall of the abdomen and bladder. The ureters open externally; the penis is short, imperforate, and without urethra; the testicles frequently remain within the abdomen; and the scrotum remains atrophied and empty.

Atrophy of the Testicles.—This is another cause of sexual incapacity. It has various causes, such as gonorrhea, varicocele, syphilitic orchitis, and parotitis. Once established, it is permanent and irremediable. As a class, men afflicted with this disability resemble those just mentioned in whom the testicles are wholly lacking.

Passing from these illustrations of physical defect, concerning which there can be no question as to their etiological relation to incurable impotence in men, we proceed to recall other conditions of the anatomical class that may or may not create sexual inability, and are often erroneously made to serve in that relation, but are generally curable or temporary.

Extremes of age are obviously a bar to sexual activity, but are not permanently and absolutely so. In childhood and adolescence up to puberty this rule applies, with the exceptions on the side of precocity. In old age impotence occurs without any well-defined limit. It is unsafe because a man is old in years to declare him lacking in sexual power. Some extraordinary exceptions have been recorded and will be remarked a little later.

Hypospadia and epispadia are still other instances of abnormal development. Men afflicted thus are often accounted impotent erroneously. Casper lays down the rule that " where the formation is *otherwise* that of a normal male,

hypospadia and epispadia of themselves form no basis for assuming sexual incapacity so long as it can not be proved in any given case that it is impossible for any seminal fluid to enter the vaginal canal."[1]   Of course, the act of intercourse can be only imperfectly performed under such conditions of defect, the incapacity varying in degree according to the
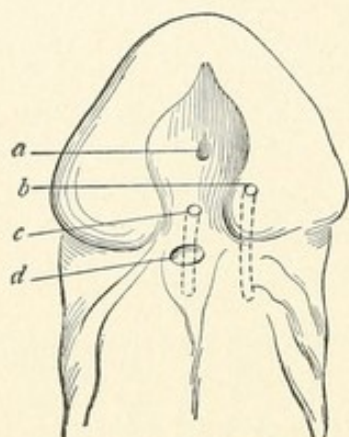
FIG. 13.—Glandular hypospadia : *a*, Depression at normal site of meatus ; *b*, sinus half an inch deep, admitting No. 5 F., just under skin ; *c*, sinus three-fourths of an inch deep, admitting No. 5 F., under skin above urethra ; *d*, meatus (Curtis).
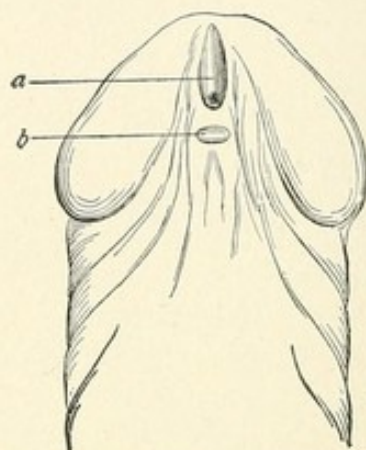
FIG. 14.—Glandular hypospadia : *a*, Depression at proper site of meatus (with deep dimple at the bottom) ; *b*, the meatus (Curtis.
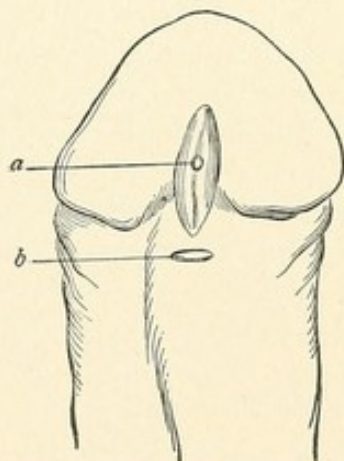
FIG. 15.—Glandular hypospadia : At *a* opens a narrow blind pouch which extends for one inch just above the urethra—*a* lies between two well-marked lips ; *b*, the meatus (Curtis).
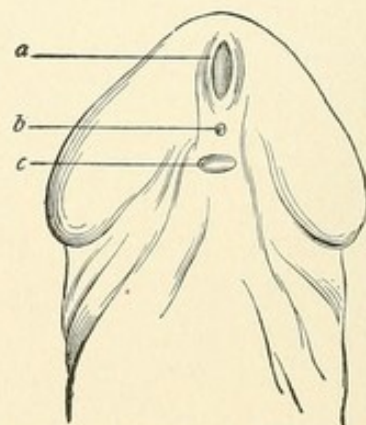
FIG. 16.—Glandular hypospadia : *a*, Depression at proper site of meatus ; *b*, sinus a quarter of an inch deep, admitting No. 1 F. ; *c*, meatus (Curtis).

amount of malformation.   A moderate degree of hypospadia, the urethral opening being near the glans, would offer no presumption of impotence for obvious reasons.

Epispadia, with the urinary meatus opening upward, either near the glans, or far back, is extremely rare.   Casper says such a deformity never occurs alone.   As regards hypospadia

[1] *Forensic Medicine,* Sydenham Edition, iii., p. 251.

with the urethral orifice placed even well back toward the perineum, some extraordinary cases of fecundity are reported by Foderé, Belloc, and others. In some of these instances the deformity was transmitted as an inheritance. One case (Joanna K.), reported by Fraxel and quoted by Casper,[1] is certainly very remarkable:

An unmarried woman, twenty-seven years old, who had given birth to a child, stated under oath that for the last three years she never had carnal connection with any man, but frequently with a person supposed to be an *unmarried woman,*
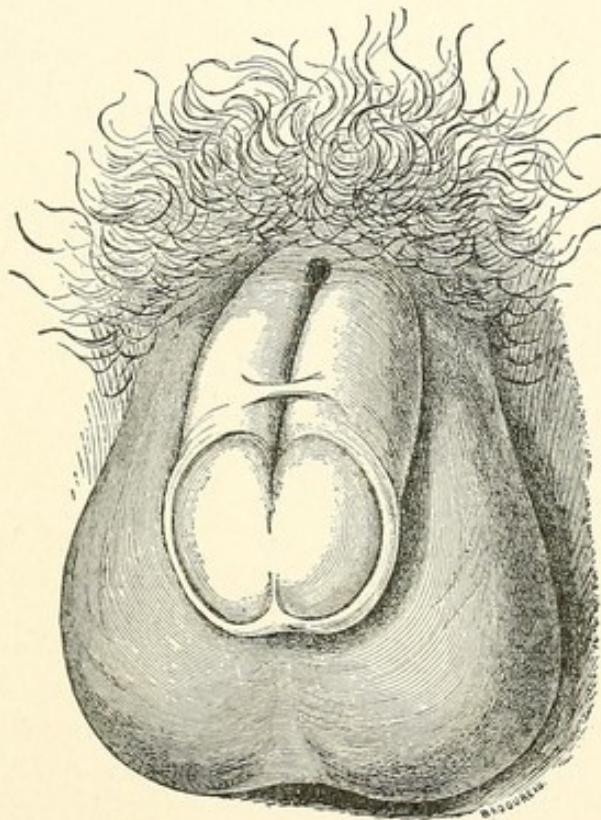
Fig. 17.—Complete epispadia.

Joanna K., thirty-seven years old, whose whole habitus was that of a man. She was tall, her muscular fiber was firm, her limbs were angular, her features were manly, and her chest was hairy; she had no female breasts, and her pelvis was narrow. The scrotum was separated into two sacs; there was a fissure covered with a red translucent cuticle, and in this cleft, close to the root of the penis, was an opening of small size—the urethral meatus. The penis was short, thick, and imperforate; on its under surface was a smooth furrow, corresponding with the situation of the urethra and extending from

[1] *Loc. cit.,* iii., p. 250.

the imperforate glans to the meatus in the perineum. The urethra then opened externally immediately after passing the triangular ligament. The child, of whom Joanna K. was the father, was mature and healthy, but had sexual organs almost the exact copy and counterpart of those above described.

Certain malformations and malpositions of the penis are sometimes spoken of as causing impotence. Generally they are remediable and are simply curiosities. They do not usually become subjects of embarrassment to the medical jurist. They will be mentioned without further comment :

1. Adhesion of the penis to the scrotum ; incurvation of the penis. A surgical operation is available to remedy this defect.

2. A double penis might be thought theoretically to interfere with intromission, but recorded cases prove the contrary. A case is related by Taylor.[1]

A young Portuguese in 1865 excited much interest among medical men in London. He had two penes placed side by side, the right smaller than the left, but both subject to erection at the same time. He stated that he used the left penis in sexual intercourse. On the outside of each penis there was a scrotum with one testicle ; between there was a shrunken (?) scrotum from which the testicles had reascended into the abdomen. He urinated by both organs.

3. Abnormalities in size result in relative impotence, whether the defect is large or small. The beneficial effect of use on immature organs has been demonstrated. Wilson (quoted by Curling) found a man twenty-six years old, in whom the penis and testes were of the size of those of a boy of eight years. The organs acquired the usual size after two years of marriage. Excess of size may involve *relative* incapacity for intercourse. Casper gives cases of divorce by the Swedish Consistory of the seventeenth century.

4. Distortion of the penis is due to congenital shortness of the corpus spongiosum, leaving it like the string of a bow, sometimes with hypospadia ; or to the formation of circumscribed indurations in the erectile tissue and fibrous sheath of the corpora cavernosa, giving a twist or deviation to the diseased side or to a congenital shortness of the frenum, which is easily remediable.

Allied to these structural abnormalities are certain acquired deviations from the normal state. These may sometimes suggest or enter into the question of impotence in men. For example, disease may interfere with sexual ability by obstructive growths and formations. The penis may be concealed in a

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[1] *Principles and Practice of Medical Jurisprudence,* ii., p. 290.

large scrotal hernia, by hydrocele, by elephantiasis of the scrotum or prepuce, by cancer, or distorted by cicatricial induration of the corpora cavernosa.

Gummata of venereal origin act similarly. Calcification (so-called ossification) of the septum pectiniforme or corpora cavernosa, giving an intractable curvature, is remediable only by surgical removal. Professor S. D. Gross mentions the curious instance of the retention of a bullet in the corpus cavernosum encysted in the right side, and impairing the sexual function. Varix of the dorsal vein of the penis is another rare affection of the parts.

Other causes are sometimes mentioned as possible physical factors in the etiology of impotence: Phimosis and paraphimosis; stricture of the urethra; sarcocele (if both testes are involved); lithotomy—in consequence of injury done to the floor of the prostatic urethra; urethral or preputial calculi, causing inordinate bulk; extravasation of blood into the cavernous structure. All these are remediable in a greater or less degree.

Gross states that disease of the bladder and prostate is a more frequent cause of impotence than is generally imagined. Thus, chronic cystitis, calculi, and paralysis of the bladder always seriously impair and often destroy sexual capacity. Excessive hypertrophy of the prostate is another efficient cause.

Disease of the seminal vesicles is regarded by the same author as another source of impotence. It is clearly beyond the reach of ready demonstration, and the relation must be largely inferential. For example, inflammation, abscess, tuberculous deposit, fibrous degeneration, and the formation of earthy concretions are in this class of causes.

Functional Disorders.—Besides these purely physical defects and abnormalities—more or less demonstrable and remediable, there is a second series of cases which depend on *functional vices* of the male genito-urinary system. They are often difficult of diagnosis. Their etiology is complex and obscure. They constitute a very numerous class, but they are of more interest to the practitioner, to the physiologist, or to the pathologist than to the medical jurist. They may be referred to one or the other of the two classes, according to Gross.

First, "atonic" impotence is due to failure of the genito-reflex center in the lumbar portion of the spinal cord to excite the genital organs to functional activity under the ordinary stimuli. It depends on, or is maintained by, subacute or

chronic inflammation of the *prostatic urethra* with morbid sensibility or hyperesthesia of that part. It is usually due to masturbation, gonorrhea, sexual excesses, and constant excitement of the genital organs without gratification of the passions.

Secondly, another class of functional disorders of the male sexual organs, resulting in impotence, has to do with the existence of disease in other parts of the body, or with the abuse of drugs, etc. Sexual power is now and then greatly impaired if not absolutely destroyed by the prolonged use of certain cerebral sedatives, such as opium, morphin, chloral, potassium bromide, alcohol, tobacco, and cocaine; or by the habitual abuse of some brain stimulants, such as cannabis indica; or by the administration of or exposure to arsenic, antimony, lead, or iodine. It may be symptomatic of certain diseases, especially of the nervous system, such as brain worry, spinal meningitis, myelitis, locomotor ataxia, diabetes, albuminuria, and paraplegia.

Then there are certain subjective or moral causes of impotence. These are developed in men otherwise normal in all respects. They are temporary only, and are remediable. They are essentially emotional, and are to be distinguished from the imagined impotence from which some young men suffer. Though thus psychically founded, this sort of incapacity is very real, and while it lasts it renders its victim powerless to control it.

Examples of this disability are described by authors as being furnished by young husbands with too ardent desire; or too zealous in their purpose to discharge the bridegroom's duty; fright; timidity and apprehension of trouble; disgust or aversion; grief; disappointment. In short, anything that powerfully affects the mind; for (as Casper remarks) the emotional excitement of the nervous system, which is much more efficacious in fitting a man for intercourse than the mere stimulus of a store of seminal fluid, may be hindered by depressing influences, such as hate, aversion, disgust for the woman; a fact explicable physiologically as well as demonstrated by actual experience. In this category should also come cases of impotence growing out of incompatibility or idiosyncrasy, exhibiting examples of relative impotence.

Sterility in the Male.—As already stated, the law does not trouble itself about the question whether, in any given case, the sexual intercourse is or is not fruitful. The question of impotence is the only one which has strictly legal interest. The generative act, if performed at all, presumes the discharge

of fertile seminal fluid. Hence, a normal condition of the genital organs, anatomically considered, implies normal functional activity; while obviously, absolute and irremediable defects in anatomical structure give rise to the conclusion that there is sterility as well as impotence. Procreative ability is determined by the presence of active zoösperms in the seminal fluid, and the absence of these means sterility on the part of the male.

Although as a medicolegal topic sterility in the male has relatively little interest when compared with the disability just discussed, it may be well in a few words to note some of the factors which enter into the etiology of this procreative incapacity. Sterility in the adult male appears in two generic forms; either as azoöspermism—the condition in which only unproductive and unfruitful seminal fluid is secreted; or as aspermatism, or the condition in which the spermatic fluid is not secreted in any form. Statistics show, according to Gross, that in one-sixth of the sterile marriages the husband is the party at fault, and that his fault grows out of the first of the conditions just stated—namely, azoöspermism.

Age is, of course, an important matter in this relation. The age at which the testicles begin to form prolific spermatic fluid varies with all the causes that promote the advent of puberty. The ordinary age is fourteen, as a rule, but, exceptionally, puberty may be earlier or may be greatly delayed. Dr. Rüttel[1] tells of a boy of fourteen who impregnated a girl of the same age. Taylor says that this is the earliest age at which, within his knowledge, procreative power has appeared in the male. Mann[2] reports the case of a boy of thirteen, who was possessed of procreative power, and cites it as being the youngest age on record of this sort. As long ago as Henry VI. of England, it was decided that the issue of pregnancy should be pronounced a bastard if the imputed father was under fourteen. The records of the Taunton Almshouse in Massachusetts show on good evidence that a girl of ten years and eight months gave birth to a child, alive and healthy, the father being fifteen. Dr. Stone[3] cites an instance of remarkable precocity of sexual development in the case of a boy four years of age. He was four feet and a quarter of an inch in height and weighed seventy pounds. His bones and muscles were developed, and his voice was grave in tone. There was a growth of hair on the pubes; the penis was flaccid, and was

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[1] Henke's *Zeitschrift*, 1844, p. 249.
[2] *Forensic Medicine and Toxicology*, p. 83. From the *British Medical Journal.*
[3] *American Journal of the Medical Sciences*, October, 1852.

three inches and a half in length; and there were two well-developed testicles. Improper conduct with his aunt attracted attention to his precocious development.

Advanced age is usually attended with sterility in proportion to the decline of natural vigor. There is no fixed period for sterility. The presence or absence of spermatozoa is the real test. Curling has found these in the spermatic fluid of men at sixty, seventy, and eighty-seven years of age; Casper found them at the age of sixty-nine. Duplay believes, from his anatomical observations on the bodies of old men, that the causes of sterility in the aged are to be found rather in the excretory than the secretory apparatus. He found obliterations in the vas deferens, the canal of the epididymis, and the vesiculæ seminales, thus preventing storage and passage of the fluid.

Taylor[1] says: " Besides the *presence* of living zoösperms in the spermatic fluid as an indispensable condition for impregnation, it is a curious fact that the active *motion* of the zoösperms is likewise essential to fecundation. Thus, when they are motionless, ova are not fertilized by them, and the power of impregnation is in proportion to the activity of this motion." Casper recalls the fact that spermatozoa are present sometimes in the spermatic fluid of old men, and at other times, for a shorter or longer period, are absent.

In this matter of the procreative power of old men it is well to recall again that the age is of less consequence as a guide than are observations on the habits, vigor, and mode of life. The question of persistent virility was made prominent in the celebrated English case, the Banbury peerage succession. It was before the House of Lords for nearly two hundred years. It turned on the question whether Lord Banbury could be the father of two children whom his wife added to his family when he was between eighty and eighty-five years old. He was strong and vigorous; but while it was admitted on that account that he might have been the father of his wife's latest children, there was reasonable ground for disputing their claim, because it was suspected that the Lady Banbury had some assistance outside the family.

Sir Stephen Fox, married at seventy-seven, was thereafter the father of four children, of whom the youngest was born when he was eighty-one. Rüttel relates the case of a man who married at ninety-two and subsequently was the father of two children. Old Dr. Parr married at eighty and begot two children. At the age of one hundred and five he became in-

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[1] *Principles and Practice of Medical Jurisprudence,* ii., p. 288.

volved in a love intrigue, for which he had to do penance by standing in a sheet in Alderbury Church. His first wife died, and he married again when he was one hundred and twenty years old. The results of this latest venture are not matters of record.

Other causes, however, beside old age deserve mention. For example, in bilateral anorchidism there is inability to emit *any* seminal fluid. The subjects of this condition resemble eunuchs who have been mutilated in early life. They may not be genuinely impotent, but they are absolutely sterile.

Again, there may be double genital deficiencies in the excretory apparatus, so as to prevent the discharge of the seminal fluid. The epididymes may be absent; the vasa deferentia may be lacking; or the seminal vesicles may fail to communicate with the urethra. Instances of all these have been recorded. Then, too, there are cases of stricture of the ducts or deviation of their orifices, due to gonorrhea, tubercle, or syphilis; or occlusion of the canals by the products of inflammation; or obstruction by concretions in the ducts, indurations of the corpora cavernosa, or stricture of the urethra.

Opinions differ with reference to the functional usefulness of undescended testicles in cryptorchidism. Although the weight of authority favors the view that neither cryptorchids nor monorchids are sterile, scientific testimony is within reach for a contrary conclusion. Thus, John Hunter declares that "an undescended testicle is always imperfect in structure and function, and that cryptorchids are invariably sterile." Curling has expressed similar views, and states that no spermatozoa are found in the testicular secretion of a cryptorchid. Gross states that, "on the whole, the evidence in regard to cryptorchids shows that while, as a rule, they are potent, they ejaculate a fluid that is devoid of spermatozoa; but exceptional instances of procreative ability are recorded."

Eunuchs are, as a matter of course, irremediably sterile as well as impotent, if the mutilation is entire, and especially if it is done before puberty. Although, as a rule, the removal of *one* testicle does not result in defect of function on the part of its companion, it occasionally happens that atrophy of the other testicle ensues with other consequences like those of complete castration.

The opinion has been maintained that castration after puberty may leave the subject of the operation not only able to perform sexual intercourse, but that for considerable, even indefinite periods, the intercourse may be fruitful.

Sir Astley Cooper reports a case of castration in which the

sensation of seminal emission continued at intervals for twelve months.   Sexual intercourse was practised for ten years.

Wilson removed both testes for malignant disease, and the man survived the operation for two years.   He had occasional erections, and intercourse was attended with the usual sensations and the discharge of some sort of fluid.

Professor Humphrey reports the case of a man who had been castrated on account of nervous troubles.   He was able to indulge in intercourse with some sort of an emission for more than a year.

Curling removed the right testicle from the scrotum of an army officer seven years after excision of the left testicle by another surgeon.   At the expiration of four years and a half after the last operation, the patient told Curling that he had had intercourse with his wife about once in two weeks, but without any seminal discharge at the time.

Orfila says: " There may be temporary sexual ability, if the extirpated testicles were healthy—not if they were scrofulous or cancerous.   Otto found the vesiculæ seminales still full of semen in a man who died nine months after castration.   It does not appear, however, that a microscopical examination was made.   Ricord refers to a case in which, after castration, the man had erections and violent sexual desires.   This patient had a tumor of the cerebellum.   Krahmer relates that " a man had extirpated both testicles with a razor, and that he had an involuntary discharge from his penis on the eleventh night after the mutilation."

All these negative and rare observations come far short of proving the virility of men who have been castrated.   It is not to be denied that a man thus mutilated may retain, for a short season, his procreative power by virtue of the seminal fluid stored in the vesiculæ seminales and out of reach of the knife. The possibility is to be recognized that imputed paternity under such conditions may be well founded ; but the contingency is the rarest possible.   There may be prostatic fluid without testes.   Absence of spermatozoa determines male sterility, and there can be no spermatozoa without testicles to make them.

In all these cases children are usually lacking as corroborative witnesses, although the possibility of fertility under such conditions and for a brief season may be admitted, guardedly. This possibility has some confirmation in the results of experiments on animals.   Massazza, in 1891, found that castration does not immediately abolish procreative power in animals. Active spermatozoa were discovered in the spermatic ducts nine days after removal of the testicles.

Sexual Disability in the Female.—This subject is usually considered under the title, sterility; but there may be impotence in the female subject as well as in the male, as the author has already insisted. Medical jurisprudence has to do mainly, in these cases, with the purely *physical* causes of disability, because other conditions are not easily demonstrable. As in male subjects, these causes are classified as temporary or permanent, curable or irremediable. The various conditions which are described and accounted as genuine causes of female impotence and sterility, one or both, are not all adequate or reasonable grounds for presuming sexual incompetence. Moreover, the subject on this side is of less interest to medical jurists than is its application to men, because most medicolegal questions of this class relate to men, and because the recognized physical causes of the incapacity are more readily studied in men.

If we exclude from our study, for obvious reasons, the incapacity for sexual intercourse which belongs to childhood and youth because of the immature development of the external organs of generation, there is but one condition about the female genitalia which can be regarded, beyond all question, as a strictly physical bar to sexual intercourse, and thus a genuine cause of impotence in a woman, while it lasts, for even this condition is not beyond surgical relief. This condition is *congenital absence of the vagina*. It is sufficiently rare to be a curiosity, but, if present, it is undeniably adequate as an obstacle to connection. It may or may not be associated with other anatomical defects.

Dr. W. L. Burrage, of Boston, reported an example of this:[1] The patient was nineteen years of age, single, with a negative family history. She had never enjoyed rugged health, and she had never menstruated. She became engaged to be married, and her menstrual condition led her to consult a physician as to the propriety of becoming married. Examination of the genitals revealed the following conditions: The labia, vestibule, and clitoris were well developed; the urethra was dilated; the hymen was absent. In place of the ostium vaginæ was a wrinkled area of mucous membrane, in the center of which a minute opening led to a pocket 1.5 cm. deep and lined with mucous membrane. Careful bimanual examination, and with sounds and catheters, failed to reveal the presence of uterus, ovaries, or tubes. The septum between the rectum and bladder was thin, and the organs (rectum and bladder) were normal. An operation of a plastic nature was done with the design of making an artificial vagina between the bladder and rectum.

[1] *American Journal of the Medical Sciences,* March, 1897.

It succeeded to the extent of making a canal 2.5 cm. in diameter and 4.5 cm. deep. The girl married, and her husband two years later reported his entire satisfaction; her health had improved, and her desire for children had been gratified by adopting a baby four months old.

Foderé relates such a case of a less promising character in its results:[1] A woman, twenty-five years old, was married in Paris. She lived with her husband six years without consummating the nuptials. She was then examined by a midwife, who declared that she could find no sexual organs. The woman had never menstruated. She was examined by a surgeon, Dejours, who found the condition described by the widwife, and proposed an incision into the fleshy mass occupying the site of the vulva and vagina. He cut inward to the depth of two inches, but found no vagina. He kept the wound open two years by artificial means, but this did not satisfy either husband or wife, and a suit for divorce was begun. Eminent surgeons gave their testimony as to the woman's disability, but the Court concluded that the defect was curable. The woman died after ten years of misery. A post-mortem examination was made, and neither womb nor vagina was found.

Burrage has reported the result of his researches in literature relative to the frequency of this anomaly. He finds records of 360 cases reported from the earliest times up to 1897. Autopsy records were found in 35 cases, of which 24 were in adult women. These post-mortem records state that rudimentary tissues representing the womb were usually found above the closed vaginal region. In all of the 35 cases, save 6, ovaries were found. Inheritance appears to be an uncertain element in such cases, as a small number of instances are related in which women of the same family were thus afflicted. Aberrations of development in fetal life affecting the fusion of the ducts of Müller are the true cause of the anomaly.

If we remember the general rules that, in a legal sense, impotence in women must be predicated on physical conditions clearly demonstrable and beyond surgical remedy, the difficulties with this side of the subject will be much reduced, since we have seen that even the apparently irremediable anatomical causes residing in the *absence of the vagina* may be mended by surgical art in many if not in all cases. If this is the case with regard to so serious a condition as congenital absence of the vagina, the medicolegal troubles with other vaginal abnormalities will not be insuperable. For example:

[1] Beck, *Medical Jurisprudence*, Eleventh Edition, i., p. 139.

Occlusion of the vagina by inflammation and cicatrization, or by a hymen of tough, resisting membrane, or by a malformed hymen, are curable and remediable, and are not a good plea for divorce proceedings.

So, also, irregularities, malformations, and obstructions of the vagina are among the doubtful causes of impotence in women because they do not necessarily form a bar to intercourse or procreation; and they may be surgically relieved. The vagina may take a very abnormal direction, and instead of terminating at the vulva may seek another outlet. For example, its outlet may be in the rectum:[1] A woman became pregnant and in due course was attacked with what she believed was colic. Her physician, who had previously discovered her malformed vagina, presumed that her pain was due to retained menses; cutting through the septum in the direction of the supposed canal and passing his finger in he found the fetal membranes presenting. A living child was delivered. The wound was kept open, and a second child was the result of another pregnancy. A minute opening into the rectum was found after the first delivery, and by this, though it admitted a small probe only, conception was accomplished. Another curious digression of the vagina is reported by Morgagni. This time it was above the pubes and close to the umbilicus. In this case the woman became pregnant, the unique vaginal opening was dilated, and a child was delivered. The woman survived. Certain French judicial decisions have sustained a plea for divorce on account of such vaginal aberrations.

Beck[2] allows **extreme brevity of the vagina** to be an incurable cause of impotence in the female; but not necessarily offering a presumption of sterility. Dewees found in one case a vagina of only an inch to an inch and a half in depth. Extreme constriction of the vagina is occasionally seen after puberty. It is incurable; gradual dilatation by bougies is practicable, and, after patient treatment by dilatation, impregnation is clearly possible. In the *Mémoires de l'Académie de Médecine* there is a report of a case in which the vagina was so narrow as scarcely to admit a quill. The woman became pregnant and was delivered at term. Subsequently the vagina became fully dilated. Such dilatation of the vagina is frequent after pregnancy.

Again, obstruction of the vagina by fibroids, cancer, or prolapse may be offered as a plea for legal separation. Such

[1] Ogston, *Lectures on Medical Jurisprudence*, p. 64.
[2] *Medical Jurisprudence*, Eleventh Edition, ii., p. 142.

obstructions are clearly within the reach of surgical remedy ; as are also cicatricial formations following injury. Dyspareunia, also, caused by vaginal or vulval hyperesthesia, is a remediable condition. It is usually associated with some curable local disorder, like piles or fistula.

Sterility in Women.—As in men, so in women, the law makes no account of incapacity for procreation and reproduction provided the organs concerned in that function are physically fitted for intercourse, or may be made so by surgical interference. Therefore, the subject of female infertility may be discussed very briefly, since we are concerned only with those matters which may assume some importance in civil or criminal jurisprudence.

Age at both extremes is an obvious natural cause of sterility, but one must not be too arbitrary in assigning limits, and considerable latitude should be given in defining the fertile period. If we are to rely on published instances, the usual normal period of childbearing in temperate climates (thirty years, from fifteen to forty-five) has many exceptions. We hear of menstruating babies with large breasts and well-developed genitals.

Dr. Jagoe, of Mississippi, reports the case of a negro child, born in 1885, who began to menstruate in July, 1887 ; her mammæ were prominent and her pubic growth of hair was in full evidence.

Dodd tells of a girl who began to menstruate at the age of twelve months. She became pregnant when she was eight years and ten months old, and was delivered of a seven-pound baby.

On the other hand, at the other end of life, we hear of women bearing children at sixty ; menstruating at seventy-five, or, if we may credit Orfila, at ninety-nine. It is indeed impossible to state, dogmatically, a rule beyond or outside of which we must not go. Each case must be judged by itself. Care must be taken to note whether the woman in question, though too old according to the usual rule, presents the usual general marks of decline,—an aged look, disappearance of subcutaneous fat, withered breasts, and wasted thighs. These appearances studied in connection with the actual age, may enable us to reach a conclusion as to senile sterility in any given case.

Among the more remote doubtful causes of female sterility may be mentioned in this connection certain malformations and diseases of the womb and appendages. In this class we include such conditions as bicornate uterus, uterine flexions or

versions, carcinoma, fibroid tumor, endometritis, leucorrhea, menorrhagia, gonorrhea, and contraction of the os and cervical canal. Of all these it may be said that they do not represent absolute and irremediable causes of sterility; that most of them are susceptible of successful surgical or gynecological treatment, and that conception, gestation, and delivery have repeatedly been observed in the presence of either of them. The most that we can say is that impregnation in such conditions is accomplished under difficulty, if at all, but that it is not impossible.

Congenital absence of the womb is, of course, sufficient to determine sterility. The vagina ends in a cul-de-sac, and there is no menstruation. Usually, the health is not impaired, and the condition is consistent with normal anatomy otherwise. There is no claim of impotence in such cases It is obvious that the same comments will apply to cases in which the uterus is lost by surgical operation, by hysterectomy.

Andral mentions a case of complete absence of the uterus which occurred under the observation of Dupuytren at the Hôtel Dieu. The woman was twenty-seven years of age. The vagina did not exceed one inch in length, and behind the cul-de-sac in which it terminated the rectum only was found. Above and behind the bladder were found the broad ligaments, with the Fallopian tubes and ovaries; where the tubes met there was a small solid tumor with only a slight resemblance to the womb. The mammæ were well developed, and the external genitals were well formed, and there was nothing masculine in the appearance of the woman. She had never menstruated.

If we investigate more deeply in the pelvis for causes of sterility in women, we come upon a region outside the strict jurisdiction of the medical jurist and discover a certain class of occult organic causes demonstrable by dissection only, and of interest to the pathologist. Such are the diseases or the congenital absence of ovarian or Fallopian tubes. But even here the medical witness may be ready with well-acquainted facts touching some of these imputed causes of sterility. He will be able to declare that persistent amenorrhea is not inconsistent with pregnancy; that many women who have never menstruated have borne children; that many women have continued to menstruate after the loss of both ovaries by ovariotomy; and that women have borne children after one ovary has been removed. Of all these, he will be able to cite illustrative cases.

The author can not better summarize these observations on

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the causes of impotence and sterility, in both sexes, than to quote the words of Orfila :

1. "There are certain causes of impotence in both sexes, appreciable by us, which are absolute and irremediable. It is sufficient to point out the existence and character of these causes in order to prove that the individual is impotent.

2. "Certain other malformations, evident on inspection and palpation, and remediable by art, give rise to *temporary* impotence.

3. "Mental and moral causes are not sufficient to establish an irremediable degree of sexual incapacity.

4. "When the plea of temporary or relative impotence is set up for any reason, for instance, to meet a charge of bastardy, nothing but medical proof that the disability really existed (the evidence being established at the time of intercourse) could safely be admitted in law.

5. "Sterility can be admitted in law in a case of incurable impotence only.

6. "In every other circumstance all that we are entitled to assume amounts to mere suspicion insufficient to lead to the dissolution of a marriage or to the disinheritance of an infant."

The author will conclude this subject by some memoranda as to the method of conducting an examination in cases of alleged impotence.

Fortunately for morals and our sense of decency, we live at a time when such an examination is possible without involving grossness and indecency. Physicians of two centuries ago were less enlightened as well as less morally clean than those of to-day. The annals of forensic medicine contain descriptions of the most disgusting methods practised for the determination of questions relating to virility.

But, happily, for the interests of morality all such vile and low expedients have long been abandoned. They were superfluous as well as vile, because all that the medical jurist is required to do, or should try to do, is to prove a condition of things best described in a negative form. That is to say, when a given case of impotence or sterility is presented, and the Court asks of the expert : "Is this man impotent?" or "Is this woman sexually incapacitated?" he may, as a general rule, very properly answer in his report that his examination has revealed nothing justifying the conclusion that the person examined is not capable of sexual duty.

Like the function of digestion, the function of reproduction is presumed to be normal in all adult individuals, and the possession of this normal power neither requires to be nor can be

proved to exist by medical evidence. Accordingly, the task of the expert in a disputed case of virility or fecundity is to ascertain by the physical examination of the individual in question whether any obvious absolute conditions exist which are clearly sufficient to stand in the way of the function of reproduction, and which are irremediable.

Thus, he will note the age, general appearance, habit of the body, and state of the health of the person examined; he will learn the family history and the personal clinical history; he will inspect the genital organs with care, noting their degree of development and their obvious anomalies, if any exist; he will explore all openings and canals by probes, sounds, or catheters, making bimanual palpations and other such examinations to determine the exact physical condition. Beyond this, he has neither the excuse nor the obligation to go.

CHAPTER VII.

RAPE.

THE violation of a woman's chastity (sexual intercourse with a woman against her will and without her consent) has in all times and in all civilized countries been regarded as a crime of the most felonious character; "and rightly so, since chastity is the bond and safeguard of almost all the social virtues and of all domestic happiness; and so, more broadly, it becomes intimately related to the well-being and progress of the State itself."[1]

The statute at present in force in Massachusetts is as follows:

Chapter 466.

AN ACT relative to the punishment of rape.

Be it enacted, etc., as follows:

Section 1. Whoever ravishes and carnally knows a female by force and against her will shall be punished by imprisonment in the State prison for life, or for any term of years.

Section 2. Whoever unlawfully and carnally knows and abuses a female child under the age of sixteen years shall be punished by imprisonment in the State prison for life or for any term of years, or for any term in any other penal institution in the Commonwealth.

Another statute relating to indictments for rape defines the crime as follows:[2] "The unlawful forcible carnal knowledge by a man of a woman against her will and without her consent; or the carnal knowledge by a man of a female child under the statutory age of consent."

The legal meaning of rape is sufficiently plain in the words just quoted. It is carnal knowledge of a human female by force and against her will. But what, in law, is "carnal knowledge?" Until the beginning of the nineteenth century there was no real agreement on this matter among authorities. But in the time of George IV., Parliament made a law for England, which was adopted by American writers. The crime of rape,

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[1] Tidy's *Legal Medicine*, ii., 182.
[2] *Revised Laws*, 1902, chapter 218, section 38.

according to current rules of law, is established on proof of penetration of the vulva only, without any invasion of the deeper parts as a necessary element. The vagina may not be involved; the hymen may escape all injury; and if the victim of the attack can show that the assailant entered her person *at all*, however slightly, it is enough to prove an indictment.

The expression "partial penetration" is not recognized in law; therefore, the principle under which the law acts is that the *intent* is the same whether much or little is attained.

It is the beginning and not the consummation of the lustful assault which appeals to the lawmakers. And this wholesome rule, which is equally applicable to all cases, is all the more imperatively protective with reference to children under the age of consent, which, in the majority of the United States, is fourteen years.

Defloration and rape are to be distinguished one from the other, and this distinction is suggested in what has just been said. Defloration is the effect of first intercourse upon the ostium vaginæ. It may result when the act is freely granted; it does not at all of necessity involve felonious purpose. To be sure, it *may* be an element in rape, but not necessarily so, for rape is rape, as we have seen, when much less than defloration is accomplished.

The estimate of the lawmakers relative to the crime is reflected and expressed in the punishments which have, from time to time, in various countries and under various conditions of progress, been provided.

The Athenians, according to Gibbon, punished the ravisher with death. Among the Romans, the law provided for the death of the convicted ravisher or the confiscation of all his property. Among the ancient Jews, if the victim of a rape was a betrothed damsel, the death of the ravisher was the penalty; if she was other than a betrothed girl, and was unmarried, the enforced marriage of the parties resulted. In England rape was a capital crime, punishable with death until the reign of the late Queen Victoria; it is now regarded as a felony, and is punished by prolonged imprisonment, with hard labor attached.

Force Defined.—The law uses the expression "by force" in connection with the carnal knowledge which constitutes a rape—"whoever ravishes and carnally knows a female *by force* and against her will." This implies, of course, that the force is such as suffices to overcome the will of the victim—not that it is necessarily *physical* violence. There are many examples of rape demonstrated by satisfactory evidence without any

proof, medical or other, that *physical* violence was not used; yet in the meaning of the law the act was " by force." Thus there are many instances of the crime under circumstances which rendered the woman incapable of resisting or of making a demonstration that her consent was withheld. A woman, for example, under the influence of terror from the use of threatening language or actions may yield without resistance. Here the force used is *moral* force, but none the less unlawful. Or if the woman is under the effects of narcotic drugs, ether, coma, hysteria, or hypnotism, and thus unable to give or withhold consent, the sexual connection under such circumstances is held to be by force and punishable. Sometimes in connection with this element of *force*, certain curious questions arise and queer defences are made :[1]

" In the trial of a man indicted for rape, the complainant, a married woman, testified that the defendant and some others seized her on the street at night and carried her into an alleyway, where he and the others ravished her. There was a verdict of guilty, and the defendant moved for a new trial. The defendant requested the Court to charge the jury that, to constitute the crime of rape, it was necessary that the complainant should have manifested the *utmost* reluctance, and should have made the *utmost* resistance. The Court did not comply with this request, and the refusal to do so was made the ground for asking a new trial. The importance of resistance was held by the Supreme Court of Appeals to show two elements in the crime : Carnal knowledge by force by one of the parties and non-consent thereto by the other ; and the jury must be satisfied of the existence of these two elements in every case, by the resistance of the complainant if she had the use of her faculties and physical powers at the time, and was not prevented by terror or the exhibition of brutal force. So far, resistance by the complainant is important and necessary ; but to make the crime hinge on the uttermost exertion the woman was capable of making would be a reproach to the law as well as to common sense. Such a test it would be exceedingly difficult, if not impossible, to apply in a given case. If the failure to make extreme resistance was intentional, in order that the assailant might accomplish his purpose, it would show consent ; but without such intent it shows nothing important whatever. A new trial was not granted."

The Age of Consent.—The law very properly makes a distinction with regard to the age of the victim of rape, and establishes a limit of considerable importance. Girls in Massa-

[1] *Boston Medical and Surgical Journal*, January 29, 1880.

chusetts, under the age of sixteen, are regarded by the law as technically under the "age of consent," as it is called. That is, children under puberty are presumed to be incapable of understanding the nature of the crime, and in consequence of this undeveloped moral sense they are supposed to be lacking in that discretion which gives or withholds consent intelligently. Sexual intercourse, then, with girls under this age of consent (an age arbitrarily established by the Legislature) is held to be a crime of the same nature and degree as it is when the victim is a woman over sixteen years of age, who resents and resists the intrusion, and does not yield her permission.

In the latter class of cases there must be evidence of an overthrow of the will. In the former class (little girls) such evidence is not required. In women and in girls above the age of consent, the consent of the female does away with the imputation of crime and is a valid defence, and a very common one. In the class of young girls and children who are incapable of sexual desire or of discretion, the element of force and of resistance is not taken into account. Because of the greater depravity implied in an attempt at sexual connection with a little girl, helpless, innocent, and ignorant, the pains of the law have always fallen most heavily in cases of conviction under this class. In all accusations of this kind the proof of the crime rests not on the behavior of the young victim, or the amount or kind of force used, but upon the fact that sexual intercourse has been effected or attempted, and upon that alone. In England, indeed, it has been decided that consent does not excuse or alter the nature of the crime when the female is of these tender years ; even solicitation by the child does not extenuate it or afford a good defence.

The age of consent differs in different communities. For example, in the majority of the United States it is fourteen. In Alabama it is ten ; in Mississippi it is ten ; in Louisiana it is twelve ; in Texas it is twelve ; in Iowa it is thirteen ; in Nebraska it is fifteen ; in New York and Pennsylvania it is sixteen ; in Kansas and Wyoming it is eighteen. In England it is a felony under thirteen, and a misdemeanor between the ages of thirteen and sixteen.

With changes in the sentiment of the community touching social morals there is apt to be a modification of the statutes to correspond. Hence, from time to time, the Legislature has been asked to raise the age of consent. Petitioners have usually been women interested in social reform. Thus, in Massachusetts, changes have been marked. Prior to 1886

the age of consent was ten years; in that year it was raised to thirteen years. Encouraged by previous success, another attempt to raise the age was made in 1895, this time to eighteen, but this was unsuccessful. In this matter there may be danger of overdoing the protective principle. For obvious reasons, if the age of consent is made too high, the door of opportunity for evil practices is opened, instead of being closed and bolted.

The writer was called to investigate the case of a school-girl who was caught in secret childbirth, a few weeks after her sixteenth birthday. Her newborn baby was in a slop-jar and its living was thus prevented. Her room was across the entry from that of the young man the avowed father of her child. Access and temptation were easy, and common sense forbade proceeding against the young man for participation in an act in which the girl was a willing partner. She had the physical maturity of a girl of eighteen or nineteen years.

The reason for protecting little girls by means of a statutory "age of consent" is very obvious. Their immature moral sense and their undeveloped will-power make them the easier victims of lust, and hence the greater need that the law should shield them. For the same reason it is held to be rape if a man has intercourse with an *idiotic, imbecile,* or *insane* woman, she being deemed incapable of intelligent submission.

But suppose the woman to be an adult and mentally sound, and that she submitted from *ignorance as to the sexual character* of the act, the crime would still be rape. In England a case occurred recently in which a physician was tried on this charge.[1] He had sexual intercourse with a young girl who made no resistance solely because she believed that the defendant was, as he represented, treating her medically. All the judges held the case to be rape. A similar instance occurred in England still more recently.

But if these instances of rape under peculiar conditions with regard to the mental state of the victim, her youth, defective or perverted intellect, form one extreme wherein the force used was moral force, there are other certain cases at the other extreme in which the fact of sexual intercourse being proved or admitted, something further is needed to establish the criminal and violent nature of the act. The criminality of the intercourse in these cases consists alone in the physical force which has been used to accomplish the unlawful purpose. Thus it has been recognized in law that a rape may be committed on a common prostitute, or by a man on his mistress, or even on

[1] Wharton and Stillé, *Medical Jurisprudence,* ii., section 273.

his own wife, the previous character, condition, and reputation of the complainant being considered as of no effect as a bar to the prosecution; but only as requiring so much the clearer and more decisive proof of physical violence to compel surrender. It is less likely that a woman of easy virtue would resist to the same degree, other things being equal, as would a chaste woman. Hence the need of conclusive proof when complaints are made of the crime of rape; and in this proof must come anatomical evidences of traumatism to corroborate the woman's statements. In these cases something more than alarm or terror must be shown.

Concerning the time of entering the complaint: Delay is no bar to a prosecution, but it is a serious obstacle to conviction. The old Scottish law held it indispensable that a woman who had been ravished should not delay making her complaint *ultra unam noctem;* if so, her complaint was not listened to. Now, however, this strictness is not observed, though any undue delay in communicating the outrage, at least to her most confidential relatives, and any long postponement of a medical examination, still form serious drawbacks to a woman's testimony. The evanescent character of the physical appearance of rape makes an early submission to medical inspection of much importance, and the earlier a woman gives an account of her wrongs and has her story confirmed by a proper medical examination, the greater will be the chance of convicting the ravisher. The English law prohibits bringing a " prosecution-proceeding " for rape if more than three months have elapsed since the alleged commission of the crime, and the victim was between the ages of thirteen and sixteen, or the attempt at rape was made upon an idiotic or imbecile woman. Certainly, it may be remarked, generally, that the longer the delay in calling attention to the signs of the alleged assault, the greater is the suspicion that the complaint is not genuine or well-founded.

Finally, concerning this preliminary review of the legal relations of rape, what kind of evidence is required in the courts to prove a charge of this crime? It is obvious that, from the nature of things, the crime is usually attempted and completed when the victim and the ravisher are alone or suppose themselves to be so. It is for this reason that the evidence of the woman only was formerly held to be sufficient. At present, however, the courts generally seek for further evidence which shall be corroborative. The facility with which a woman, who has yielded willingly to a man's advances, may set up a charge of rape against him, and the dif-

ficulty of disproving it, render such confirmatory evidence of great importance. Hence it is very generally the custom to summon medical testimony to substantiate or to refute the statements as to violence, and to speak concerning the physical appearances which are left as the effects of the violence, if it has actually occurred.

In proceeding to study this purely medical side of the subject, a clearer apprehension of it will be promoted, if what is said is arranged under three heads:

1. The violation of little girls under the age of consent (ten to sixteen years).

2. Rape after the age of consent and before the woman has been deflowered otherwise—that is, rape of an adult virgin.

3. Rape of adult women who have been accustomed to sexual intercourse.

The Violation of Girls Under the Age of Consent.— It is a suggestive fact that the records of the courts and of medicolegal writers show that the majority of the victims of felonious sexual assault are of tender age, too young to offer resistance, or to comprehend the character of the violence of which they are the recipients. Tardieu gives these statistics: Of 22,017 cases which had been brought before French courts in twenty-five years (1851 to 1875), of which he had notes, he found, on investigation, that 4360 cases were of rape of adults, and 17,067 cases of children; a percentage of 77 of the latter. Of 356 victims of rape, Delens found that only 5 per cent. occurred in women over twenty years of age. In cities the cases occur mostly among children, and in the country among adults. Casper has records of 406 cases, in which 70 per cent. of the cases occurred in children from two years and half to twelve years, and 84 per cent. in children under fourteen years.

There are several reasons for this preponderance of cases among little girls. Among these is the comparative ease with which a man's assault may be committed and his lust gratified, because of the immaturity and physical weakness of the victim. Another reason springs out of the disgusting and altogether repulsive and horrible idea entertained by the ignorant and profligate that if a man afflicted with gonorrhea has connection with a healthy chaste virgin, he will be cured of his venereal disease; and little girls are made use of for this purpose as being least likely to offer resistance. Woodman and Tidy assert that this filthy superstition is very widely prevalent, and that old women doctresses not infrequently

prescribe this criminal act to young men who consult them about urethral discharges.

Brouardel makes this comment:[1] " People unfamiliar with medicolegal practice have an idea that a rape or an attempt at rape is a struggle in which a young man, in full vigor, amorous, excited, brutal, endeavors by violence to obtain the favors of an attractive young woman, who succumbs to him only after energetic resistance. All the details in this picture are false or only exceptionally true. The reality is much sadder, if possible. Most often the guilty party is an individual having some authority over the victim by right of relationship or neighborhood. Frequently the assailant is one weakened by old age or intemperance, not one excited by lust or by sexual passion. The victim is a little girl, defenseless, generally a mere child with stunted intellect, bred in poverty, one upon whom it is easier to distinguish the disorders and effects resulting from repeated acts to which she has habitually consented, rather than traces of a single brutal assault leaving the evidences of the violence used."

Now, it is easily understood that the physical effects, the objective proofs, of the violation of young girls and children offer all varieties, in their acute primary manifestations, from the most serious and even fatal injuries, to the most superficial and evanescent lesions. This great diversity is necessarily determined (1) by the amount of the force and violence used; (2) by the degree of resistance exercised; (3) by the relative disparity in vigor of the two. From the undeveloped state of the sexual organs in the young girl, sexual intercourse as a complete act can not be accomplished without producing extensive injury, for obvious reasons. But that such intercourse is possible with such consequences is attested by recorded instances, where the resulting lesions were lacerations of great severity.

Taylor gives the following striking instance:[2] A female infant of eleven months was with her mother, who was among some camp-followers. A soldier on the march took the child to carry it. The child was well when he took her. He walked on quickly and was out of the mother's sight in half an hour. When she came up he had the child standing on the ground facing him, and he was bent over it; one hand held the petticoats up and the other was covered with blood. He told the mother that the child was ill and passing blood. Next morning, on washing the baby, marks of violence to the genitals

[1] Hofmann, *Legal Medicine*, Brouardel's Notes, p. 671.
[2] *Principles and Practice of Medical Jurisprudence*, ii., p. 444.

were seen, and a surgeon, who was called in, found the child
in collapse; it died in a few hours.   On examination all the
external parts were found to be torn and inflamed; the
perineum was torn nearly through; the nymphæ and the
mucous lining of the labia were lacerated; the whole present-
ing the external appearance of a large wound.   The vagina
was greatly dilated and torn from its attachment to the neck
of the uterus posteriorly, making a large rent into the abdom-
inal cavity in which a quantity of bloody serum was effused.
Of this case, Hofmann says:[1]   "One can not admit that these
lesions were produced by the penis; they appear rather to
have been the result of brutal manipulations made with the
hand; favoring this hypothesis is the fact that the mother
found the soldier's hand bloody when she reached the spot
where her baby was."

Several years ago a thrill of horror ran through the com-
munity when the news was received of the terrible death by
burning, to which the citizens of Paris, Texas, subjected a
negro in the month of January, 1893.   The crime for which
he suffered this fearful penalty was intimated, but not detailed
at the time, in the newspaper accounts.   A correspondent, Dr.
J. M. Fort, in the *Virginia Medical Monthly* for March, 1893,
reports the facts of the case thus:

"A little flaxen-haired girl, aged three years eight months
and five days, was picked up at her father's gate about night-
fall by a tall, lean, raw-boned negro, about thirty years of age,
and about one hundred and seventy-five pounds in weight.
The negro carried the child to a secluded wood on the out-
skirts of the city, and there, after night, perpetrated a crime
unheard of in the annals of history.   The question as to how
he accomplished the act was asked the negro, and he answered,
'I smothered the child's cries by putting my hand over her
mouth.   I then tore the parts and made them large enough to
force an entrance.'   The child was outrageously torn and
mutilated.   The examining physicians report complete lacera-
tion of the perineal body, the rupture connecting the vagina
and abdominal cavity, so that the penis of the negro must
have passed immediately into the abdominal cavity.   It was
not learned, as the brutal negro did not seem to know, at
what stage of this torture the child died.   The child was
choked until its tongue lolled from its mouth, and remained
so.   The bruises from the grasp on its throat were plainly
defined."

There are cases at the other extreme which the law regards

[1] *Loc. cit.*, p. 94.

as rape, but in which the medical proof of the act is difficult and sometimes impossible. In the legal sense, rape may be a matter of merely vulval penetration, not necessarily of vaginal entrance or of seminal emission, the beginning and not the end of the act being the material fact to be proved. The hymen may remain uninjured, and the effects on the external organs may even be wholly negative. In such a case, where the medical inspector finds nothing, however clear the other evidence may be, he is bound to declare accordingly. But he must admit that such negative results are insufficient to control other proof, and that they are not inconsistent with evidence otherwise well based.

The author saw the following case at the Boston City Hospital in June, 1892: A girl of eleven years of age said she had been seized by a man in a dark entry, and that he had made an indecent assault upon her and hurt her. She told her mother after three or four days, and she was examined at the City Hospital several days later. Only some redness and abnormal moisture about the vulva remained. The man was indicted, and spent six months in prison.

In such instances of relatively trifling injuries, the error, if error it is, lies in the law which has relaxed its force as to the stringency of the required proof of violation. This relaxation, while designed unquestionably to afford greater protection to chastity at all ages, has, on the other hand, opened the door pretty widely for the entrance of fraudulent charges of rape preferred by unscrupulous mothers or other kindred for the purpose of levying blackmail and getting money by fraud.

Fraudulent Cases.—It behooves the physician, therefore, to be on his guard in examining children under puberty, lest he unwittingly become, on the one hand, a party to the prosecution of an innocent man, or, on the other hand, an agent for the discharge of a scamp whose intentions to gratify his lust on a young girl were none the less wicked because in his execution of them he did not leave strongly marked traumatic lesions. A proper and conservative caution will constrain the medical man to be thorough in his examination, and to make repeated inspection of the child's genitals if earlier examinations are unsatisfactory.

That these fraudulent allegations of rape on children, sometimes for the purpose of extorting money, sometimes for gratifying revenge, are not fanciful is fully recognized by medico-legal authorities. Many such cases are on record. Foderé relates a case in which the mother of the child not only sub-

orned a witness who testified to the alleged fact of rape, but attempted by irritating her child's genitals to simulate the appearances of rape. Ogston tells of another case in which a respectable married man fifty years of age was arrested in Aberdeen on a charge of rape, alleged by the mother to have been committed on her child of eight years. The child, examined apart from her mother, told a plausible story which tallied in all respects with the mother's account. The child's genitals, however, afforded no proof of any attempt to violate her, and the accused was able to show that he had merely passed in and out of the woman's room, and had not spoken to the child.

Tidy[1] reports that a girl eight years of age, said to be the victim of a criminal assault, showed violent inflammation of the vulva, and swollen labia with numerous erosions. The nymphæ were congested and edematous. All the parts were much inflamed and covered with thick greenish pus; the hymen was unhurt. Several enlarged glands were felt in each groin. She was cured in fourteen days. The child ultimately confessed that the condition presented by the parts resulted from rubbing them with a blacking brush.

Casper gives an instance which illustrates the extremity to which these sham cases are carried occasionally; this case can hardly be paralled: A tradesman of irreproachable character was accused by a woman of having violated her daughter, a child of eleven years, and of having given her a gonorrhea. The child was scrofulous. Her clitoris was unusually developed, and the entrance to the vagina was inflamed and painful to the touch; the hymen was obviously stretched, and there was a copious urethral discharge. On examination the defendant was found to be free from disease, and the cross-examination brought out the fact that the mother, after fruitlessly endeavoring to extort money from the tradesman, had delivered her child to her own paramour whom she knew, from her own condition, to be affected with gonorrhea.

Although it is perfectly possible for a rape to be accomplished on a little girl within the limitations established by law, and no anatomical lesions be left as its result, nothing upon which the desired medical evidence can be based, yet this is not true of the majority of cases, even under the present legal definition of rape. Tardieu has notes of 632 cases which were brought to his notice, and in more than two-thirds of them he was able to find ample proof to corroborate the charge. There is good reason for this in the youth and delicacy of the

[1] *British Medical Journal*, November 20, 1880.

organs, and, on the other side, in the brutality of the manipulations or the violence of the assault.

Signs of Rape.—The usual objective affirmative signs of a rape which the external genitals of a little girl show, if seen soon after the assault, are these: The vulva is swollen, red, hot, and tender. There are ecchymoses, excoriations, and perhaps erosions of the mucous membrane of the labia majora. The region of the ostium vaginæ is especially inflamed. The examination is difficult because of tenderness, and it may require ether or cocaine in a 20 per cent. solution as a local anesthetic. Micturition and defecation are painful. The manner of walking is suggestive; it is not upright, but approaches a straddling gait. These are the usual physical signs when the lesions represent moderate severity only, short of the violence which produces lacerations, followed perhaps by sloughing, or a great degree of traumatic injury easily interpreted.

Then, finally, what Tardieu calls the "capital sign," a purulent or muco-purulent discharge from the genitals, appears. Its color is greenish-yellow; its quantity is abundant; its development is rapid. It begins on the second or third day, sometimes earlier, and is attended with severe smarting. It is announced to the mother of the child by the attempts to relieve the itching with the fingers at the genitals, as well as by the soiling of the child's clothes. In color and consistence it is with difficulty to be distinguished from the usual discharge of the primary stage of gonorrhea, and it is particularly liable to be mistaken for actual gonorrheal infection when, as sometimes, though rarely, it happens that the mucous membrane of the urethra is also affected, and secretes a discharge. Casper says that this characteristic discharge is almost constantly found in children from twelve to fourteen years old whenever the genital organs have met with rough usage by an attempt at rape or otherwise. So far as the legal relations of the case are concerned, it matters not whether the assailant has given his victim a traumatic blennorrhea or a true gonorrhea, except that the latter should by so much the more increase the weight of his punishment, if he is convicted. But it does become of the utmost consequence that the physician called into the case should know and recognize the fact that not every case of vulvitis or of vaginitis in a little girl is evidence of a rape, since he should be in a position to testify clearly whether the appearances which he has observed are or are not those which would reasonably and probably follow an attempt at criminal intercourse. There

are many instances in which a purulent discharge, with aphthous inflammation of the vagina, is met with in young girls, which, upon a superficial examination, might readily be mistaken for gonorrhea or the results of violence, but which in reality are the consequence of natural causes, developed spontaneously.

It is all the more important to know this, because spurious cases and false accusations are readily based on misleading signs. Great caution, therefore, should be used in reaching conclusions from examinations, which should be repeated if there is any doubt, and the physician should insist on seeing the man in the case in order to determine his state.

The causes of the idiopathic forms of vulvitis are ascarides, uncleanliness, a scrofulous constitutional condition, with neglect and low nutrition. A diagnosis between a gonorrheal and a traumatic vaginitis is somewhat more difficult than that between the *latter* and an idiopathic inflammation. It is of small practical consequence from the present point of view, since gonorrheal infection of a little girl, indisputably demonstrated, presumes guilty approaches by some man carrying the disease; although the possibility, remote indeed, of other methods of inoculation is not to be forgotten.

Traumatic Rape.—The onset is rapid, and its maximum is reached in from three to five days; its course is short, the cure being consummated in from fourteen to twenty days. The lesions are limited to the vulva and vagina; other mucous surfaces are free. Swelling, redness, and tenderness of the genitals are quite general and uniform. The discharge is profuse, thick, and of a greenish-yellow color.

Gonorrhea (Rape with Infection).—Its onset is slower than in traumatic rape, the maximum being reached between the fourth and the eighth day. Its course is long and obstinate, extending through weeks or months. The urethra is complicated; the vessels around the ostium vaginæ are much injected; and the discharge is very abundant and greenish in color. Buboes are not unlikely.

Catarrhal or Idiopathic Vulvitis and Vaginitis.— The development is slow and the duration is prolonged. There is considerable constitutional disturbance, and other mucous surfaces are involved. Eczema of the thighs is common, but there are no traumatisms. The discharge is relatively scanty and creamy in consistence.

As an aid in establishing the differential diagnosis, we ought not to forget the service which bacteriology can render. The detection and demonstration by culture-methods of the specific

organism of gonorrhea, the gonococcus, is of great value in enabling one to reach a conclusion. The technic is well known.

Finally, we may find as *late manifestations* certain ulcerative processes about the vulva, which should be taken into account as possible secondary elements in the diagnosis of a rape. The usual ulcerations seated about the female genitals are: 1. Indurated chancre. 2. Soft chancre (chancroid). 3. *Plaques muqueuses.* 4. Superficial ulcerations due to the intensity of the vulvitis, either idiopathic, traumatic, or gonorrheal. 5. Herpetic inflammation and ulceration.

Indurated or true chancre presents specific characters sufficiently easy to recognize. If there is any doubt, it is best to wait, for time will decide. Absence of induration and of glandular non-suppurative, secondary infection means non-specific ulceration, as a general rule.

Regarding chancroids, Hofmann[1] says: "It is often very difficult to distinguish the soft chancre from other ulcerations, particularly the traumatic sort." The seat of the ulcer is not a guide; frequently chancroids are found on the labia majora, at the entrance of the vagina, and about the inferior commissure. The same locations are found for catarrhal and traumatic lesions.

The base and borders of chancroids are quite similar to those of other ulcerations. The main distinction, after all, is found in the progress of the ulcer. Chancroids extend rapidly; ulcerations, erosions, and traumatisms remain limited to parts originally involved and heal much more rapidly than specific lesions. Glandular hyperplasia with suppuration belongs to both kinds of ulcer, but is most often seen with chancroids. Chancroids may be reproduced by inoculation; other ulcerations, though they may extend by inoculation, make a small local inflammation, and they never give the results or progress which characterize chancroidal pus.

As to herpetic ulceration, Fournier gives the following diagnostic points:

In Herpes.

There is no affection of adjacent glands; the base is soft; the contour is scalloped from the running together of many small circles. The limitation is rapid; cicatrization is rapid, and is attended with itching. Erosions are habitually multiple, of small size—often miliary. They are more superficial than in chancre.

In Chancre.

Adenopathy is constant; the base is indurated; the contour is never scalloped; the lesion has a round, punched-out aspect. The limitation is slow; cicatrization is slower generally, and is indolent, without itching. The lesion is generally single; the disease is extensive—more than herpes. It is less superficial than in herpes.

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[1] *Loc. cit.*, p. 82.

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Another form of severe genital disease is liable to give rise to error; this is *noma pudendi.* It is a rare condition, and so may easily deceive. It consists in an unhealthy septic inflammation about the external genitals, speedily ending in necrosis, and generally proving fatal. The inflammation previous to the gangrenous stage is not attended by any discharge, a negative sign of some value in helping to exclude traumatic or idiopathic vulvitis. Casper calls the initial appearance those of *pseudochancre.* Velpeau describes the disease as beginning with a grayish-red or blackish vesicle; this ulcerates and sinks below the level of the surrounding tissues. The gangrene extends and the labia are covered, as this extension proceeds, with a fetid sanious discharge. The constitution of the child suffers severely, and a typhoid condition leads at length to a fatal termination.

The cause of the disease is not well understood; occasionally the affection is endemic. Its development might easily mislead ignorant parents into a suspicion of criminal acts directed against the child, but a physician, if he sees the case from the beginning, ought not to be deceived. It happened, however, rather singularly, that the *first* case of the kind in which the attention of the medical profession was called emphatically to the subject, was one in which there were such grave suspicions that both legal and medical authorities were temporarily deceived by it. The case is related by Dr. Percival: Jane Hampson, four years old, was the patient. The mother stated that the child complained of pain about the genitals, the day before she was seen as an out-patient. On examination, the parts were found to be inflamed and tender. The girl had slept two or three nights in bed with a boy of fourteen, and she had complained of being hurt by him. Although appropriate local treatment was applied, the child grew worse and died ten days after the onset of the symptoms. An inquest was held, at which the attending physician of the girl testified that, in his opinion, the child's death was due to external violence. A verdict of murder was found against the lad. Not many weeks elapsed, however, before several similar cases occurred in which there was no suspicion of violence, and in a few of these the patients died. The physician was convinced that there had been an error in his testimony. Accordingly, when the case was called for trial, a candid statement of the mistake led to a dismissal of the complaint and the discharge of the accused.

There are certain negative considerations that have reference to rape as it is studied in connection with this class of victims—

little girls. In these young subjects we do not commonly find any injury to the hymen; its deep-seated location, the narrowness of the pubic arch, and the immaturity of the parts all serve to protect the ostium vaginæ under ordinary conditions. Hemorrhage and blood-stains are absent, too, as a rule, because there is no vaginal entrance to cause the evidences of rupture of the tissues. Moreover, injuries on other parts of the body at a distance from the genitals are not to be expected, since there is no resistance and struggling. Evidences of seminal staining are not impossible in these cases. If stains are present, we may be required to identify their character. This subject will be taken up in the next chapter.

Tardieu describes certain lesions and alterations in the genitals of little girls, indicating, in his belief, more or less frequent repetitions of the crime upon them. Among these he mentions the following: Premature development of the external genitals; the labia majora are thick and widely parted; the labia minora are enlarged and project beyond the outer labia; the clitoris is red and swollen; the ostium vaginæ is dilated; the hymen is forced inward and upward so as to make a vulvar infundibulum or funnel-shaped depression; the hymen is also thinned and reduced to an annular curtain which is stretched but not ruptured.

These changes, coupled with an excessive precocity of manner, are the evidences which demonstrate to Tardieu that the girl is habitually sacrificed to lust.

CHAPTER VIII.

RAPE OF YOUNG WOMEN. THE SIGNS OF VIRGINITY.

THE study of the violation of chaste virgins suggests three questions applicable to any given case, assuming the allegation of sexual intercourse to be true : 1. Whether sexual connection occurred now for the *first time*. 2. Whether it occurred at the *time alleged*. 3. Whether it was forced and without the *consent* of the woman, and so unlawful.

The first question brings us at once to a most important topic in relation to the general theme, namely, the **signs and proofs of virginity.** The most curious and absurd notions have from time to time obtained recognition and have been published as to the signs of virginity. The earlier works on forensic medicine contain some comical descriptions relating to this subject. One old author, for example, speaks of " the fresh rosy lips and bright beaming eyes, with a free yet modest look," as being peculiar to virgins. Roman writers describe as a sign of matronhood and so, negatively, of the loss of virginity, a swelling of the neck resulting from defloration. Hence, it was a custom at the time of marriage to measure the throat before and after the nuptials. About the same reliability is to be placed on the imputed change in perspiration and in the direction of the urinary stream which some authors have described.

It had been the custom of writers on forensic medicine to repeat, one after the other, the usually accepted signs of virginity until Parent Duchatelet showed the unreliability of many of them by finding them present in the persons of Parisian prostitutes. He was led to make the investigation by the following occurrence: Two young women of Paris complained to the police that they had been insulted on the street by some young men, who called them common prostitutes in the hearing of those passing. The men were summoned before a magistrate. They claimed that the known character of the girls was a justification of the offensive epithets. The girls offered to submit to a medical examination

as to their virginity. The proposal was accepted and a reputable physician was appointed and sworn by the magistrate to perform the duty. He reported that, in respect to one of the girls, he was wholly unable to say whether or not she was a virgin; she might be and she might not. But the other one he *thought*, was *not* a virgin, though he would not swear positively. It subsequently transpired that both the women were prostitutes, and that each had been a patient two or three times in the hospital for syphilis.

This incident led Duchatelet to make an elaborate investigation concerning the usual state of the genitals of prostitutes. This inquiry he made carefully, with skilled aid. The results which he formulated were as follows:

The **external genitals** of prostitutes do not present any absolute uniform differences or appearances to distinguish them from those observed in married and chaste women. There were young girls, recently engaged in prostitution, who had vaginas as large as those of women who had borne children. On the other hand, there were many women who had been twelve and fifteen years on the town, who showed the signs of premature age, but whose vaginas and other parts presented nothing noteworthy. Duchatelet found one woman, fifty-one years of age, at the Pension de Madelainettes, who had been a prostitute from the age of fifteen, and whose genitals might readily pass for those of a girl of eighteen. Such observations, made with great care, on a large scale, and impartially, are well calculated to lead to a revision of many of the classical proofs of virginity, those that have been handed down from author to author as a sort of inheritance. It is well to test the value of authority of this kind by new investigations from time to time.

In this matter one will do well not to rely too much on any one of the reputed indications of virginity. A careful review-comparison of all the data is requisite. What are these? First, of the less important: The **breasts** of the virgin are undeveloped in their relation to the rest of the body; the texture of the organs is firm; they are conical; the nipple is small and the areola around them is narrow and without pigmentation.

Regarding the **genitals**: The labia majora are firm in consistence; they are symmetrical; they are in close apposition; covering the urinary meatus and the deeper parts.

The **labia minora** (or nymphæ) are relatively small; they are concealed within the external labia; they are of smooth and delicate texture; they are unwrinkled, and of a pinkish-

red color, in contrast with the yellow or light brown found under other conditions.

The **clitoris** offers evidence of little value. If it is small or undeveloped, it presumes virtuous virginity. Brouardel, however, found three sisters, undoubtedly intact virgins, in whom the clitoris was congenitally enlarged. Climate has some effect in this matter; so does self-abuse, short of sexual intercourse.

The **fourchette** and **posterior commissure** should form a sharply defined bridle or curtain at the posterior part of the vulva, with a well-defined fossa navicularis within it. This part is rarely destroyed by intercourse, but frequently yields at the first delivery.

The **vagina** of virgins is narrow and constricted; its rugæ and columns are well defined; and its tissues are smooth and soft.

All these parts and organs, developed typically, are of value as presumptive indications of virginity. Their value is somewhat impaired by two sorts of exceptions: 1. Prostitutes may show every one of them. 2. Accident, disease, faulty nutrition, evil habits, and prolonged and repeated gynecological examinations may obliterate them from the genitals in virgins who are wholly innocent of the sexual act.

There is, however, one portion of the vulva whose intact condition is regarded as of more importance than all the others put together. This part is the hymen. Its medico-legal relations have for many years been a fruitful theme for controversy. Its existence at all is doubted by some of the elder writers of repute (Paré, Buffon, etc.). Beck gives a long list of doubters. But to-day it would be rather unsafe to be skeptical on this point. The best modern authorities assert its constant presence in the untouched virgin ostium vaginæ.

Devergie found it in subjects at all ages, from infancy to old age. Its alleged absence is declared to be due to imperfect inspection and report. Casper says that in several cases in which it was first reported absent a reëxamination found it. Hyrtl declared its absence in **double** vagina, but Hofmann asserts that he has found it even here.

There is some variety in its situation. In infancy and childhood it is deep, requiring wide separation of the thighs to find it. It is vertical in childhood; more **horizontal** later.

The **typical** shape is described as **annular** with a central round orifice. This is rather rare, however; the orifice is usually excentric (away from the center), and anterior rather than posterior. This determines changes of type from the

PLATE I.
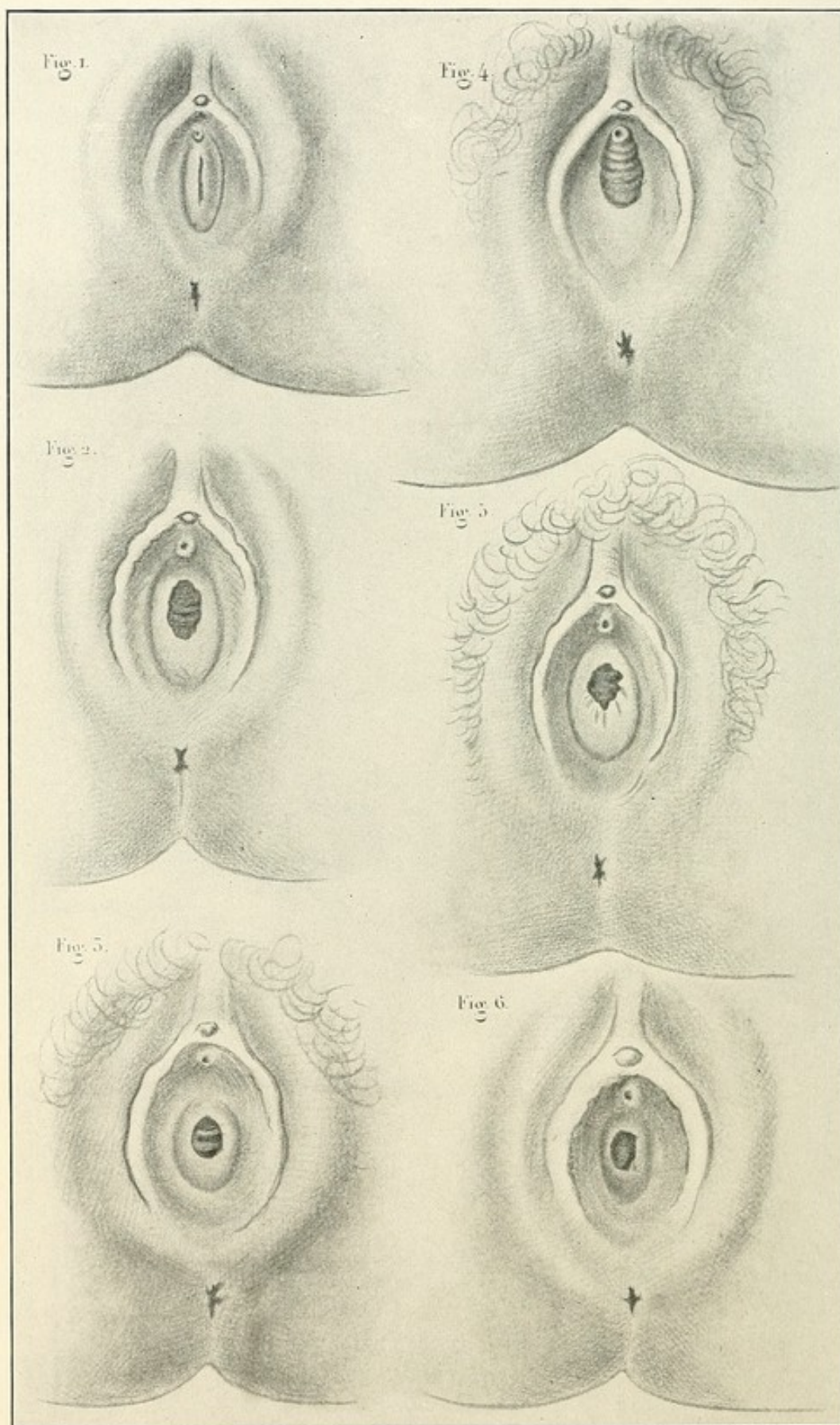
Normal Hymen (from Tardieu).

annular to the crescentic. The latter (crescentic) is the usual form. It appears as a semilunar curtain across the posterior or inferior segment of the ostium vaginæ, with its lateral insertion lost in the labia minora. Between these two types are many varieties. Sometimes the orifice is minute, hardly admitting a probe, and differing but little from complete atresia; sometimes it is very large, admitting the index finger and even permitting coitus without injury.

Tardieu, who has examined more than six hundred subjects with special reference to the hymen, describes five normal varieties which he places in the following order of frequency:

1. A form consisting of two lateral lips, touching one another in a vertical line. This shape, he says, is almost constantly found in childhood and sometimes after puberty. 2. The hymen forms an irregularly circular diaphragm with an opening (larger or smaller) in the anterior third (*hymen annularis*). 3. The diaphragm is exactly circular with a central round opening (*hymen circularis*). 4. The hymen is crescent-shaped with a concave border projecting forward and two horns ending on the inside of the labia minora (*hymen semilunaris*). 5. The hymen is represented by a low circular or semilunar edge; this is often overlooked and mistaken for entire absence of the hymen.

Unusual forms and departures from the normal type are: the double hymen; the cribriform hymen; the biperforate, or hymen bifenestratus—or septus; the imperforate hymen; the hymen denticularis, with serrated edge; the hymen fimbriatus, with a fringed edge; the hymen with deep congenital notches, simulating defloration; and the hymen *en languette*,[1] in which a narrow tongue projects from the rear fold of the membrane and is attached anteriorly just below the urethra.

The tissue of this curtain has all varieties of thickness and resisting power. It may be so thin as to be transparent; it may be dense, fibrous, or tendinous, requiring surgical interference to enter it. Age does not appear to modify its condition as regards density, but it may become relaxed at its edges by menstruation and other vaginal discharges. Sometimes the septum between two fenestra is extraordinarily tough and unyielding.

If the organs are in their normal condition, the hymen never forms a tense curtain tightly stretched across the ostium vaginæ. It is folded upon itself, in order to adapt itself to the vaginal canal, which is not a rigid open canal, but a passage with walls apposed anteroposteriorly. This infolding occurs

[1] Lutan, *Journal de médecine de Paris*, August 6, 1893.

in a line with the raphe of the perineum in such a manner that the two lateral halves of the hymen form a crease, or wrinkle, or plaits in prolongation of the perineal raphe. Thus folded, the hymen assumes an appearance like a cone whose apex is directed forward or outward. This lateral folding and conical shape may disappear in part in girls above puberty, there being a slightly increased tension sometimes, which suffices to obliterate the wrinkles formed.

It was formerly the teaching relative to the development of the hymen, that it was histologically a part of the vagina; but the latest writers are not agreed as to the acceptance of this view. The cases of absence of the uterus and vagina in which, nevertheless, a well-formed hymen with a shallow vaginal pocket was found, seem to disprove it. Again, recent observations have determined the absence of smooth muscular fibers from the hymen, and this again tends to show a dissimilarity with the vagina anatomically. Pozzi holds that the hymen is developed entirely distinct from the vagina, and that it is derived from the *urogenital sinus*, which is embryologically quite independent from the Müllerian ducts, whose coalescence from above downward helps to form the upper part of the vaginal canal, the part nearest the womb, while the *urogenital sinus* develops from below upward, and determines the anatomy of the vestibular vagina. It is a question which still awaits settlement.

Now, however we may speculate as to its formation, if this membranous curtain is found entire, uninjured, without cicatrices, it should be regarded as a presumptive passport and certificate of virginity. The presumption under such conditions is wholly in favor of the young woman, because the *usual* effect of the first sexual intercourse is to tear and rupture the hymen and so far to destroy its integrity as to leave unequivocal proofs of the injury. When the hymen is present, therefore, we may reasonably infer that its owner is a virgin; but when, on careful search, remnants only are found, we are justified in concluding that the woman is not a virgin, and that the hymen is absent in consequence of sexual intercourse.

These conclusions, however, should not be made without some reservation. It will not do to be dogmatic; for errors of dogmatism are *inexcusable* on the part of a medical jurist. It is to be remembered, on the one hand, that perfectly chaste and innocent women may suffer the loss of the hymen by other than sexual violence; and, on the other hand, unchaste women, as Parent Duchatelet proved, may, under exceptional conditions, retain this sign of virginity. Then, too, among

women in wedlock, as well as among those who are habitual prostitutes, the condition of the parts may favor the integrity of the hymen after repeated sexual intercourse. It may be loose, flaccid, imperfectly developed, elastic, or it may be placed at an unusually or relatively large ostium vaginæ.

Moreover, there are not a few cases wanting, of pregnancy advancing to maturity, in which the hymen was found intact, and so discovered first at the time of labor. Such instances are related by Ruysch, Baudelocque, Paré, Montgomery, Blundell, and Scanzoni. These are instances, generally, of remarkably tough and resistant hymens which have withstood the ordinary violence of intercourse.

Ogston[1] says of the wife of one of the physicians to St. Thomas's Hospital, that her hymen closed the vaginal orifice, leaving only some small apertures. It was strong and dense, and had resisted the husband's endeavors to rupture it. She sickened, her abdomen enlarged, and her legs became edematous, and she went to Bath to be treated for dropsy. There was no improvement, and she started homeward, uncertain if she could survive the journey. On the way she was seized with severe pains, supposed by her to be colic. The pains were so intractable that she was obliged to stop over at an inn. In less than half an hour she was cured of her dropsy by the birth of a well-developed living child.

These exceptions, however, prove the rule, and do not invalidate the title of the hymen to its high place among the signs of virginity. Upon it the most reliance is to be placed, and the few uncertainties which attach to it, under exceptional conditions, do not materially vitiate its value in the great majority of instances.

Defloration.—Having thus studied the usual signs of virginity, we are prepared to pass next to the no less important topic—the signs of recent defloration and, *later*, the additional signs that the defloration was against or without the consent of the young woman ; in other words, indications of a rape upon a virgin at the time alleged by her.

The examination should be recent to be satisfactory, because in three or four days the physical signs will have become greatly modified. These physical signs of defloration are determined by several conditions: 1. Disproportion between the penis of the adult man and the genitals of the woman, hitherto intact. 2. Age and vigor of the man. 3. Age and health of the woman, her power of resistance, and the elasticity and relaxation of her genitals.

[1] *Lectures on Medical Jurisprudence*, p. 103.

The *usual* conditions are in favor of the man, as he has the decided advantage in regard to strength, vigor, and determination. Under such circumstances we should look for some or all of the following appearances about the vulva of the victim as **physical signs of defloration in a virgin:** 1. Bruising of the clitoris and labia. 2. Swelling of the vulva, with heat, tenderness, and pain in the parts. 3. Excoriations of the clitoris and nymphæ. 4. Vascular injection near the excoriations. 5. Sometimes lacerations of the vulval mucous membrane. 6. Ecchymoses under the mucous membrane of the labia—sometimes hematoma (Hofmann); all these render painful any opening of the thighs or examination of the vulva. 7. Excoriations of the vaginal mucous membrane, with a viscid, pale, mucous discharge. The vagina may appear much distended if intercourse, whether violent or otherwise, has been repeated, and the signs of injury are more pronounced. 8. Discharges (as in the previous class) of a gonorrheal kind, or non-infectious, as the case may be. 9. Finally, the important testimony which a ruptured hymen offers. If present, it is a capital sign. Its value is increased by being associated with the other appearances previously mentioned. It is not invariably the result of intercourse, but is sufficiently frequent to establish the rule. Tardieu found rupture in 207 cases of rape out of 632 instances. In position and form it is generally found to extend from the front backward, the membrane giving away at its weakest part, making a *single* rent. More rarely there is a double tear; sometimes greater laceration results, and four or more rents have been observed. The varieties of the lesion are determined by the shape; the resistance and extent of the hymen; the presence or absence of vaginal folds behind it reinforcing it; and the degree of force used. Sometimes, though rarely, the fourchette is included in the rent; even the perineum has been found torn.

A recently ruptured hymen shows all the usual characters of a lacerated or contused wound. It has red and blood-stained edges, and there are swelling and tenderness. Inflammation quickly develops, and suppuration soon follows, which may be so severe as to delay healing. The ordinary time, if rents are not deep, is two or three days; under unfavorable conditions, gravity of the lesion, impaired health, and degree of violence, it may extend to eight or twelve days. If a specific inflammation complicates the case, a much longer time will be required. When the last stages of healing are reached it will be impossible to determine the interval that has elapsed

PLATE II.
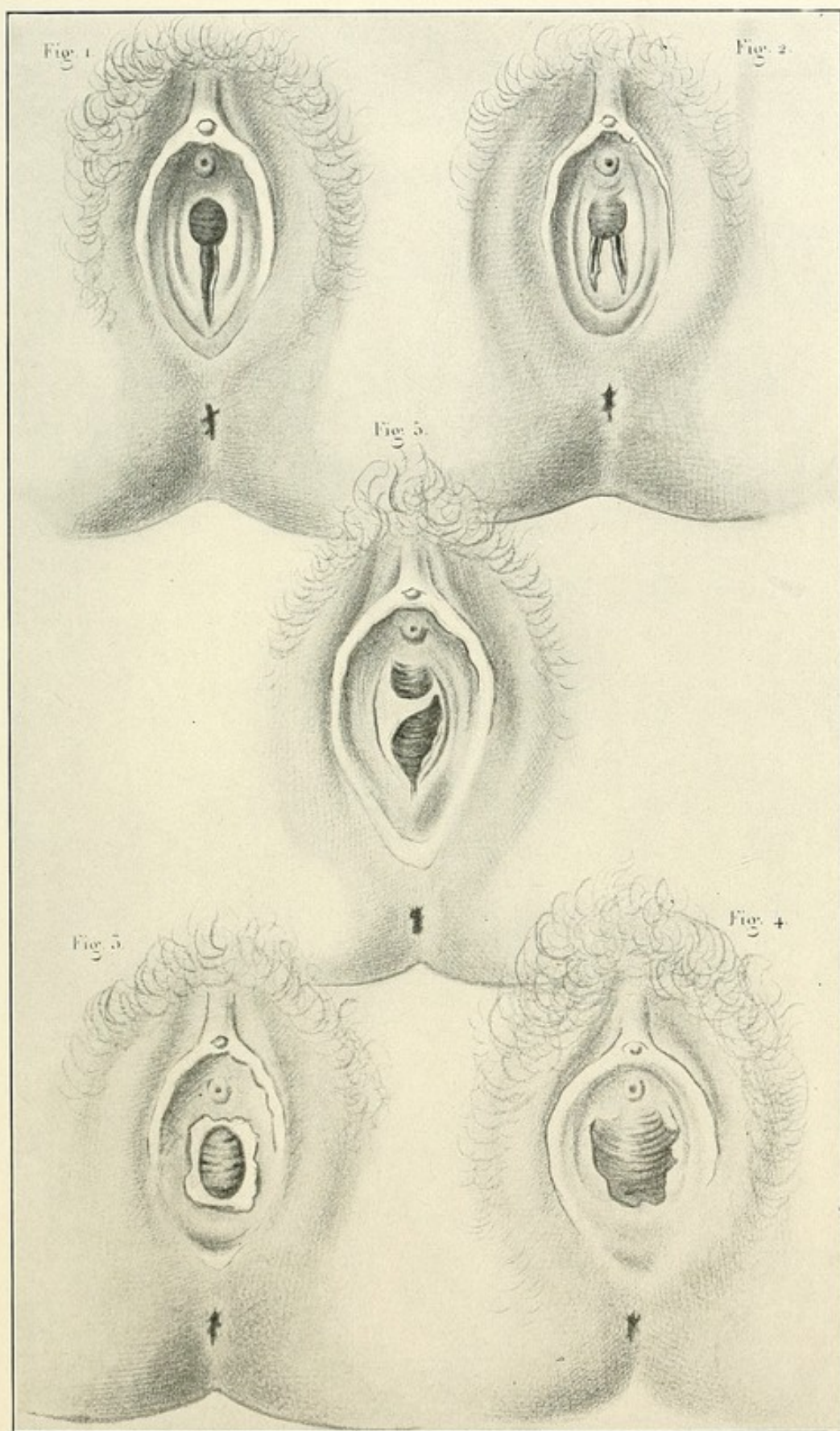
Defloration (from Tardieu).

since the hymen was destroyed. This suggests a question: Do rents in a ruptured hymen unite so as to restore the integrity of the membrane, with linear scars to suggest its original injuries? Tidy denies the possibility of it. Vibert admits the possibility, but asserts the infrequency of that result. Brouardel and Tourdes assert that the healing may be perfect, leaving only a trace—a cicatrix, red at first and then white—requiring that the hymen should be stretched and its folds obliterated to bring the linear scar into sight. These effects are probable only when the defloration is complete.

All that has been said, however, although it describes appearances which suggest rape and are consistent with that crime practised upon a young woman hitherto a virgin, must be admitted as stating a presumption only. We might find all these appearances about the vulva of a bride or about the genitals of any young woman who had consented to the sexual act, but had found that it was more painful and violent than she had anticipated it would be. All the physical signs described are the signs of defloration only. Unless present in an exceptional degree of severity and extent, there is nothing about them, singly or collectively, which, by themselves considered, without concurrent proof of other facts, would enable one to declare with certainty that they were the effects and evidences of a *forced* sexual connection.

Indeed, we may go further and declare that they do not necessarily indicate that they are the fruit of the sexual act at all. The appearances about the hymen, especially, require caution in their interpretation. Other causes of ruptured hymen are obviously to be recognized in addition to violent sexual assaults. Some of the causes are lawful; others are distinctly under the penalties of the law. Some are accidental; others are intentional.

In the former class we may mention: Gynecological examinations, roughly or carelessly made; the introduction of pessaries or specula; the breaking of chamber vessels on which the patient was sitting; the finger of the examining expert in an alleged rape (Hofmann); impalement or falling astride a fence or a chair; septic ulceration (diphtheria).

In the latter group of unlawful violence we have illustrations in recorded cases of violently thrusting the finger into the vulva, or the use of a foreign body with malicious intent.

Among alleged improbable causes of ruptured hymen we may include acrid discharges, rough riding on horseback, leaps and falls, menstrual clots, forcible separation of the thighs, and masturbation.

Granting these possibilities as affecting the value and significance of the objective signs enumerated, we come next to consider another sort of evidence which, if present, with the genital injuries, will certainly exclude the notion that those injuries were not the result of violence connected with the sexual act.

Seminal Stains.—This evidence is found in the presence of seminal fluid, either as a stain on the woman's clothing or as a deposit in the vagina or about the vulva. It is one of the most valuable of the corroborative evidences of rape. But it is valuable medically—not required legally.

The gross appearances and physical characters of a seminal-fluid stain are described as follows: It will usually be found in a dried condition, on the clothing. Its color is a grayish-white. Its outline is circumscribed with rounded edges, with a grayish line at the circumference of a deeper tint than that of the center. This is determined by holding up the spot and letting the light pass through it. If the stain is recent, the spermatic odor will be recognized; this may be brought out more clearly by moistening the specimen and warming it slightly. If the heat is carried to a higher degree, the stain, previously white or grayish-white, will assume a pale yellow tint which is characteristic. This last test has proved successful even with the matter of a suspected stain which was soaked out of a dark-colored fabric and was then transferred to white linen.

In 1896, Florence, of Lyons, discovered a chemical reaction which may be of much value as a preliminary test. It consists of the effect produced on a seminal stain by the ter-iodid or tri-iodid of potassium. This reagent is a solution of iodin and iodid of potassium, in water. Its formula is as follows: iodid of potassium, 1.65 grams; iodin, 2.54 grams; distilled water, 30 centigrams. When a drop of the liquid obtained by moistening a seminal stain is placed alongside of this solution on a glass slide or watch-glass, so that the edges of the drops come in contact, there appear almost immediately large numbers of peculiar, brownish-red, pointed crystals of rhomboidal shape. These crystals also form turnstile groups or crosses, like the rhombic hemin crystals. This reaction is available for old and dried stains as well as for recent ones. The exact nature of the crystals has not yet been determined, nor has the nature of the substance which occasions the reaction been demonstrated. Florence calls it *virispermin*. The observer claims that the reaction is characteristic, and that it will not apply to other secretions—

such as blood, urine, sweat, saliva, tears, bile, milk—or to pus or mucus.

Later researches by Richter show that the substance called virispermin by Florence is not specific and characteristic of the presence of spermatozoa, but that it is one of the products of the decomposition of albuminoid material, namely, lecithin or cholin, which gives the reaction. He found the test crystals in specimens of all the organs of the body, which were in process of decomposition. Seminal fluid, however, still seems to be the only secretion in which these crystals form quickly and in large amount after drying; therefore the value of the test as a preliminary one is not impaired, for by it those stains can be readily determined on which time should be spent in searching for the only positive proof of semen, namely, the zoösperms.

Whatever may be the uncertainty attaching to the physical or chemical examination of seminal stains, we can still have recourse, to the microscope, and through its aid can determine accurately the nature of the suspected deposit. Of course, great delicacy and caution must be used for the satisfactory search for the seminal element, the zoösperm; but with care it is quite practicable to find this organism even in old and dried stains, and once it is found it is a positive evidence about which there can be no question.

How are the zoösperms identified? Wagner describes these bodies as follows: "They are extremely small, scarcely exceeding $\frac{1}{50}$ or, at the very utmost, $\frac{1}{40}$ of a *line* in length. The little, oval, somewhat flattened, almond-shaped or lance-shaped body or head is perfectly transparent, and seldom exceeds $\frac{1}{600}$ or $\frac{1}{800}$ of a line in length. The filiform tail at the top is thickish and so strong that the double contours are plainly visible. Toward its end, however, it becomes so fine that it can not be followed to a point even with the highest powers; so that it is possible that the length exceeds that given above."

How long after their discharge from the seminal vesicles can the spermatozoa be identified? They are certainly hardy creatures and retain their vitality remarkably. Bayard reports his success in finding them active in healthy vaginal mucus seventy-two hours after intercourse. Other observers make more astonishing statements. A case is on record in Beale's *Archives,* in which active spermatozoa were found in the mucus taken from the vagina of a little girl fourteen days after she had been raped. Müller has shown that the organisms will retain life and activity eight days in vaginal mucus. Hofmann found them active in the seminal vesicles in from eighty to one hundred hours after a man's death.

With regard to their preservability as post-mortem specimens, there seems to be hardly any limit. They certainly resist putrefaction very successfully, if recorded cases are to be trusted. Bayard found them in seminal stains, on cloth, after intervals varying from one to nearly six years. Roussin detected them after a period of eighteen years.

How shall we best go about finding these minute bodies in a suspected stain on clothing or on other surfaces? The writer will content himself with a mention of the technic devised and described by Dr. W. F. Whitney, of the Harvard Medical School, as the best as well as the latest with which he is familiar. Dr. Whitney's words are:

" A small bit is cut from the cloth on which is the suspected spot, or if it is on a hard surface, a little is scraped from it. This is placed on a cover-glass, wet with a drop of distilled water, in which it is carefully teased apart with fine needles and the large fibers removed. The drop of fluid is carefully evaporated over a flame and fixed to the surface by rapidly passing it through it three times. Upon the film thus formed are poured a few drops of an aqueous solution of *eosin*, which is allowed to act for a few seconds and then washed off with distilled water. An equal amount of a strong aqueous solution of *methyl green* is then poured on and gently heated over the flame until it steams. It is again washed, dried, and mounted on a drop of Canada balsam dissolved in xylol. The preparation thus obtained is permanent, can be examined with the highest powers of the microscope, and exhibited in court if necessary.

" When entire, well-preserved spermatozoa are found, there is no difficulty in their identification. But when the stains have been dried for some time, it is usually difficult to obtain such ones, for the heads are then very easily broken off from the tails. And in an unstained preparation the former can easily be mistaken for spores, or *vice versa*, and the tails are almost invisible from their smallness and transparency. With the method above given, certain differential *characters of the head* can be made out, which leave no doubt as to their identity. Its composition is stated in the books to be of the same character as the nucleus of a cell (chromatin) and stains with the same reagents. But the *whole head does not stain alike*. At the base is a hemispherical portion which stains a *deep green*, while the anterior part and the tail take the *red color of the eosin*. This serves at once to identify it, as there is no other oval spore or cell which has an excentric hemispherical nucleus.

" And, furthermore, this not only shows that they are sper-
matozoa, but also that they are from man. For in no other
animal is there a deep staining. For in all the others the
head stains of a very diffuse light green, with only a very
narrow zone of a pale-red color about it. Then, too, the shape
of the head is different, being more pointed in man (wedge- or
lance-shaped), while it is rounder (shovel-shaped) in the lower
animals. Those of the dog are most like the human, both in
shape and details of staining ; but
a little experience will show dif-
ferences quite plainly.

" With this method, stains vary-
ing from a few days to two years
and a half old were examined, and
in all the differentiation of staining
was preserved, and the identifica-
tion could be easily made."

Sometimes, in cases that come
to notice very soon after the
alleged assault, it may be prac-
ticable to find evidence of it at
once in the vaginal mucus of the
complainant, without the technic
of staining. In such cases the
transfer of some of the vaginal
fluid directly to the object glass
by means of a glass rod or a
fine syringe, like a hypodermic
syringe, or a curette, or a pla-
tinum spatula, and an immediate
examination of the specimen
with a moderately high mag-

FIG. 18.—Spermatozoa : *a*, Human ; *b*,
of the rat ; *c*, of menobranchus (× 480)
(Raymond).

nifying power, may reward one with the discovery of the tell-
tale organisms.

It is necessary to remember the caution that, although the
appearance of the zoösperm is so characteristic once it is
known, it is not so very difficult to mistake other bodies for
these. The object most likely to deceive is one described by
Donné as found quite commonly in the vaginal mucus of
women careless of cleanliness. This animalcule (like the
spermatozoön) has a body and a tail. But the body or head
of the vaginal organism (trichomonas vaginæ, as it is called)
is three times larger than that of the zoösperm ; it is granular
instead of transparent ; it is round instead of oval or lance-

shaped; it is ciliated instead of smooth; and the tail is short and more filamentous.

As regards other matters likely to pass for zoösperms, such as fiber of cotton or linen, spores, ciliated epithelium, and other things, if the precaution is made and adhered to not to accept as a zoösperm any object save a complete and entire specimen, with body and tail united, there can be little chance of error. This precaution is the more requisite and imperative because of the purpose for which the microscopic search is usually made, as an aid toward establishing the guilt or innocence of a suspected party, because, even if the presence of the spermatozoa is fully established, in a suspected stain, that fact regarded by itself stands as corroborative evidence only. It shows that there has been a seminal discharge, presumably in the course of attempted or consummated sexual intercourse. It does not prove that the act was without consent on the part of the woman; it is no evidence of unlawful violence, constituting rape.

On the other hand, failure to find zoösperms is not enough to overthrow a charge of rape. For besides the fact already dwelt upon, that the law does not require proof of a seminal discharge to establish an indictment for rape, we have certain negative considerations which go to explain non-success in our microscopical search for zoösperms in cases where, by other means, we are pretty well assured that the act of intercourse has been completed and some sort of testicular or prostatic fluid has certainly been discharged. Thus, for example, the spermatic fluid may be so diluted with blood from the woman's torn genitals or with a leucorrheal discharge that the presence of spermatozoa can not be detected. But a most instructive fact in this connection is, that seminal fluid derived from the seminal vesicles does not always contain spermatozoa, even in young and vigorous men. Their absence is not very unusual in the case of old men, and the same negative fact has been determined in the case of healthy adults who just before the examination have had repeated connections. And we ought not to forget in this relation the pathological condition of azoöspermy as a continuous state. But even the presence of these possibilities, and others analogous, should not prevent the physician when he is called upon to investigate a case of rape, from making diligent search for zoösperms, remembering always their true value and significance as evidence.

Other stains upon the woman's clothing or person, either mingled with the seminal stains or separate from them, will frequently be found. Hemorrhage, leaving dried blood-stains

about the genitals or on the dress near them, is to be expected as a rule in the case of young women previously virgins, who are ravished with any marked degree of violence. The examination should be early, directly after the defloration, if possible, in order to be rewarded with positive discoveries. It is evident that, in regard to the matter of blood-stains, mistakes are possible in two directions:

1. In cases of false and fraudulent accusation the genitals and the adjacent linen may have been intentionally soiled with blood in order to sustain a sham charge.

2. In persons of menstruating age the catamenial discharge might hastily be mistaken for a hemorrhage from an injury.

As regards the former, attention to the situation, shape, and appearance of the spots should enable one to avoid a blunder. There could certainly be no excuse for the Berlin physician in the case related by Romberg, in which he certified that he had found blood coagula and seminal stains on the clothing near the genitals of a little girl, and that these discoveries, in his opinion, were evidence of rape. The coagulated blood turned out to be prune juice, and the seminal stains were grease spots.

The difficulty of differentiating menstrual from traumatic blood-stains is increased by the fact that there is a close similarity, if not actual identity, in the composition of the blood from both these sources; that menstrual blood contains the albumin, salts, and fibrin of ordinary blood, and that the cell elements, the blood disks, are the same. But we are helped by finding in menstrual blood the *epithelial* elements derived from the genital passages and cavities, and, of course, we are still further helped by the presence or absence of physical signs and effects of violence in shaping our conclusions.

We have proceeded so far in our examination as to determine, in the presence of various physical signs about the genitals of a young person, and with the additional fact that certain stains about her clothing are seminal stains, that the patient has really been deflowered, as she alleges. But we have not yet come upon the medical evidence that her consent to the act was withheld or that she resisted, and that her resistance was overcome by physical or moral force. This evidence is the more valuable, because it may be found after the signs about the genital organs have begun to retrograde or have wholly disappeared.

What, then, are the proofs which, associated with these, will serve to indicate the forced and violent, and so unlawful,

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character of the act? These evidences are to be sought for on other parts of the body than the genitals. If a woman can show bruises and excoriations in places on her body not readily accessible to herself, and out of her ready reach, and best interpreted as incidents of a struggle—when taken together with conditions about the genitals as described, the medical witness may with good conscience affirm that the complainant's story is corroborated by objective lesions. Bruises and other injuries are most likely to be found on the neck, the groins, the thighs and knees, the wrists, the breasts—in one case a nipple was torn off by a bite (Tardieu). All these should be carefully noted as to their size, shape, color, and situation.

It is not, however, the frequent fortune of the medical inspector to come on such a clear and unequivocal case. There are instances of rape, well established by evidence other than medical, in which hardly any of these confirmatory objective signs were left. The woman's clothes may have been thrown over or about her head to prevent struggles; she may have been stupefied by fright or drugs; or anesthetized by chloroform, or brought under the influence of hypnotization; or attacked and held by several men; or the signs may have all disappeared at the time of examination. Therefore, the sum of the matter is, that the absence of physical signs will not permit the medical witness to say that a rape has not been committed, but only to declare negatively that he finds nothing in the physical examination to establish the charge. On the other hand, to enable him to testify clearly and conclusively in an affirmative way to a rape at the time and in the violent manner alleged, he should have the concurrence of all the physical signs, or of most of them. Between these two extremes cases would have to depend for their issue on the weight of all the evidence available.

The law has *itself* established these extremes and is satisfied with them. It does not insist on proof of vaginal penetration. It convicts of rape upon proof of lustful assaults upon the female genital organs far short of leaving rents or ruptures, hemorrhages or seminal stains. Under such circumstances the conviction must rest largely on other than medical evidence. With regard to these lesions of lesser gravity, all that the medical witness can declare is, that they are not wholly inconsistent with a woman's story of lustful attack, but they are far from establishing it independently and conclusively.

Certain secondary complications deserve a passing word. The presence of the evidence of gonorrhea or syphilis upon her

person is sometimes adduced by a woman in proof of her charge of rape. The only concurrence of circumstances in which such an allegation would be of much value would be this: 1. The woman must show that she was previously free from any form of venereal disease, or of any disease with a vaginal discharge, or with genital ulcerations; and she must establish that the period between the assault and the onset of the venereal symptoms was the normal period of incubation for specific infection. 2. It must be shown, too, with reference to the assailant that, at the time of the assault, he was actually suffering from the same disease which the woman now presents.

Such a coincidence is hardly to be expected; certainly its easy demonstration would not be looked for. In fact, there are so many fallacies inherent in such an inquiry that the physician will be wise if he preserves a conservative course and expresses himself with extreme caution.

We have seen that little girls are liable to a blennorrhea of idiopathic origin. Adult women are not exempt from a vaginal discharge having a close resemblance to that of gonorrhea, but wholly innocent of venereal origin. Its causes are masturbation, abuse of vaginal injections, calculi, and retained menses or retarded menstruation. It is difficult to diagnosticate leucorrhea and gonorrhea. The discharge of leucorrhea is muco-purulent, while that of gonorrhea is more purulent than mucous. Modern researches in bacteriology are of service, showing gonococci in the pus-cells. But, as in cases of rape upon little girls, it will be prudent not to be too emphatic in interpreting a discovery of these micro-organisms unreservedly.

Suspicious ulcerations about the genitals require the same remark. They are not all of venereal origin. Assuming that they are specific in character, one will do better not to be too dogmatic about assigning their origin and age. Concerning the differential diagnosis, it may be well to add the caution that syphilitic ulcerations, which, if found on the genitals of a little girl, would be important proof of impure sexual contact, would lose much of their relative value as evidence if found upon the person of a young woman. They are to be regarded as one element only, and that not a controlling one in the case. The previous character and condition of health, the presence of other confirmatory signs, and the presence of the disease on the accused are to be taken into account in the reckoning.

CHAPTER IX.

RAPE OF MATRONS.

In the two preceding chapters has been considered the diagnosis of rape as it presents itself about the persons of little girls and of virgins above the age of consent, and the study of this subject is concluded with the medical proofs of violation as they are found upon women to whom sexual intercourse is not a new experience. What are the signs of rape, in these cases, which enable the medical witness to testify in support of the complainant's accusation?

Obviously, these objective evidences are much reduced in their range when compared with those presented in the other classes of victims. This limit grows out of one chief fact, namely, that there is no defloration in the affair; there is no evidence pertaining to the hymen; there are no physical effects of a first sexual intercourse of recent date. But, under conditions favoring them, local injuries may be available even in this class.

Signs of Rape upon Matrons.—In some women the vagina is relatively small, a condition which the married state does not overcome. Should a rape be committed on such a victim by a man with large sexual development, local injuries to the vulva and the ostium vaginæ might well result. So, too, if great force and brutality attended the assault; or, if several men successively assaulted the same woman, evidences of local injury might well be expected. The absence of these injuries would not, moreover, permit us to say that a rape had not been consummated. There are recorded cases in which men, with the aid of accomplices to hold the victim, have accomplished their lustful purposes on married women without leaving any trace of the crime in the shape of genital traumatisms.

Of special importance as evidence in these cases of married women or widows are bruises, excoriations, and abrasions, the proofs of resistance on the part of the woman and of violent assault and determination on the part of the ravisher. The usual situation of these lesions, as in the class of victims last considered, are the groins, the thighs and knees, the arms and

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shoulders, the neck (to stop outcries), and the breasts. All these appearances require special care to determine their significance and value with reference to the alleged rape, and to eliminate them from other relationships having nothing to do with rape; especially to exclude the probability that they were inflicted by the woman upon herself intentionally.

Traces of hemorrhage could hardly be found in these cases, except under circumstances of great force and brutality. The chances that blood-stains, if found, may be of menstrual origin should not be overlooked. Seminal stains are, however, a very probable incident in the line of proof, and should be looked for; and, if found, they should be demonstrated chemically and microscopically with the same care as in the case of rape on young women, by the double staining method and the iodin test, as described in the preceding chapter.

The same remark applies to venereal disorders as results of rape on women previously deflowered, in wedlock or otherwise. The character of the woman; her previous health; the nature and stage of the present infection; the presence of the same disease in the assailant; and the time that has elapsed since the alleged assault; all these matters have to be considered and impartially interpreted. Bacteriology will be of the same assistance here as in other cases previously considered, and may afford valuable confirmatory proof. But it is subject to the same limitations.

Tardieu[1] has indicated certain consecutive or secondary effects of a rape, which have some interest, whether they occur in the subjects of the violence now under study, or in women hitherto intact. These effects may be of all degrees of severity and duration. They may take the form of functional nervous derangements, namely, frequent fainting attacks; delirium; hystero-epileptic convulsions; nervous exhaustion; melancholia, with sometimes suicidal tendencies; palpitation, and chorea. Then, again, they may result in menstrual irregularities, in gastric disturbances, and the like. All these are the legitimate fruits of the severe strain and nervous shock incident to the terrible experience a woman undergoes in the ordinary circumstances of a rape.

It is well, however, to be cautious. Such complications afford an open door for deception and fraud. Exaggeration is very natural under such circumstances. There should be a pretty clear relationship between cause and effect in order to make the effect important.

If the woman who enters a complaint of rape is a prostitute,

[1] *Viols et attentats à la pudeur*, p. 54.

the medical evidence to support her allegations should be especially strong and convincing. Her previous character is obviously of no avail to aid in substantiating her charge. She must, therefore, bring forward much more demonstrative and convincing proof than her mere statement of the circumstances of the assault. It is only in cases of extraordinary violence, in which the force used was physical force, that objective signs to prove that the sexual act was accomplished without consent, are available. Here it is, more than in any other class of cases, that ecchymoses, abrasions, and the like, are of use. And they are the only useful proof. Gonorrhea or syphilis, if present, should not be interpreted to the damage of the accused too readily, and seminal stains about the woman's clothing should give rise to wholesome skepticism.

The observations concerning rape have, thus far, in the study of the subject, had to do with its diagnosis on the living subject. The author has gone forward on the presumption that the medical inspection had for its object to confirm or to upset a living woman's statement that she has been assaulted and ravished. There is still another variety of victims, concerning which the medical evidence of rape is of the greatest importance. These are the cases in which *fatal results* attend or follow the assault. For example, in the course of the violence, when she is strangled to suppress cries ; or is suffocated by clothing ; or is asphyxiated by pressure on the chest ; or she may suffer death from direct consequences, such as hemorrhage from wounds ; violent emotion growing out of fright ; the effects of overexertion in struggling, causing, perhaps, fatal syncope ; from paralysis of the heart, or from fatty degeneration. Apoplexy is another possibility as an effect ; or death may result by consecutive inflammation ; or by suicide immediately after the rape.

Cases are on record, also, of such laceration of the genital organs in the act of sexual connection as to result in death directly. Such was the instance related in a preceding chapter, that of the little girl who was violated by the soldier on the march, when the vagina was torn from its posterior attachment to the cervix uteri, and the peritoneal cavity was opened. The case of Amos Greenwood in England, in 1859, is one often cited in this class of instances. He was charged with the rape of a girl of less than ten years, and with her death in consequence of the injuries. He was convicted. The Paris, Texas, case, already referred to, is another illustration. Another negro was burned in October, 1895, in Texas, for a fatal assault on a woman. Then there are instances of the

death of the victim of rape as an immediate incident of the crime with a motive to conceal it.

A man was tried in England[1] for the rape of a child eight years old. The rectovaginal septum was entirely broken through. After the assault the ravisher killed the child by thrusting her head into the pan of a privy.

The case of Mrs. Hattie McCloud, January 8, 1897, is a striking illustration of this class of cases.[2] It was one of peculiar atrocity. The victim was well known and universally respected in the community. She lived with her daughter at the summit of a hill in the suburbs of Shelburne Falls. She was assaulted in the early part of the evening, while travelling up the steep hill in the direction of her home. Her body was discovered the next morning, in the woods near the road, and it was apparent, even without medical evidence, that she had been outraged, robbed, and murdered. The accused was indicted for murder, convicted, and hanged.

It is obvious that the utmost exactitude and care are needed to avoid error in an investigation of this sort, when the rape is complicated with other forms of violence, although the element of fraud is eliminated, and lies are not available as helps to the prisoner. Ogston[3] gives an instance of this class of cases, which occurred in Scotland in 1830: Margaret Paterson, an unprotected female, was making her way on foot one evening from Edinburgh to Dalkeith, when she came up with a cart driven by two Gilmerton carters. She was taken into the cart by these villians under the pretence of assisting her on her journey. They forcibly held her in the cart, and repeatedly violated her person. Not only so; they afterward took stones from the road, coals, straw—everything they could immediately find, and forced them into her vagina with a savage, lustful brutality hardly credible. When she fainted under her tortures, they threw her out of the cart into a ditch by the roadside, where she was found the next morning. She lived three days in great agony. Luckily, she was able to identify her assailants, and they were convicted and executed. After her death, the autopsy disclosed the vagina and rectum full of foreign bodies, and the two passages broken down to one, and the abdominal organs highly inflamed.

In all such cases, in which death results as a concluding incident of a rape, the medical inspector should exercise his

[1] Tidy, *Legal Medicine*, ii., p. 239.
[2] *Transactions of the Massachusetts Medicolegal Society*, ii., p. 346.
[3] *Lectures on Medical Jurisprudence*, p. 117.

powers of observation to their fullest degree. The injuries to the genitals; the injuries to the body on parts remote from the genitals; and the evidence of spermatozoa in the vagina or on the woman's person or clothing; all these should be sought for under the most careful and precise purpose not to overlook any evidence, and they should be described with great exactitude, remembering that the inquiry concerns not only the immediate cause of the death, but a most important train of felonious incidents leading up to that immediate cause.

Evidences Found on the Accused Ravisher.—An examination of the accused man may be of service in securing medical evidence of the alleged rape, whether the woman is living or dead. There may be appearances about the genitals or other parts of the body of the man charged with the crime that would confirm the charge made. Thus, the struggles naturally made by the woman would leave their marks and proofs in the shape of bruises, scratches with the nails, and bites. These would most naturally be found on the face, hands, and genitals of the assailant. Blood-stains on the clothing or person of the accused are sometimes an indication of his guilt. This is derived either from lesions about the woman's genitals or from injury to the man's *frænum præputii.* But even when considerable damage is done to the female genitals, so that bleeding is free, this bleeding may leave no trace on the accused. Several cases of this negative kind are recorded.

Thus, Taylor[1] relates the following case: In January, 1858, a girl seven years old was brought into Guy's Hospital to be treated for injuries resulting from a rape by a boy of less than seventeen years old. About half an hour had elapsed, and on examination a complete destruction of the hymen was found, with a laceration extending into the perineum. There had been profuse bleeding, and the girl's clothing was saturated with blood. There was no complaint of pain, and there were no scratches or other lesions on any part except the vulva. The boy had been caught in the act, and was taken into custody at once. He was examined by a surgeon an hour after the assault, having been under observation meanwhile, without any chance to change his clothing or to cleanse himself. There was no blood about his genitals or on his clothing. It is probable that the act was so quickly accomplished that the boy escaped blood-staining.

If the accused has not urinated after the rape, and an

[1] *Loc. cit.,* ii., p. 431.

examination of his genitals is made in sufficiently close relation to the time of the alleged assault, seminal fluid may be found in the urethra. But seminal stains on his clothing are of less consequence as proof, for obvious reasons, than they would be on the clothing of the complainant. Sometimes the clothing of the man, as well as his skin, shows the signs of struggling and resistance on the part of his victim; tears and dirt stains, also, should be looked for.

Ogston [1] relates the following instance: A man named Robb was tried in Aberdeen, in 1849, for rape. He had entered the woman's chamber by going down a chimney, and the corduroy trousers which he wore had left their corded impression on the soot. Some of the soot, too, adhered to the trousers. The man thought he had cleaned it off sufficiently, but enough was left to serve as chemical material, and this, with the finding of one of his buttons in the bed, helped to convict him.

Of course, note should be taken of the age and vigor of the man with relation to those of the woman; and the woman's story of violent entry upon her privacy will be subject to judgment as to whether it is a likely one from that point of view. If the accused party is a young lad, or an old, feeble man, or a man presenting an abnormal development of the genital organs, rendering him impotent, there can be no difficulty in reaching a conclusion as to the validity and credibility of the charge. If the woman alleges that a *specific* disease has resulted from the forced intercourse, an examination of the man's genitals is particularly important, and the following questions will suggest themselves for answer: Does the disease in the two parties agree in nature? Is its stage of development, if it is the same, analogous? If syphilis is charged, are there still active ulcerations on the frenum or behind the prepuce? Is the inguinal region free from the secondary glandular inflammations? Are the throat and the region of the anus free from lesions?

Moral Evidence.—The physical proofs which have been described are mainly corroborative of the moral or circumstantial evidence on which reliance is largely placed. Formerly, the woman's own statement was deemed enough to secure a verdict. Now, however, the prosecuting officers ask, Is the woman telling the truth? For an answer they seek the aid of medical observation. This is especially needful, owing to the number of fraudulent cases. Amos says that there are twelve sham cases to one genuine one. The moral

[1] *Lectures on Medical Jurisprudence*, p. 118.

evidence is mainly a matter of police inquiry. But even here, many things may enter into the case, which can best be interpreted by medical men. For example, a woman found narcotized immediately after sexual violence affords presumption against consent. Insensibility may have come from other causes than drugs. Terror, shame, syncope, and hysterical coma are more equivocal, but not wholly without value.

The kind of terror inspired may be indirect; it is interpreted as an element in the unlawful assault just the same. Maschka records a case in which the assailant, with intent to ravish, seized the woman's infant and threatened to dash its brains out unless she yielded. The maternal instincts of the terrified woman brought her to submission. In this case the coercion came about through an indirect channel, but none the less effectively.

Deep intoxication is sometimes used by a man to render his victim helpless. This is rather against than in favor of the woman, unless she is very young, for ready acquiescence in this sort of preparation by a woman is evidence of low moral tone. The English law provides a special penalty for the administration of any " drug, matter, or thing " with intent to have carnal connection with a woman. The statute regards the offence as a misdemeanor (not a felony), and includes the use of so-called aphrodisiacs in the prohibition. The use of the so-called " knock-out drops " (chloral hydrate solution) in liquor is an example of the criminal employment of drugs for felonious purposes; although, most commonly, these agents are used by women upon men for purposes of robbery.

It is occasionally an incident of complaints of rape that the woman alleges that she was drugged in her sleep by the use of some anesthetic, and that she was violated while thus insensible. Is this state of things possible? Dolbeau is of the opinion that in the vast majority of cases an attempt to give ether to a sleeping woman would awaken her at the outset of the anesthetization. The very greatest caution would be needed in administering the ether to make the performance successful. Ravishers have neither the knowledge, nor the skill, nor the time for such deliberation. Of course, there is a difference in individuals as to the soundness of the sleep, but the rule may be laid down as a general one, that a woman's statement that she was given chloroform or ether during her sleep and then ravished by some unknown person, is not credible.

Chloroform and ether have played an important rôle, however, under other and more ordinary conditions, namely, when

administered for surgical or dental operations. It is well known that anesthesia excites erotic sensations in women and sometimes gives rise to embarrassing demonstrations and expressions, both in the earlier and later stages, in entering and recovering from the anesthetic state. It is a wise precaution, therefore, for a physician never to anesthetize a female patient when he is alone with her. He should have the attendance of a nurse, assistant, or other witnesses. Neglect of this precaution has brought considerable trouble to the doors of very reputable practitioners. Women who make the charges are doubtless honest in their belief; but it is simply a delusion or dream growing out of the anesthesia.

Several instances of charges of this kind brought against *dentists* are on record. Wharton and Stillé[1] report full details of such a case in which "an eminent and highly respectable" dentist of Philadelphia was a defendant in a criminal charge brought against him by one of his patients, a young lady of unimpeachable character, who swore that while she was in the dentist's operating-chair in his office, and alone with him, he had given her ether at her request to quiet the pain of an operation on her tooth; that she felt dizzy, cold, and numb, but did not lose her consciousness; that her eyes were closed and that she did not try to open them; that the dentist felt her pulse, and then proceeded to take the most improper liberties with her, which she described in circumstantial detail. She felt pain, she said, when he entered her person. She did not cry out, or resist, or open her eyes, but she was conscious all the time, she said. When she opened her eyes, after it was all over, her clothes were disarranged, and the dentist was at the washbowl. She closed her eyes before he returned, and when he came back to the chair he put her clothes in place and lifted her higher into the chair. In a few minutes, she said, he spoke to her and told her that he would have to take the tooth out. She assented; he gave her more ether and extracted the tooth. As soon as she felt able to walk, she left the dentist's office and walked to a friend's house, stopping for some ice cream on the way. She parted with the dentist at his front door without making any complaint to him. On the contrary, she made an appointment for his professional services some days later, and seemed in her usual cheerful spirits. Several hours later she mentioned what had happened, to the friend at whose house she stopped. That night she was taken unwell after the usual interval. She was not examined by any physician, and the whole case rested on

[1] *Medical Jurisprudence*, i., section 245.

her statement alone. But the jury believed her story, and brought in a verdict of guilty against the defendant dentist, who was sent to prison for a term of years.

A case illustrative of the erotic effects of anesthesia occurred in Montreal, in 1858. A woman persisted in the statement that a dentist had violated her while she was under the influence of nitrous oxid gas. She insisted on this in the face of the sworn declaration of her husband, who had stood by during the entire operation, and had seen nothing improper.

The place where the crime is alleged to have been committed is regarded by prosecuting officers as of considerable importance, and the following questions would occur for investigation: Is it out of the way and secluded? Does it show any evidence of a struggle?

If the woman *cried out*, to call for help, some difference in significance of the cries will rest on the question whether she knew or supposed that some one was coming, or was within hearing distance. If she called for help when she was in real stress and was uncertain if help would appear, that would be one thing; if she heard some one coming who would be likely to interrupt an indelicate proceeding to which she had consented, and she then screamed, that would be quite another. But sometimes there is no calling for help, and some curious excuses for the omission are given.

Ogston[1] relates a case in which a man was accused of a rape on a young woman in her father's house, early in the night, in a room next to the one where her parents were asleep. She admitted that she did not scream because she feared she would wake her mother.

Controverted Questions.—It has been doubted, and by some authorities denied, that a healthy adult woman, in the full possession of her senses, can be overcome and ravished by one man, unaided. It is said that she generally would have it in her power to foil her assailant. It is clear, the author thinks, that if she kept her presence of mind, was in good health, and self-reliant, she would usually have much advantage on her side. Arguments on this question have been chiefly based on the presumption that the sexual act was completely performed. Rape within the meaning of the law is something that may be far short of this. But even here, if the strength of the two parties, the man and the woman, is nearly alike, and the woman does not yield to fright, she would be able to keep the man off long enough to overcome his ardor.

[1] *Loc. cit.*, p. 122.

This matter can not be settled, however, according to theory only. It is a practical question to be determined in each instance on its own merits. Could the man accused of the crime accomplish his purpose, as alleged? That is the problem which each case presents. In its settlement one must carefully balance all the data, remembering that, however one may theorize about the matter, enough cases are on record of adult, healthy, chaste, and determined women overcome by single ravishers, to make a respectable minority, and to lead one to be cautious in expressing his opinions.

Can a woman be violated while she is asleep and without waking her? Casper is skeptical; he thinks it impossible. Others (Guy, Taylor, Wharton and Stillé, Ogston, and Luff) admit the possibility of such an occurrence, and cite examples of married women who slept so soundly that they knew nothing of the approaches of their husbands. Woodman and Tidy are of the opinion that rape during sleep could occur only in the case of married women or those accustomed to sexual intercourse; or in such deep sleep that it should properly be called morbid (catalepsy). Tardieu is positive that defloration is impossible during sleep, because of the pain.

Montgomery reports a case which is to the point:[1] A serving-maid at a Scotch hotel proved to be pregnant, and she solemnly declared that she was not conscious of having had intercourse with any man. Suspicion, however, fell on one of the stablemen of the hotel, and he subsequently admitted that, having found the woman in a deep sleep after unusual and prolonged fatigue and watching, he had connection with her and, as he believed, totally without her consciousness of the act, as she made no movement which could be said to indicate it. The parties were married and the girl's reputation was saved.

Can a woman become impregnated by a man in the act of rape? Formerly, the answer would have been in the negative. In Scotland a charge of rape could not be sustained if the alleged forced intercourse were followed by conception. This is a rude and unscientific test, and physiology and experience have set it aside. There is no sensation when a Graafian follicle breaks and the ovum is set free, and there is no reason why the fertilization of this body should be felt or made manifest at the moment. Conception does not depend on the consciousness or volition of the woman. If the state of the uterine organs is favorable to impregnation, that will follow intercourse, whether the latter is voluntary or

[1] Ogston, *Loc. cit.*, p. 121.

not on the part of the woman. Even penetration is not necessary for such a result. Women have conceived after intercourse when they were asphyxiated or narcotized, intoxicated or asleep—when they could not be conscious of any volition or sensuous feeling.

In the matter of rape, however, the question of subsequent pregnancy is not of much importance either way; because, to make it a significant evidence of rape, proof would have to be forthcoming of the woman's chastity and continence both before and just after the alleged violation. This proof would not be attainable generally. The question certainly does not have any interest in the large majority of the actual cases— those of little girls and old women.

The Scotch judges have ruled that this sort of carnal knowledge is not rape. The woman being sound asleep, there is no resistance to the act, therefore it is not "carnal knowledge by force."

Considering the facility with which false charges are brought and the effrontery and falsehood of women who, finding themselves pregnant out of wedlock, seek to cover or excuse their shame by fraudulent complaints, it is well to use considerable caution, and to recall Valentine's wise remark: *Non omnes dormiunt qui clausos et conniventes habent oculos.*

Hypnotism has recently come into prominent notice in connection with charges of rape, and is recognized in French, Austrian, and Hungarian law. The first case of the kind, however, was reported long ago—in 1860: A girl of eighteen consulted a hypnotizer as to her health. She visited him daily for several days, and four months and a half afterward she found herself pregnant, and made a complaint against the magnetizer. The authorities referred the case to a medical commission, instructing them to answer two questions: 1. The stage and date of her pregnancy. 2. Whether the complainant might have been violated and impregnated while her volition was either partly or completely abolished by hypnotism. The medical inspectors found the pregnancy to be advanced four months and a half. They concluded that, as a person in magnetized sleep (so-called) is insensible to every kind of pain, sexual intercourse might have taken place while the young woman was in that state, without the participation of her will and without her consciousness of her act. Their opinion was confirmed by Devergie; but with some reserve on the ground of the possibility of fraud.

Still more recent observations are favorable to the view that rape and subsequent pregnancy are possible under these cir-

cumstances. Ladame[1] contributes a long article on hypnotism and rape, in which he says that only four authentic cases of the kind in question are on record. Liman, of Berlin, declares that in twenty years no cases occurred in his experience. Hofmann, of Vienna, does not know any cases in German literature. In the first recorded case in France, in 1858, Coste and Broquin summed up as follows: "We think that it is possible that a young woman could be deflowered and impregnated against her will, her powers of volition being annihilated at the time by 'magnetic' influence." Devergie and Tardieu gave a qualified assent to these conclusions, in consultation. In another case, in 1865, the experts reached the same conclusions. Tardieu, in 1878, and Brouardel, in 1879, also reached the same conclusions. Ladame[2] relates a case in his own experience, in which a girl accused a magnetizer of impregnating her while she was hypnotized by him. De la Tourette insists on the possibility of accomplishing the crime of rape on a hypnotized subject wholly without her power of resisting; and Brouardel, Vibert, Tourdes, and Charcot also agree. Still one must be extremely cautious not to become the ally of fraud; and one must take into consideration the circumstances under which the hypnotic state was induced—whether the woman willingly submitted to be hypnotized.

Luff[3] says: "While admitting the hypothetical possibility of the violation of a woman or a girl of a certain neurotic type while in the condition of so-called hypnotic sleep, such accounts must be regarded as very suspicious, and rather as specious excuses for non-resistance than as truthful statements."

Can a man during his sleep and without his knowledge have intercourse with a woman with whom he is lying? Such a case must be very rare. It may happen under the promiscuous conditions in which the poor sleep. Taylor says he has met with more than one case, and cites an instance in which a girl, fourteen and a half years old, while in bed with two brothers, thirteen and sixteen years of age, was awakened by the pain caused by the approaches of the elder brother. He excused himself by deep sleep and bad dreams. Another case is cited by Taylor, in which two husbands impregnated their wives while the latter were asleep. Defloration under such circumstances is impossible, for good reasons.

Concerning the defence usually adopted by an accused

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[1] *Annales d'hygiène et de médecine légale*, June, 1882.
[2] *Ibid.*
[3] *Text-book of Forensic Medicine*, 1895, ii., p. 267.

person : If there is no chance for him to prove an *alibi*, he claims other facts to exculpate him. He will allege impotence ; he will explain various external lesions, such as scratches, bruises, etc., on his own body as having a perfectly innocent origin. He will insist that the lesions found on the genitals of the girl, his imputed victim, are due to her own self-abuse or to self-inflicted violence ; that discharges are idiopathic and not traumatic, and are due to uncleanliness or disease. If defloration is alleged, he will seek through his counsel to place the defloration long before the stated time, and so will try to relieve himself from all relation to it. He will declare that the act, if admitted at all by him, was with the woman's full consent—and this is a common defence. He will endeavor to throw doubt upon the claim that the injuries sworn to by the woman were due to sexual intercourse, and will attempt to show other reasonable and probable causes.

This subject may best be concluded, the writer thinks, by a comprehensive summary statement of the practical duties of the physician when he is called upon to examine cases of this kind for the purpose of giving evidence in court :

Suggestions for the Medical Inspector.—Lose no time before the interview with the girl or woman the alleged victim of the assault. Visit her as soon as possible after the act, and do not give her opportunity to make preparation. The recent objective proofs of rape will have generally lost their significant value by the fourth or fifth day unless they are of extreme primary severity. Carefully note the time of the visit, even to the hour and the minute. This may prove an important element in the case with relation to the complainant's delay in entering the complaint, or the defendant's claim of absence from the scene. Let the complainant (child or adult) tell her story in her own way without any leading questions. This is especially desirable if the victim is a little girl. If possible, a child, under such circumstances, should tell her story out of her mother's hearing. Note should be taken of the way in which the girl or woman walks—whether the movements of walking are suggestive of genuine pain, due to the inflamed condition of the genital organs. Observe meanwhile the degree of vigor, the state of nutrition, and the ability for self-defence as exhibited by the complainant.

The genital organs should be inspected with *special* care. For this purpose the patient should be placed upon her back upon a couch, and her thighs separated so as to expose the deeper vulval region. In young children this may be so painful as to require anesthesia, local or general. A detailed

memorandum should be made of any traumatic lesion and inflammatory effect found about the parts—any swelling, redness, excoriation, laceration, or bruising. Note with care the condition of the hymen and fourchette. Observe the character of the lesion—whether recent or remote, if any is found.

Take note of any discharges which are present. Study them with reference to their origin—whether traumatic, leucorrheal, or gonorrheal. Inspect the urethral orifice with reference to its share in the trouble. If the case is a very recent one, a few hours after the imputed assault, the search may be rewarded by finding stains of blood or seminal fluid. In either event, note with care the situation of the stain on the person or clothing. If the stain is on clothing, the physician should take the apparel for more deliberate examination and for microscopical inspection by himself or by an expert of his choice. Specimens of vulval and vaginal mucus may be secured and examined for spermatozoa at the time of the visit, if the microscope is used on the spot. Inspect other parts of the body besides the genitals. The inspector may find ecchymoses and excoriations on the groins, thighs, knees, neck, breast, arms, or hands of the woman as proof of her resistance. Care should be taken, however, to examine them critically in regard to their location, shape, and degree, with reference to these questions: 1. May they not have been made by the woman herself designedly? 2. May they not be the result of innocent accidents? 3. Do they correspond with the interval since the alleged assault, and with the natural incidents of such an assault?

The claim of venereal infection as an incident of the rape will come, if it comes at all, long after the primary lesions and traumatic effects have disappeared. If the physician is called upon to examine the complainant as to that element, it is important to establish the fact that the same form of disease exists in both parties involved in the act; that it had not existed in the woman or child *before* the time of the assault; and that its present appearance is consistent with the alleged interval since the assault. Repeated examinations will probably be required to reach sound conclusions as to the significance of the appearances under observation.

If the complainant is an adult woman who alleges pregnancy as the result of the rape, the stage of the pregnancy should be a special question of inquiry, in order to determine the relation of cause and effect. The examiner will remember that conception is entirely possible under the conditions attend-

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ing a rape; and one of the questions to be asked is in regard to the time of the last menstruation with relation to the assault.

If the victim of the rape should die in consequence of, or by means of, the assault, a specially careful examination of all parts of the body should be made. Besides seeking for the various proofs already mentioned, other explorations should be made to ascertain the true cause of the death. The mouth should be inspected for the presence or absence of foreign bodies forced into it to stifle cries.

If the instructions include an examination of the man charged with the crime, secure first his consent to the inspection, because it is the right of every person to decline to uncover evidence that may criminate him. But if he, conscious of innocence, or reckless of consequences, assents to the investigation, note his age and relative strength and vigor. Examine his genital organs with reference to the presence or absence of local injuries or venereal lesions. The region of the *frenum præputii* is especially of importance in this connection. Examine his stripped body for bruises and scratches, and note their probable age, as well as their situation and character. See if there are blood-stains or seminal spots on the genitals or clothing. If blood-stains are found about the genitals of a man who is not suffering from piles or hematuria, the presumption is strong that they signify recent sexual violence. If the man is seen just after the act and before micturition, seminal fluid may be found in the urethra. Look with care at his clothing; also take notice of tears, stains, and loss of buttons.

In stating conclusions in court, the medical witness should be cautious about going too far. If his observations, conducted with due care, fail to reveal lesions fairly and reasonably attributable to violence, he should not hesitate to say so candidly. If, on the other hand, he does find genuine objective signs about the vulva and ostium vaginæ, his declaration should be that he has found the evidences of violence upon the genitals. Of course, the question would naturally follow: Were the appearances such as would reasonably result from forced sexual intercourse? To this question his answer will be framed according to the nature of the traumatisms observed by him. He will remember that the medical evidence in these cases is mainly corroborative and confirmatory. The proof of the precise character and circumstances of the assault is derived from other witnesses; and that proof must determine the nature of the marks he has observed.

Finally, individual cases in practice must be subjected to careful analysis and investigation on their own merits. The medical man's common sense and knowledge of anatomy and surgery will enable him to avoid mistakes and permit him clearly to understand and recognize the medical and medico-legal significance of each instance of alleged rape brought to his notice ; to differentiate sham cases from genuine ones ; and to give evidence upon facts which he has observed, and not upon probabilities or possibilities which he surmised.

In the words of Brouardel, "the medical man in a case of imputed rape must *close* his *ears* and *open* his *eyes* to enable him to form a sound opinion, and he should swear only to what he himself knows of the case."

CHAPTER X.

CRIMINAL ABORTION.

IT is often asserted that the felonious destruction of fetal life is nowhere on the face of the earth so prevalent as in America. Whether or not we admit the full force of this assertion, it is certain that the charge has received much support by the voluntary avowals of our own profession that the abortionist plies his dark and cowardly, but profitable, trade among us with altogether too much license and too little danger of punishment. A few years ago the subject received unusual attention. The pulpit even was aroused to make a mention of and to condemn what was deemed a growing and formidable evil; while physicians in their society and other meetings protested more openly and emphatically against it.

Medical writers could not find language strong enough to express their denunciation. Thus, Thomas,[1] in his classical work, speaks of it as "a great national crime," and wonders that "while the law pursues with relentless vigor the man who murders his fellow, it allows so much immunity to him who murders the young child in its mother's womb." . . . . "On my table," he says, "is one of the most popular and respectable daily journals of New York, one which finds its way into the first circles of society and into the hands of maidens and matrons throughout the land. In its columns I count fifteen advertisements well known as being those of professional abortionists, men and women who make a business of infantile murder."

Professor Hodge, in a lecture to his medical class in Philadelphia, said: "In this country, in our cities and towns, where literature, science, morality, and Christianity are supposed to have so much influence, where all the domestic and social virtues are reported as being in full and delightful exercise, individuals, male and female, exist who are continually imbruing their hands and consciences in the blood of unborn infants."

Now, all this emphatic testimony—and very much more of the same sort might be quoted—has had one effect, and

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[1] *Diseases of Women*, p. 63.

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that is, to give our country a bad name abroad, and it has not been uncommon to see the crime referred to in medical journals as particularly an *American* crime. We do not deserve all the bad things that are said of us. At least, we are not worse than our neighbors beyond the ocean. The sentiment of the regular medical profession is without question practically unanimous in denouncing the crime. This is reflected in their public expressions as well as in their private actions.

Thus, at a meeting of the Councillors of the Massachusetts Medical Society, in 1858, the following resolutions were adopted:

"*Resolved*, That the Fellows of the Massachusetts Medical Society regard with disapprobation and abhorrence all attempts to procure abortion, except in cases in which it may be necessary for the preservation of the mother's life.

"*Resolved*, That when any Fellow of this Society shall become cognizant of any attempt unlawfully to procure abortion either by persons in the profession or out of it, it shall be the duty of such Fellow immediately to lodge information with some proper legal officer to the end that such information may lead to the exposure and conviction of the offender.

"*Resolved*, That no person convicted of an attempt to procure criminal abortion can consistently with its By-Laws any longer remain a Fellow of this Society."

These resolutions express the feeling of educated medical men concerning the crime. Nevertheless, the unlawful practice continues. Newspapers advertise the methods and agents, and the abortionists seem to prosper and escape.

In the course of a legislative hearing in the city of New York, in 1894, the statement was made, under oath, that two hundred men and women habitually advertised their readiness to procure miscarriages. The witness stated that he had been arrested repeatedly and charged with criminal abortion, but that he had always obtained speedy release by the payment of money which was divided between a shyster lawyer, blackmailing police officers, and a corrupt judge. Is there any wonder that the crime prospers under such conditions?

The Character of the Victim.—The women who submit themselves to this criminal procedure and thus become its abettors and accessories, if not its principal agents, are not all of one class. They are not all of them single women whose virtue has proved an inadequate custodian of their chastity, and who, having become pregnant through illicit lust or by the force or artifice of the seducer, seek by an induced abortion to save, in the eyes of men, that honor

which, with men's help, they have forfeited. These women, the mothers of illegitimate unborn children, whose murder they are willing to plan, do indeed make the majority of those who make the abortionist's business a profitable one, and they are especially the class who supply the fatal cases for later investigation. But they by no means exhaust the accountability of abortionists. There are mothers in wedlock who seek to avoid the discomforts of lawful maternity in this unlawful manner. Sometimes they are the wives of men with whom, either at or before marriage, they have entered into a compact to bear *no children*. Sometimes they are the mothers of several living children, and they now assume the right to say that their families are large enough, and that further increase will be objectionable.

The crime is confined to no one class in society, but is found infecting the entire community of women at all ages within childbearing limits: the high and low; the rich and poor; the intelligent and educated and the ignorant; the professedly religious and those of easy belief. There is no artificial or natural limit or influence which acts as an effectual moral restraint. Conscience is put to sleep by sedative influences of fashion, and specious excuses are invented. These women will tell us, for example, that the fetus has no life before a certain time in pregnancy, and that hence there is no offence in getting rid of it before that stage is reached. They will declare, often, no doubt, with a sincerity that has come from tradition and false teaching, that so long as the contents of the womb manifest no sign of life perceptible to them, they may cast it off as a mere ovarian product, as guiltlessly as if they were emptying the bladder or the rectum. In short, these unnatural mothers, yielding to a prevalent fashion in these matters, see no sin in feticide, no harm or cause for regret in an accidental miscarriage. The misfortune lies in the conception only.

For a woman seduced and anxious by any means in her power to retain the outward aspects of chastity, there is some shadow of extenuation when she takes the risk of life and death for herself in a desperate attempt to rid herself of the evidence of her fall. For a lawfully married woman, in good health and with no excuse save that of expediency or fashion, thus to become a participant in the killing of her unborn child, there is no word of palliation. The seduced woman seeks to hide her shame. The matron has not even this poor excuse.

This is not an imaginary picture. Regular physicians are

by no means strangers to this evil tendency in the community. Any practitioner will be a fortunate exception to the usual experience if before he shall have been in practice a single half year, he is not waited upon by some woman with an urgent, tearful call upon him to procure an abortion for her by instrumental or other means. She will urge him by all sorts of inducements, including golden ones, and if he still holds out, she will tell him in a spiteful sort of way that she knows very well where she *can* have it done—and most likely she is telling the truth. At all events, physicians are to be congratulated every time they resist the tears and the entreaties of this sort of applicant. They may know that in such resistance they have the moral support of every one of their fellows in the regular medical profession. They ought also to be made aware of the fact that a surrender of their honor and professional integrity in such an emergency will, if discovered, bring down upon them well-merited disgrace. For the pledge against criminal abortion, to the observance of which Hippocrates, the Father of Medicine, compelled his disciples by oath, has ever since been considered binding on all honorable physicians.

The crime is recognized as an infamous one in almost every code of medical ethics. One of the oldest of these (Percival), on which many of the more recent ones have been founded, says: " To extinguish the first spark of life is a crime of the same nature, both against our Maker and against society, as to destroy an infant, a child, or a man." And this expresses the general feeling among educated physicians. Its known commission has always been followed by ignominious expulsion from reputable medical fellowship. And mere suspicion that one is tainted with the odor of the crime, although it may be without proof, imprints an indelible stigma, so that no young man or old man in medical practice can be said to exercise ordinary prudence if he deliberately exposes himself to the risks which the term " abortionist " conveys.

In contrast with the sentiments of the regular medical profession to-day on this subject, it is interesting to note that abortion was freely practised and permitted in classic antiquity, and was not punished as a crime under the Roman law until the third century of the Christian era. Later still, the ancient German law prohibited the induction of abortion and punished abortionists. And the *Caroline Code* of France prescribed capital punishment for convicted culprits, a man by the sword, a woman by drowning.

In half-civilized Eastern nations abortion is still permitted.

In Persia, where deliveries at term out of wedlock are punishable by death, all pregnancies of this sort are brought to an end at an earlier stage by artificial means. Stricker and Schort relate the same fact of the East Indians. Abortion is practised also in Turkey upon such an extensive scale as to be regarded as one of the causes of a steadily diminishing population. Pardo states that at Constantinople in the space of six months three thousand cases of induced abortion came to public notice, and that for successive years one might see in a druggist's shop in Stamboul a fetus in a bottle displayed as a sign of the business done there.

In the Fiji Islands the practice of abortion has long prevailed extensively, the women emulating their Christian sisters. The female islanders have an aversion to large families, and there is a sense of shame if pregnancy occurs too often. The women spite their husbands, also, by resorting to abortion, if marital unfaithfulness is suspected.

The Law as it Relates to Induced Abortion.—Concerning the legal relations of the subject, but a few words are necessary, inasmuch as we are chiefly concerned with what the law requires of physicians in the way of medical evidence of the crime. We are concerned, too, simply with the law as it is, and not with what we believe it ought to be. It would be easy, but not for our present purposes profitable, to quarrel with the law, both common and statutory, as it is now administered—to show that in reality it has recognized in criminal abortion no offence against the fetus as such : it does not punish for killing a child, but for causing or attempting to cause a woman to miscarry. The offence is looked at simply and only as regards the woman who is herself a party to the crime, an accessory, if not a principal.

To constitute a crime of any sort, a malicious or wicked intent must be present or must be presumed ; and in criminal abortion the intent is really directed against the unborn child, to destroy the fetus, not to harm the mother. Yet the law ignores this, and disregards the destruction of human life in the fetus, and punishes according to the harm done to the mother. If she dies, the abortionist, if convicted, goes to prison for a long term of years ; if she survives, the punishment is much less severe. Thus, no account is taken of the relation of the child to the criminal act ; no punishment is provided for the destruction of the child's life ; nothing appears in the law to indicate that the fetus has any rights to be defended ; but the punishment for causing an abortion is made according to a wholly different scheme.

Without dwelling longer on these defects and inconsistencies of the law, let us look more closely at the actual legal requirements imposed by the law regarding the crime. In the first place, within the meaning of the law there is no distinction, such as midwifery makes, between abortion and premature labor; between the expulsion of the fetus before and after viability. Abortion, legally considered, is the violent and premature expulsion of the product of conception, without regard to its age, viability, or development. No matter what the stage of pregnancy, attempts to terminate it unnaturally by artificial means, or prematurely, are unlawful.

It is sufficient, therefore, that the attempts at producing miscarriage have been made with *unlawful intent,* and whether the measures used were successful or not, the crime is the same. The accused party can not shield himself by using the consent or even the solicitation of the woman as his defence, since the commission of the act necessarily implies at least tacit submission on her part.

It is not essential, in order to constitute it a crime, that the attempts made should actually have been successful. The criminal act may be brought home to an individual and he may be punished therefor, if it can be shown that he really employed the measures alleged for the purpose and with the intent to cause the expulsion of the fetus. "Whoever," says the Massachusetts Statutes,[1] "with intent to procure the miscarriage of a woman, unlawfully administers to her, or advises or prescribes for her, or causes to be taken by her, any poison, drug, medicine, or other noxious thing, or unlawfully uses any instrument, or other means whatever with the like intent, or, with like intent, aids or assists therein, shall, if the woman dies in consequence thereof, be imprisoned in the State prison not exceeding twenty or less than five years ; and if the woman does not die thereof, shall be punished by imprisonment in the State prison not exceeding seven years or less than one year, and by fine not exceeding two thousand dollars."

The comprehensive strictness of the law is further illustrated in the next section of the same statute, designed to reach another class of offenders :[2]

"Whoever knowingly advertises, prints, publishes, distributes, or circulates, or knowingly causes to be advertised, printed, published, or circulated any pamphlet, printed paper, notice, advertisement, or reference containing words or language giving or conveying any notice, hint, or reference to any per-

[1] *Revised Laws of Massachusetts,* 1903, chapter 212, section 15.
[2] *Loc. cit.,* chapter 212, section 16.

son, or to the name of any person, real or fictitious, from whom, or to any place, house, shop, or office, where any poison, drug, mixture, preparation, medicine, or noxious thing, or any instrument or means whatever, or any advice, direction, information, or knowledge may be obtained for the purpose of causing or procuring the miscarriage of a woman pregnant with child, shall be punished by imprisonment in the State prison not exceeding three years, or by a fine not exceeding one thousand dollars."

Since it is the purpose and intent which, by the terms of these statutes, constitutes the crime in these cases, it is not required that the product of conception should be a fetus, normally formed. It would be criminal abortion if the abortionist used means or instruments to cause the womb of a woman to expel its contents, on the *assumption* that she was pregnant, and the contents should prove to be a monster, mole, or hydatid growth. The offender would, if convicted of the " intent " to procure a miscarriage, be punished just the same as if a fetus fully and normally formed had been sacrificed. But if the accused should set up the defence and maintain it, that, admitting the instrumental operation, he had interfered with the contents of the woman's womb because he believed that that womb contained a blighted ovum or a *dead* fetus, which from every point of view it was desirable to remove, then his defence would be a good one.

The law goes one step further. It says, again, that as it is the intent of the offender which is to be proved, it is not essential to a conviction that the woman's pregnancy should be incontestably established as an element. The woman and the abortionist may have both been mistaken as to the pregnancy ; but if an operation designed to empty the womb supposed to be pregnant is proved, that proof will lead to conviction, although the womb was not holding any product of conception at the time of the operation. Bayard cites a case in which a woman was convicted of an attempt to procure an abortion, and was sentenced to eight years in jail, although the victim of her operation was not pregnant, but had some uterine symptoms due to ovarian disease.

This principle of law was fully illustrated in certain rulings made in a Massachusetts case in 1883, wherein the author was medical examiner. An uneducated physician had been arrested, indicted, tried, and convicted upon a complaint of abortion, and in the course of the proceedings his counsel moved to set aside the verdict, because the indictment contained no allegation that the deceased woman was pregnant

when the accused attempted to procure her miscarriage, as charged. After the conviction, the case was appealed to the Supreme Court upon the foregoing, with other exceptions. The exceptions were overruled by the Court, and the rule was made very plain and exact, that "it is not necessary to the maintenance of an indictment for an attempt to procure the miscarriage of a woman, that the woman should be pregnant with child."

Formerly the law was much more exacting in this matter. It was necessary to bring proof that the woman was actually pregnant at the time of the abortionist's procedure. It was required, also, that the product of the conception should be a living, growing, normal fetus whose life was destroyed in the operation for the abortion. It resulted from this that prosecutions were rarely successful, the difficulties attending such proof being extreme. More recent legislation has modified the requirements in the line of reason and common sense.

It is important to recognize the fact that the law does not make any exception or formal recognition in favor of justifiable operations to induce premature labor. The statute is general in its application. It is, of course, obvious that the best sentiment of the medical profession and of obstetric teachers is favorable to interference with the progress of a pregnancy, (1) whenever there is such anatomical deviation or mechanical obstruction in the mother's pelvis that the birth of a viable child is impossible; or (2) whenever the mother is suffering from such grave disease that her life is in imminent peril and can be saved only by the arrest of gestation. Under such conditions the physician is not only warranted in inducing premature labor, but is required to do so by a sense of duty to his patient, with a view thereby to save one life at least, and, if possible, the lives of both mother and offspring.

Thus, if the mother's pelvis is deformed, beyond well-understood limits; if she is incurably sick from acute or chronic disease; if her placenta is diseased in such a way and to such a degree that a normal labor at term with a living child is improbable; if there are obstinate vomiting, uremic convulsions, uterine tumor, vaginal constriction, or any other conditions inevitably interfering with the progress of gestation, and placing in jeopardy the life, sometimes of the mother, sometimes of the child, sometimes of both together, these are deemed sufficient warrant for operative interference to empty the womb, viewed as a purely medical or humanitarian matter. But the law does not take these exceptional conditions into account, and there can be no doubt that under a strict inter-

pretation of the statute relating to abortion a discretionary power is not allowed to physicians in such cases. It may be said very truly that as, in the law, no exception is made in the interest of wounds made surgically, and it is held that the surgeon's intention is always beneficent and not malicious, and if the patient dies it is not homicide, so the same principle should hold here, and there is a moral if not a lawful justification in the technical violation of the statute in some cases.

Nevertheless, as the law now stands, a prudent practitioner will not expose himself to any risk, if a few precautions will save him. In the event of the death of the mother and child in such an emergency the attending physician might find himself in jeopardy, with the imputation of gross carelessness and criminal neglect hanging over him—an imputation which requires years to remove. So the attending physician should never undertake to do an instrumental operation without these precautions: 1. The consent of the patient, with that of her husband or family. 2. Especially, a consultation with some other physician or physicians in whom there is full confidence. Attention to these simple and sensible safeguards, by making the conduct appear by its candor and openness in the strongest possible contrast with the secret methods of the abortionist, may save great embarrassment.

A similar precaution is proper in another sort of contingency—after an abortion which is the work of other hands. It is the practice of abortionists to operate on the woman and then send her away to a distance to get over it as best she can. It frequently occurs that regular physicians are called upon to finish jobs begun by quacks, under these circumstances. It can readily be seen how much, and what kind of risk a physician runs, into whose charge such a case falls. It is a very easy matter to transfer to him a suspicion which belongs elsewhere. Therefore, common prudence dictates, when a physician is summoned to a case of this kind, that the moment he recognizes the character of the case he should bow himself out of it at the earliest opportunity.

His best course is to insist that the patient shall enter a hospital, and that she shall thus relieve him from any responsibility in the matter. But if this is impracticable for any reason, and the dictates of common humanity require his further attendance, a consultation is of all things the most imperative. A medical friend should be taken into the affair with him, and should be made acquainted with the utmost candor with all the facts, the patient's own account of the clinical history being recited in his hearing. Such a course is

the best safeguard against any subsequent embarrassment growing out of false imputations.

Medicolegal Relations of Abortion.—Turning now to the **medical relations** of the subject, the period of pregnancy at which most criminal abortions are procured or attempted is between the third and the sixth month. The explanation of this lies in the fact that during the very earliest period of gestation women are somewhat uncertain concerning their condition, and they wait until that uncertainty is removed by the lapse of time. *After* the *sixth* month the motions of the child within the womb are felt, each week adding to their vigor. The risks and consequences of an abortion become then more real and more appealing, and courage is insufficient. If any attempt to terminate the pregnancy is made *before* the beginning of the third month, it is usually undertaken by the woman herself at home, with the use of drugs, horseback exercise, and long walks. She postpones instrumental interference to a somewhat later period, and this usually falls in the third or fourth month.

The medical evidence to establish a charge of criminal abortion is directed to the answer to the two following questions: 1. Has the woman, living or dead, been recently and prematurely delivered? 2. If so, by what means and in what manner was the delivery brought about? That is to say, was the abortion natural, accidental, and innocent, or was it forced, intentional, and unlawful?

We must consider, first, the proofs that abortion has actually occurred in any given instance. These proofs are mainly to be sought for in the physical condition of the suspected woman. She may be living and able by her statements to assist or to obstruct the inquiry. She may have succumbed to unexpected consecutive disasters growing out of the abortion, and her dead body will be the real field of inquiry. The law, as already stated, makes no distinction as to the stage of pregnancy at which the unlawful act is committed. The offence is identical in the second month and in the ninth month. Therefore, as a point of departure for the medical study of this crime, a brief synopsis of proofs of recent normal delivery *at or near fetal* maturity will be appropriate.

Proofs of Recent Childbirth.—The signs of recent delivery, under normal conditions, at or near term, as they are found on the *living* subject, may be well studied under three classes, according to their relative value.

There are several doubtful and uncertain signs which, standing alone, are of little value. The skin on the front of

the abdominal parietes is relaxed and wrinkled. Its pigmentation is suggestive. Edema of the same region is sometimes seen. Striations, or *lineæ gravidarum*, or *lineæ albicantes*, the so-called silvery lines, are in evidence. Varicose veins in the legs are observed. A slow pulse is common. Certain subjective symptoms are present, such as painful micturition, after-pains, thirst, pain in the breasts and genitals, profuse sweating, sleepiness, and exhaustion. All these, considered by themselves, prove nothing. They may be present in women who are not in childbed. They may result from the removal of a fibrous polypus from the womb. Indeed, they are so far independent of the puerperal condition as controlling signs, that they may be found in a male patient. Their value in relation to recent delivery is corroborative or suggestive only.

There is another set of signs which have a greater value. They are local and relate to the genital tract and the mammary glands. Inspection of the **vulva** shows it to be swollen, edematous, pigmented, with patulous and gaping labia; the *ostium vaginæ* is dilated, and the inner aspect of the labia shows lacerations. Remnants of torn hymen and fourchette may be seen, and perhaps injury of the perineum. These are all best observed in primiparæ. Repeated deliveries modify their value. The **vagina** is congested, edematous, abnormally moist; its rugæ are obliterated, and it is generally dilated so as to admit freely the whole hand. The **cervix** is fissured; its canal is patulous, admitting one or more fingers. *Within the uterine cavity* the placental site may be felt (Winckel). The **fundus** of the **womb** is felt above the pubes. The **lochial discharge**, for two days, is bloody, with clots and débris; on the third day it is serosanguinolent and more mucous; after the seventh day it is paler, thicker, and glairy—"lochia alba." The **mammary glands** are enlarged and knotty; their areolæ are pigmented; the skin is striated; the veins are swollen, and there are tubercles (of Montgomery) on the areolæ. Their secretion is colostrum for seventy-two hours, then milk.

These various signs, though much more suggestive and valuable than those in the former group, are still short of being fully demonstrative, especially if they are studied singly. For example, the secretion of milk may occur independently of parturition. The changes about the genital organs may be observed, also, as the result of inflammation, malignant disease, or the passage of foreign bodies.

What is left, then, as data for a positive diagnosis, if all the signs now described are subject to doubt? Winckel tells us

that "positive proof of the occurrence of childbirth is furnished only by the discovery of parts of the ovum." For this purpose we seek the aid of the microscope. If the search in the débris of the lochial discharge fails to discover the elements of embryonic development, we may nevertheless be successful if we secure a bit of material from the cavity of the womb by means of the curette. Discovery of placental tissue, of shreds of decidua with large nucleated fatty cells, would be a demonstration. Discovery of the villi of the chorion would be equally positive proof.

It will occur, however, to the reader to ask, How long are these various signs, probable and positive, *available* as proof? How long after the womb has emptied itself in childbirth can a positive diagnosis be made of recent delivery? It is clear that, under normal conditions, Nature loses no time in clearing up the evidences of parturition. The diagnosis becomes difficult just in proportion to the period which has elapsed since the delivery; and, after a time, varying in different individuals and in the same individual according to the order of the pregnancy (whether primary or later), it becomes impossible. Thus, the local appearances about the vulva, and the general state which goes with them, are all undergoing convalescent repair after forty-eight hours. The globular induration above the pubes (fundus of the womb) sinks lower and lower. The lochia changes from a bloody discharge to a colorless mucous flow.

The milk takes on permanent characters and no longer shows colostrum corpuscles. Involution is in full progress. As a rule the marks of contusion, laceration, etc., about the vulva have pretty well disappeared by the fourth day, or have become so far altered by that time as to be of slight service. If the woman is a multipara, the diagnosis of her recent delivery must necessarily be in doubt if the examination is made after the lapse of a week or ten days. If the labor is the first of the series, the various signs may persist somewhat longer. But in any case it should be remembered that a careful review of *all* the physical signs and rational symptoms is the only safe course, the microscopical discovery of remnants of tissue peculiar to pregnancy being the most conclusive basis for a diagnosis.

In all this study of the signs and symptoms of recent delivery the thing delivered does not enter into the account. It does not need to be said that the presence of a baby, dead or alive, is a most important piece of proof. We are assuming, however, that this witness has been disposed of and is

not available; and we are assuming that the woman in the case does not aid the inquiry by any admissions or explanations.

So much for the diagnosis of recent delivery as it is studied on the living woman at or near term, without any criminal act involved—that is, proofs of recent parturition under normal conditions.

If a diagnosis of recent delivery, at or near term, based on the physical signs alone, is attended with some difficulty when the woman is living, it becomes increasingly so in proportion to the immaturity of the ovum. After the sixth month of gestation a miscarriage leaves symptoms and signs not very much unlike those attending a childbirth at the later periods of pregnancy. This is the obvious result of the size of the fetus. Between the fourth and the sixth month a physician might readily be deceived if he depended alone on his physical examination of the woman and she preserved silence. Some symptoms like hemorrhage might be suggestively profuse. The use of a sound might help by determining an increased depth of the uterine cavity.

The womb might and probably would be felt as a globular tumor above the pubes and if, with this, there were tenderness in the hypogastrium, an unnatural patency of the os uteri, so that the examining finger easily entered, some bruising of the *ostium vaginæ* with dilatation of the canal, an offensive discharge, then this state of things would be strongly suggestive, and suspicion would be justified.

Abortion at any time before the fourth month, if without accident or complications, the uterus throwing off its contents easily and wholly, might readily pass off without any very suggestive effects as symptoms. It might easily pass for a painful menstruation. This would especially be the case in multiparous women. If a woman, who had submitted herself to a criminal operation skilfully performed, at this early stage in gestation, were not alarmed by unusual flowing or pain, or by the occurrence of some unexpected incident after the operation, if she kept still about herself, her temporary illness would readily pass with her family, kindred, and acquaintances as her catamenia.

On the other hand, if for any reason she broke her reticence, sent for a physician and communicated to him her recent doings, he would find ample symptoms to corroborate her admissions. The discharge of blood; the situation and intermittency of the pains; the patulous os; the soft hot cervix; the tenderness above the pubes and in the pelvis; the

fetid discharge a little later, would all be in full harmony with an induced abortion, and would tend to confirm the woman's story. And if, with the symptoms, an ovum or embryo were shown, then the case would be complete.

Signs of Recent Delivery in the Dead.—If from this review of the signs of recent delivery at or before term, as they present themselves about the body of the living patient, we turn to a study of the proofs of such delivery as the dead body of a puerperal woman shows, we find, besides the external appearances already described, certain lesions and changes about the pelvis, shown only by an autopsy. The uterus in these conditions is, of course, found enlarged, according to the period of gestation at which the delivery occurred, and the time which has elapsed between the delivery and death.

If the childbirth occurred near fetal maturity and the woman survived it from twenty-four to thirty-six hours, we should find the womb from seven to eight inches long, externally, and from four to six inches broad; its wall would be from one to one inch and a half thick, and its weight would be one pound and a half. These figures are to be regarded as approximate only, because of the considerable diversity in different women.

The uterine walls will be softened as well as thickened; their color will be yellowish; and a section of their substance will show the cut cylinders of their enlarged blood-vessels or sinuses. The lining of the uterine cavity will be found to be uniformly smeared with a red or brownish-red fluid of the consistence of thin cream; its odor is characteristic; it is mainly altered blood. If this fluid matter is removed by a gentle stream of water, we shall probably find flocculent or pulpy remnants of the decidua, especially in the earlier months. The microscope will readily determine the true character of these villi of the chorion.

Orth describes, as an important element in the diagnosis of a recent labor at or near full term, an orange color of the mucous membrane of the neck of the womb. The cervix will also probably show some degree of ecchymosis. Lateral lacerations, too, at the os uteri are a frequent incident of a normal, though perhaps rapid parturition.

Frequently the placenta, or a portion of it, is found within the uterine cavity, and the presence of this " master sign," as it has been called, would of course leave no doubt of the recent pregnancy and delivery. This indisputable evidence is available, if at all, after the end of the second month of preg-

nancy. It is found as a dark, reddish-brown, slightly raised patch, presenting a rough, ragged, and irregular aspect. Generally it will be suppurating and partly disorganized, and in this state it can be of no assistance in determining by itself the lapse of time since delivery.

Section through this placental tissue will reveal patulous crescentic openings, the remains of the placental sinuses. The size of this placental site, if the miscarriage occurred in the third or fourth month, is about that of a silver dollar; from this it shows progressive increase until at or near term it is as large as the palm of the hand. The contraction and involution of the womb steadily reduce its dimensions.

The Fallopian tubes, round ligaments and ovaries, after delivery, are injected so that their surfaces have a diffused dull-red color.

The Corpus Luteum and its Significance.—It is, however, to the interior of the ovaries, at least to that of one of them, that we look with especial interest in this connection. We expect to find on section of the organ a *corpus luteum.* The nature of this body, its manner of development, and its value as evidence of pregnancy have been the subject of the keenest inquiry among physiologists and obstetricians, and there has not been wanting, at times, a somewhat too controversial way of treating the topic.

Taking it for granted that the reader is sufficiently well acquainted with the appearance and manner of development of the *corpus luteum,* any very detailed description of it need not be entered into. The ovary, as we know, is made up of a stroma in which are embedded a great number of Graafian follicles, each containing an ovum more or less advanced toward maturity. At or near each menstrual period in the human female one of the ova arrives at its fullest development and is ready for impregnation; the follicle is distended as a small, rounded, tense, bulging, fluctuating tumor.

At some time, in close relation to or perhaps during the catamenia, the follicle ruptures, and the ovum is discharged and is caught by the fimbriated structure of the Fallopian tube and is passed along through the tube toward the womb. Certain changes begin in the ruptured follicle now that it has lost its tenant. If the ovum is simply washed away in the menstrual discharge,—that is, if it escapes impregnation and conception does not occur,—we have the so-called *corpus hæmorrhagicum* or *corpus luteum* of *menstruation;* if impregnation occurs, we have in the ovary the *corpus luteum* properly so called, and the chief difference between the two is one of

degree. The process of development, the retrograde changes, are much the same in kind in the two cases; only, in the one case (menstruation) the entire development, maturity, and retrogression are generally rapid, being fully accomplished in six or eight weeks, counting from the rupture of the Graafian follicle to the disappearance of the *corpus hæmorrhagicum*; accordingly, the *corpus hæmorrhagicum* in a menstruating woman does not attain a high degree of development; it is less in volume, and less pronounced in its typical characters than the *corpus luteum*.

On the other hand, the process of ovulation is normally suspended during gestation, and the whole energy of the ovary appears to be devoted, so far as the *corpus luteum* is concerned, to extending over a period of months a series of
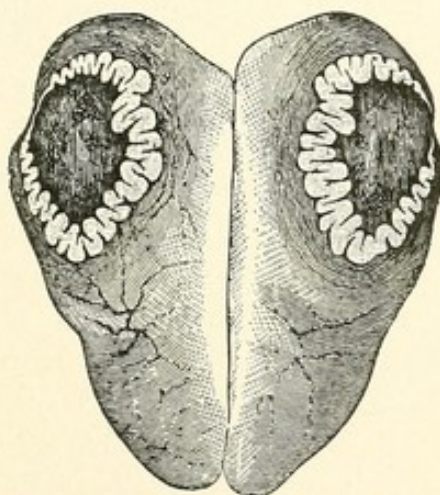
FIG. 19.—Human ovary cut open (Dalton).

processes which in the menstruating virgin is accomplished in a few weeks. The consequence of this deliberation in workmanship is a more perfect piece of work in the *corpus luteum*; its convoluted wall is thicker and more yellow; its circulation is more fully organized; its period of quiescence at maturity is prolonged before retrograde steps are taken, and it remains about the same in size and appearance during the fourth, fifth, and sixth months; while with the *corpus hæmorrhagicum* of menstruation, so far as we know, there is no time for such a pause, and the process of retrogressive atrophy follows immediately upon attaining the maximum at the end of the first month.

The question of practical interest to us now is, whether there is a sufficient difference between the *corpus luteum* of pregnancy and the *corpus hæmorrhagicum* of menstruation to

enable us to declare with certainty the character of a given specimen. That is to say, supposing an ovary to be presented for inspection, on the external surface of which there may be observed a slight irregular elevation, with a scarcely visible, stellate cicatrix at its center; that a section is made through this prominent area which exposes a veritable " yellow body," the long diameter of which is about three-quarters of an inch and its shorter diameter a little less; its wall convoluted, wrinkled, and of a dull-yellow color; its center a colorless, fibrinous coagulum—can we say from that specimen, without any knowledge of its history, that we are certain it came from the body of a woman recently pregnant and just delivered? If this question could be answered affirmatively in every case of *corpus luteum*, very little in addition would be needed as evidence in proof of disputed uterogestation. But, in point of fact, there is such lack of agreement among physiologists and medicolegal authorities on this point, that a medical witness will do well to exercise some reserve in his opinions. It would be inexcusable on the part of any physician to swear away, by that sign alone, any woman's chastity. The author does not say that there are no differences between *corpora lutea* of pregnancy and *corpora hæmorrhagica* of menstruation.

There *are* differences of great anatomical and physiological interest. But the writer insists that these differences are of such a nature, so far from being constant, distinctive, and unequivocal, so subject to modification one way or another, that we ought not to use the *corpus luteum* as a *controlling* sign in a post-mortem diagnosis of recent pregnancy, but only as one of the *presumptive* confirmatory proofs, supplementing and corroborating other appearances.

When such acknowledged experts as Dr. Lee and Mr. Wharton Jones, on being shown an ovary with a *corpus luteum*, differ upon the question whether it is derived from pregnancy or menstruation, it behooves *ordinary* medical men to be cautious. And in the present state of science, especially in view of the lack of harmony among authorities on the matter, the following comment by Wharton Jones, confirmed as it is by eminent physiologists (Bischoff, Raciborski, Meckel, Dalton, Longet), and accepted by such medicolegal writers as Taylor, Tidy, Hofmann, may be remembered as a safe guide:

"Although," he says, "*physiologically*, one may be permitted to speculate on the relation between the occurrence of *corpora lutea*, and preceding sexual intercourse, it would be rash and unwarrantable in any one to pronounce positively

from the presence of a *corpus luteum* in the ovary that such intercourse had taken place. The discovery of an ovum in the uterus in process of development could alone warrant such an affirmation in a court of law. But, on the other hand, the absence of a *corpus luteum* would not warrant the affirmation that conception had *not* taken place."

And Taylor uses the following clear language in his *Manual of Medical Jurisprudence:* "Medical evidence respecting the nature of a *corpus luteum* in an unknown case, if received at all by a court of law, should be received with the greatest caution, and only from an obstetric expert of great experience. The old doctrine on this subject, that the presence of such a body in an ovary affords certain and undeniable evidence of impregnation, may be regarded as completely subverted."

In other words, the present prevalent opinion is that a *corpus luteum* affords presumptive, but not positive, proof of pregnancy.

CHAPTER XI.

ABORTION (Continued).

IN the preceding chapter were considered the proofs of recent delivery, at term and prematurely, as they are found upon the body of a woman, living or dead, without reference to the manner in which uterine action was initiated. We studied the effects and results of childbirth; its symptoms and anatomical evidences—the *end* of the process, disregarding its beginning.

From this review we turn to the question: By what means and in what manner was a premature childbirth in a given case brought about? Or, in other words, Was the abortion accidental and innocent, or induced and intentional, and therefore criminal?

What is the nature of the evidence for which the physician should look to solve this, the really important question in our present point of view? If a miscarriage never occurred except through the application of intentional violence, the problem would be a simple one. But, as a matter of fact, frequent as are the cases of criminal abortion, these are far outnumbered by abortions from natural causes, without interference. Mr. Whitehead collected statistics of 2000 pregnancies, and found that 1 in 7 of them terminated prematurely in miscarriage. It is not necessary for us to go very far into the causes of these accidental abortions in connection with our present study. They may be classified as maternal on the one hand, ovuline on the other.

The Maternal Class.—This class comprises reflex causes, such as lactation, gastric irritation, and neuralgia. Systemic causes, like fevers, especially the infectious group; chronic pulmonary and cardiac disease; syphilis, poisoning, and acute nephritis. Local causes, such as uterine flexions, fibroids, endometritis, cervicitis, and pelvic adhesions. Physical causes, of which blows, falls, and violent exercise are examples. Psychical causes, such as fright, anxiety, anger, and mental shock.

On the Side of the Ovum or Fetus.—The causes of

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its early escape from the womb are found in its envelopes; in its source of nutrition—the placenta, fatty degeneration, apoplexy, syphilis, and twisting of the funis are illustrations of placental mishaps; its own malformation and malnutrition have an obvious influence.

In a word, any condition, whether maternal or fetal, which interferes with the nutrition and development of the fetus and causes its death enters into the etiology of accidental abortion. In any suspected case of abortion satisfactory evidence of the presence of such conditions, offering a probable and reasonable explanation of the mishap, excludes the theory of criminal interference. If these conditions are *not evident*, we consider the case a fair one for further medicolegal investigation.

What are the signs or proofs by which physicians can testify in court that the abortion in an alleged instance **was** not of this class, and that within the meaning of the law it was a criminal act? Incidentally this will involve some consideration of the usual methods employed to procure a miscarriage.

The medical evidence that a miscarriage was of the unlawful sort is derivable from three sources:

1. A knowledge of the woman's character and of her actions immediately antecedent to the miscarriage, together with her *symptoms* after the act. 2. An inspection of the woman's body, living or dead. 3. An examination of the fetus or embryo known to have come from the woman's uterus. The first and second of these sources of information are more reliable and valuable than the third.

The evidence to be derived from the woman's conduct before and in connection with the act is mainly the province of the detective; and the medical attendant or medical examiner is but secondarily concerned with it. There are, however, many points in connection with this branch of the investigation in a suspected case which are best elucidated and interpreted by a physician, especially as he is generally the one who knows the facts. Is the woman single and her child illegitimate and, if born at term, a bastard? Has she tried to conceal her pregnancy, or denied its existence? Has she been heard talking about measures adapted to bring on a miscarriage, or has she been observed studying the advertised methods? Has she been depressed, ailing, and unable to work? Has she mentioned the name of any person who is known as an abortionist, and is there any evidence that she has applied to such a person for counsel? If the miscarriage is actually in progress, is she dilatory in obtaining medical assistance? Is her manner in answering questions candid and open, or re-

served and misleading ?   In what kind of surroundings is she found ?

Drugs with Imputed Abortifacient Effects.—But of especial interest to the investigation in its bearing on the intent of the person or persons involved, is the fact that the woman has been advised to take, or has taken, any one of the drugs which are popularly considered as specific abortifacients.

In this connection it will be important to ascertain if more than therapeutic doses of the drug were taken, and if any disease was present which could call for or justify a resort to such drugs, and by whose advice they were taken.   If the woman can not satisfy you on all these points, the suspicion against her would be strong.

The nature of the drug itself is important to take into account at this point.   In the list of reputed abortifacients, at all events, in the list of therapeutic agents that have been used for this purpose we might include a very respectable part of the entire materia medica.   It is incredible to what singular and absurd substances and mixtures, as well as to what powerful agents, the credulity and ignorance of women lead them to resort in their determination to bring about miscarriage. These agents range all the way from irritant poisons, like arsenic and corrosive sublimate, to inert herbs, such as balm and chamomile.   They include drastic purgatives, like croton oil, elaterium, aloes, and gamboge ; diuretics like squills, broom, and cantharides ; tonics like quinin and iron ; emetics, ecbolics, and emmenagogues, as well as a numerous class of herbs and essential oils not readily classified.

With reference to this entire list the general statement may be made, confidently, that not one of the drugs mentioned is a specific abortifacient.   They have no such specific action as cathartics have on the intestine, or emetics on the stomach, or diuretics on the kidneys.   On the other hand, many of them, by an *indirect* action, and in certain favoring states of the pelvic viscera, may cause the womb to surrender its contents.

To the comprehensive rule that there is no *specific* abortifacient, the author of this volume would not make an exception in favor even of ergot, which has a special reputation in this direction.   The evidence is not by any means concurrent or convincing that ergot can initiate uterine action, by itself, at any stage, especially at an *early* stage of pregnancy.   Its value as a special uterine stimulant, once uterine action is begun, is unequivocal, and this has undoubtedly entitled it, more than any other agent, to claim rank as an abortifacient.

It is of relatively slight consequence, however, to discuss whether such and such drugs are abortifacient, because much of the discrepancy of opinion as to the efficacy of so-called abortive drugs would disappear, if we remember, on the one hand, what we may call the individual idiosyncrasy or predisposition toward abortion, and, on the other, the usual manner in which the drugs are taken.

Some women, as all physicians know, endanger the continuance of their pregnancy by the least departure from their usual habits; and these women, if they wish not to miscarry, have to exercise great caution in their behavior, especially if the habit of miscarriage has become established. It has been observed, too, that there occurs in certain women in their pregnancy a periodical plethora or activity about the pelvic organs, answering in point of interval to the usual menstrual period in the unimpregnated womb; and at these times in gestation the womb is particularly ready to expel its contents. Now it is clear that women so constituted, with predisposing conditions highly favorable to abortion, might find an abortifacient in almost any drug, narcotics excepted; while other women, otherwise endowed, would carry their children to term in spite of the most excessive and persistent use of drastic and irritant agents. Life even is sacrificed and the uterus keeps close possession of its contents. It is to be understood, too, that a woman determined on accomplishing her purpose to abort does not trifle with the agents she employs; she does not use her pennyroyal, her cotton root, or oil of cedar in carefully regulated doses, but she takes reckless, immoderate, even toxic doses, without including any other result or object than to bring on the uterine flow which means so much to her; about other consequences she is indifferent.

The drug which has a reputation as a " regulator" forms the usual *domestic* expedient of the woman whose menstruation is suspended after imprudent exposure. It is safe to say that nearly every woman, married or single, who suspects that she is pregnant and wishes to rid herself of her burden, resorts to the free use of medicines before she consults an abortionist. And the opportunities for obtaining drugs of this kind are many and open. One author (Van de Warker) says he knows of more than twenty-five preparations advertised for this purpose. Many of the sellers of these preparations make a direct bid for the pregnant woman's patronage by the printed caution that women in a delicate condition or in the " family-way" should not use the offered remedy. In this way the dealers and makers escape the penalty which the law provides

for the sale of abortive drugs, by saying they have distinctly cautioned pregnant women not to use them.

Besides these *advertised nostrums*, there is a large and lucrative counter-trade by druggists who make up their own private formulæ to sell to women who wish for something to " bring them right " in their monthly turns. The recklessness with which even reputable druggists engage in this kind of business is extraordinary. Occasionally a fatal result occurs ; but the lesson is lost and unheeded.

In 1866 a woman died in Troy, N. Y., from pelvic cellulitis after an abortion at six months. She confessed that she had been using drugs for three months to bring on a miscarriage, and the mixture that finally did the business was bought of a druggist in Pittsfield.

Another similar case occurred in 1861, in the same city. The woman, far advanced in pregnancy, got a combination of drugs in the form of pills, buying them from a neighboring druggist. She died, and the druggist escaped conviction on the plea that he did not know that his customer was pregnant.

The proprietary nostrums which conceal their true purpose as pretended abortifacients under the thinnest possible disguise of name and imputed use are composed generally of a purgative with other agents presumed to have a specific influence on the womb. All " periodical " *pills*, when taken in considerable doses produce cathartic effects. Usually these effects are due to *aloes*, which enters into the composition of such pills quite largely and is their base. Combined with aloes we may expect to find ergot and powdered savin.

" Periodical drops," so-called, usually contain some of the powerful essential oils, which are not only comparatively effective as abortifacients, but are also absolutely poisonous and readily destroy life. Fluid extracts and infusions also play an important part here. The oils of savin, tansy, cedar, and pennyroyal, and the fluid extract of cotton root and ergot, are constituents largely used.

Signs of Abortion Induced by Traumatism.—An abortion induced by the use of drugs is more difficult to differentiate from a spontaneous or accidental abortion than is one induced by instrumental interference. The symptoms which stand out in bolder relief in the latter are lacking in the former. The uterus itself presents no anatomical appearances which will tell whether drugs or an innocent mishap furnished the force which caused its evacuation. But we are more fortunate in the case of conclusions if we are dealing with the effects of mechanical artificial measures.

It is proper to make a single general comment about the various forms of violence to which abortionists and abortion-desiring women resort. They are not all equally efficacious. Physicians know, and abortionists know also, and too well, that of the exciting causes of abortion, the most effectual certain means for bringing on the expulsive action of the womb is the destruction of the ovum or embryo, by breaking up its integrity and attachments to the womb. But, short of this, there are many forms of violence adopted by women by the advice of abortionists, or on their own motion, to get rid of an unwelcome uterine guest. Sometimes, in some women, the very simplest measures will prove sufficient, because of the predisposing conditions already mentioned. And at the other extreme of the line it happens that the womb resists the most extreme assaults.

So slight a thing as a misstep or immoderate laughter has repeatedly been known to provoke a miscarriage. A woman once told the writer that she never had any trouble with this matter—that one or two vaginal injections of warm vinegar were enough to set her right, if she found herself pregnant.

The readiness with which miscarriages occur in some instances after the simplest exciting cause will explain the reputed efficacy of certain measures to which women themselves resort before going to the advertising abortionist. Violent exercise, long walks, jumping, tight lacing, very hot baths, running up and down stairs, riding over rough roads, and horseback exercise are some of these.

On the other hand, the books give us illustrations at the other extreme. Wagner relates the following case: A young single woman, seven months pregnant, had used savin and other drugs with a view to cause miscarriage. As these had no effect a strong leather strap was tightly buckled around her abdomen. This failing, her lover (as he himself confessed) knelt upon and compressed the abdomen with all his strength, but this did not accomplish the desired object. The man now *trampled* on the girl's person while she lay on her back, but nothing came of it. Then he took a pair of long, sharp-pointed scissors and thrust them into the girl's vagina. Much pain and hemorrhage ensued, but did not last long. The woman's health did not appear to suffer from this sportive exercise, and at the proper time a living child was born, maturely developed and without any marks on its body in memory of its rough usage.

The writer will not detain the reader with a detailed account of the instrumental and mechanical means employed by

abortionists. They vary from those most approved by regularly educated physicians to the crudest and most cruel which ignorance and recklessness could devise. Sometimes the operation is done skilfully, under antiseptic precautions, *secundum artem*, and no mark is left behind as a telltale. Occasionally, the author is sorry to admit (but for the credit of our profession he believes it to be but rarely), an educated physician falls from the course of recitude and helps his purse at the cost of his morals; but he does his wicked work with skill.

Criminal trials have brought to light a great variety of instruments which have played a part in inducing abortion. Various puncturing appliances, such as stillettes, probes, trocars, knitting-needles (on the authority of a New Hampshire doctor), goose-quills, pieces of whalebone, wire, umbrella ribs, tooth-picks, crochet needles, hair-pins, sharpened twigs, and sticks are in this class. Even skewers, curtain rods, and shears have appeared as witnesses. Various kinds of tents and bougies are in the list.

Elastic male catheters have a right of way before all other means, and the usual method of performance by abortionists consists in the introduction of an elastic catheter within the womb and permitting it to stay there. The hand alone, or the arm, is sometimes sufficient. Galvanism with special apparatus is sometimes resorted to; and syringes and injections are common.

Van de Warker asserts that an injection of water into the uterine cavity is a most common procedure in America; while puncture of the membranes is more generally resorted to in France. Sometimes a careful surgical character is given to the act; a speculum exposes the way for the sound or the uterine dilator, and antiseptic precautions save from disaster.

Can a woman manipulate herself with an instrument of any sort, within the womb, so as to produce an abortion on herself, unaided? First impressions would favor a negative answer. The situation of the external organs and the situation more especially of the mouth of the womb would seem to render the performance of such an operation very difficult if not impossible. But there are many well-authenticated cases attesting the actuality of such a feat and proving the successful consummation of the woman's designs in this direction. The author himself has met with such cases, and other practitioners have told him of similar instances wherein the evidence was trustworthy. The books, too, cite examples of this rather remarkable performance.

Hofmann[1] says: "While instrumental abortion does not seem possible except with the intervention of a third person, experience teaches us that pregnant women have accomplished these manœuvres on themselves. Graves reports a case in which a woman induced an abortion on herself by means of a knitting-needle; and another in which a woman used the whalebone rib of a parasol in her genitals."

Witthaus and Becker[2] cite the two following cases: 1. A woman used a flexible rubber sound, first disinfecting it in a 2 per cent. solution of carbolic acid. She successfully introduced it and left it until uterine pains came on, when she removed it and a miscarriage occurred. She had done the same thing three years before. 2. A woman, two months pregnant, passed an elastic catheter into her vagina, shortened by cutting off the anterior end. It was stiffened for its passage by means of a stylet. She felt pain and, supposing the instrument had entered the cervix, removed the stylet. Some blood came, and symptoms of fever and peritonitis followed. She miscarried six days after the catheter had been put in. The instrument could not be found, but after two months it was passed from the rectum. The patient was a married woman, and there was no attempt at concealment. She had successfully passed a catheter into her womb and induced miscarriage in three previous pregnancies.

Hofmann remarks that besides the use of instruments more or less dangerous and crude in their character, the abortionist frequently resorts to mechanical means of a still more elementary and physical kind. One of the most brutal methods, and one generally employed by persons who do not pretend to have much medical skill, is violent concussion of the belly by blows or other means. Separation of the ovum from the uterine wall follows; the fetus is killed and the womb is forced to act. This method has been known from the most ancient times; Ovid mentions it. It is not by any means successful uniformly. The tenacity of the womb after violence is often illustrated in cases reported.

Another mechanical means, less violent and more certain of securing the desired end, consists of *frictions and pressure used systematically over the womb, across the wall of the belly.* We know that massage of the hypogastric region is used in practical obstetrics, both during the delivery of the child and of the placenta, to provoke uterine contractions, and it is well established that the same procedure used systematically and

[1] *Legal Medicine*, p. 166.
[2] *Medical Jurisprudence, Forensic Medicine, and Toxicology*, ii., p. 103.

for a long time can bring on a premature delivery. Cases of criminal abortion by this means are recorded.[1]

In regard to the usual course of events incidental to an instrumental operation, at the time when it is performed, some women declare that they feel little except a poke or slight pricking when the operation is done. Others have moderate pain. In the majority of cases, however, the pain is immediate and severe, giving rise to a tearing sensation in the abdomen, and attended sometimes with fainting or shock. A little blood almost always follows at once. Rarely, liquor amnii escapes. From this time, if the procedure promises the desired result, the woman is advised to take hot baths and ergot of rye, and she is told that she need not avoid exercise. If the operation is successful, the expulsion of the fetus follows, generally, within sixty hours; occasionally this result is not attained under six, seven, or even eight days. Then there are a few days of moderate flowing, and if all goes well, the patient's convalescence is brief, and she is encouraged to try it again if need be.

One important source of anxiety and danger is the *retention* of the *placenta* in cases of abortion, in and after the third month of pregnancy. Hours, days, even weeks, may elapse before the womb is emptied. Bleeding continues, and frequently becomes a source of special danger from its amount; or the placenta may decompose and announce its presence by a fetid vaginal discharge, or by symptoms of septic infection.

Objective Evidences of Abortion.—In a trial for criminal abortion the medical witness will be called upon not only to give his opinion as to the efficacy, absolute and comparative, of the various means ordinarily resorted to for the induction of a miscarriage, and as to the probability or possibility that the methods alleged in the *present* indictment were an adequate cause for the effects stated in evidence, but he will also have to describe and interpret appearances about the woman's body, living or dead—whether or not they are consistent with the theory of criminal intent. We have studied the normal symptoms and signs of delivery in the living subject and as they appear on the dead subject, at or near term, or before. Are there any modifications of these, or signs supplemental, by which we can determine that the abortion was *not* an accidental and innocent incident, but forced and criminal? What symptoms does a woman present in the act of aborting, when the abortion has been induced by instrumental means?

[1] Hofmann, *Legal Medicine*, p. 105.

Evidence of acute pain in the pelvic region or hypogastrium, and in the loins; a sense of weakness out of proportion to the loss of blood, although the hemorrhage itself may be a source of apprehension; nausea and vomiting; these are the signs which attend an instrumental or forced abortion when no great damage has been done to the womb in the operation. But the injuries done to that organ by the method or the instrument may impress special characters upon the symptoms. These injuries range from trifling lesions to rapidly fatal ones. The rupture or perforation of the womb, the division of an important vessel, the admission of air to the veins, can quickly bring about a fatal termination. Sometimes, indeed, the reckless manner in which the woman herself has sought to obtain relief kills her while her womb meanwhile refuses to surrender its contents.

In one of the author's official cases, in 1878, a woman, two or three months pregnant, took an ounce of oil of cedar at 15 minutes past 9 in the morning, and she was found in convulsions in her yard at 20 minutes past 9; at 10 minutes to 10 she was dead. After she had had many convulsions she admitted taking the drug for abortion. No miscarriage resulted.

In another instance a married woman, four months and a half pregnant, the mother of a child three years old, had repeatedly declared her purpose to have no more children, and she had procured an abortion on herself the previous winter. At 3 in the afternoon she injected a bulbful of spirits of turpentine into her vagina and died nine hours later in great agony. There was no miscarriage. The autopsy revealed intense congestion of the genito-uterine tract.

If in an ordinary case, without these striking features, we discover in the statements of the woman, or those of her husband, or of others, the fact that a condition of severe shock was among the initial symptoms of the case, followed soon by expulsive pains, and if, in addition to this, the application of the hand over the abdomen gives evidence of hypogastric tenderness, we are fairly at liberty to suspect that we have to deal with a case of forced abortion, the denials of the patient to the contrary notwithstanding. If the questions to the patient are skilfully put, success may attend the inquiry at once, for, in most cases, women are ignorant of any peculiarity or significance in their symptoms, one miscarriage being like another in their view. Then, if an inspection of the vulva or a vaginal examination affords confirmatory evidence, the suspicion will be complete.

The inspection of the genital organs—the vulva, vagina,

and os uteri—may reveal lesions wholly inconsistent with the claim that the miscarriage is an accidental and innocent one. Even digital examination also may give valuable data for a differential diagnosis, such as heat, swelling, tenderness, and an edematous state of the cervix, inconsistent with an abortion without previous interference. Of course, if we find any foreign body in the vagina, a bougie, catheter, or tent, the diagnosis is absolutely established.

The symptoms of septic infection are suggestive: Chills, vomiting, abdominal pain, tenderness and distention, fever (shown by the temperature), and vaginal fetid discharge are all suspicious.

Concerning the manner of the patient, if the woman is actually suffering from an abortion unlawfully produced, the very consciousness that she is concealing something, that she is undergoing examination by one who, by his medical skill, may detect her deceit, may make her reticent, cautious, and reserved, especially as the subject of abortion is approached. If she denies, she denies with suspicious emphasis. If, on the other hand, she is led to make admissions, she may confess that she has been operated upon, and she may tell you when it was done. But she draws the line here; she will not say where or by whom.

It sometimes happens that a woman miscarrying in the earliest months of pregnancy by artificial interference sets up the plausible declaration that she is *a subject of dysmenorrhea,* and that her present attack is of that nature.

How may we distinguish between the two states—abortion in earlier months, from difficult and painful menstruation? If the manner of the patient did not throw a shadow of suspicion on the case, the character and situation of the pain ought to. The pain of dysmenorrhea is ovarian, not uterine. The pain of abortion is uterine and central rather than lateral. Both kinds of pain are periodical; but the expulsive pain of dysmenorrhea has a scanty discharge of blood attending it. The discharge, if any, comes in small gushes, and there is relief from the pain when the gushes are larger.

In abortion the pain and discharge of blood come together; there is no relief of pain by bleeding; the expulsive pains continue until the fetus comes. Moreover, the condition of the blood coming from the vagina differs in the two attacks. In abortion it coagulates readily in the vagina, or as it exudes, and it is generally in considerable amount. In dysmenorrhea it is generally too scanty to coagulate; if sufficient to form a clot, the dysmenorrheal pains will have ceased.

It is not, however, our fortune, as regular physicians, usually to become related, as medical jurists, with cases of criminal abortion at this early stage in their clinical history. Women are participators in the crime and have every inducement to concealment. Medical attendance is not usually called in except in cases of supposed great need. Early symptoms, therefore, are not observed by us, but are related to us sometimes with great reserve and reluctance. Our first introduction to such cases is usually when secondary and dangerous complications and consequences are developed. The common and usual course of abortionists is to send away their patients. The usual course of the patients is that they are reckless as to exposure, careless of neglect. They take cold and soon a peritonitis develops. Then it is that either in the hospital or in private practice the regular physician takes up the case in its second chapter. He notices a fetid vaginal discharge; a distended and tender abdomen; chills; vomiting, and a haggard look are in evidence; temperature and pulse indicate peritonitis; and the womb is felt above the pubes, perhaps.

The attending physician will, of course, ask for a vaginal examination. If this is permitted, he notices a patulous os uteri; observes its tenderness and that it is edematous. He finds the uterine cavity deeper than normal, by means of the sound; perhaps he finds some placental tissue retained.

The writer says "If permitted." The woman's consent is indispensable. Zeal must not overthrow discretion and prudence. No one is obliged to give evidence against herself, and any attempt to examine without permission is, under the law, an assault.

But this contingency must be a rare one, for the attendant is at the patient's bedside on her own invitation to give her relief from suffering. She will not, therefore, interpose objections unless, through deficient tact, her animosity is aroused. Although she may withhold information which she is importuned to give, so far as possible the manners and methods of a detective should be avoided. The physician should strive to secure the woman's full confidence by gentleness and prudence.

If it happens that, in these serious cases of secondary complications, under a sense of impending death and having accepted what she realizes is an inevitable conclusion of her troubles, the woman expresses a willingness to make a full statement of the whole business, with an exposure of the facts from the beginning, this dying declaration will have all the

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force of a sworn deposition.   A Massachusetts statute passed
in 1889 expressly included this contingency among the cases
wherein, as in homicide, a dying statement of the victim of an
abortion would be valid evidence.   Hence, the attending phy-
sician has it in his power to be of great help in such an emer-
gency.   Observing the patient's mental and physical condi-
tion, and her appreciation of her slight hold on life, he will
note her very words accurately.

In October, 1892, a woman, named Sophia C. Thompson,
was tried and convicted on sworn evidence.   She boasted
that she had had 5000 cases, and had never lost one.   A
young married woman between two and three months preg-
nant submitted herself to an operation with a catheter.   Soon
septic symptoms followed, and the patient grew steadily
worse.   When convinced of her impending death and having
avowed her realization, she told the whole story to her
mother and her physician.   On their testimony, under in-
struction of the court, the jury convicted.

Evidences of Abortion after Death.—Thus far has
been considered the evidence of abortion, with the woman, its
subject, *alive*.   A most interesting chapter remains.   This
has to do with the discovery of proofs of criminal abortion
when the *dead body* of its victim is our chief available mate-
rial.   We seek, through an autopsy, to answer *four questions:*
1. Was the woman pregnant just before her death, and was
she recently delivered?   2. If so, what was the stage of her
pregnancy?   3. What was the cause of the miscarriage?   4.
What was the cause of the death?   Of these questions,
the last two engage our present attention most closely.   The
first two inquiries have been considered in another connec-
tion.

In the majority of cases of criminal abortion which prove
fatal and come to the autopsy table for diagnosis, the cause
of death is not immediately and directly connected with the
abortionist's procedures.   That is to say, the death is due
rather to the secondary effects than to the primary violence.
Occasionally, and fortunately, one happens on a case which
is fatal in the abortionist's office, and the offender is caught
red-handed.   These are the cases of air-embolism, and in-
stances of this sort afford the best kind of opportunity for the
triumph of medical acuteness of observation and skill in pre-
senting testimony.

Occasionally one finds anatomical evidence of an abortion-
ist's work in punctured wounds, the puncturing instrument
having passed through the wall of the womb at the fundus,

even when inflammation had developed abundant exudates. In one instance on record, the puncture perforated to the liver and left its mark in that organ. The writer has seen several cases in which advancing necrosis of the uterine tissue told of septic decay set up by the introduction into the womb of dirty instruments. Perforations at the os and in the cervix are also observed, though very rarely.

This is not, however, the usual fortune of the medical examiner. Such direct and positive evidence of the connection of the abortionist with his patron's death is generally lacking. The following tabular statement of the cases which the author has personally investigated since July, 1877, will indicate the relative importance of sepsis in the cause of death from operative manipulations for the induction of abortion: Between July 1, 1877, and June 6, 1903, the writer investigated 67 cases, and found the cause of death to be:

Hemorrhage in 6 cases.
Purulent septic peritonitis in 49 cases.
Attempted, with air-embolism in 5 cases.
Diphtheritic metritis in 3 cases.
Septic infarctions in 3 cases.

To these should be added three attempts, with death by poisoning, and one death by chloroform to relieve pain.

It can be inferred from this list that, *generally*, the autopsy is of secondary aid in establishing the proof of an abortion. Independently of everything else, the proof is presumption only in the majority of cases.

Usual Cause of Death.—These post-mortem appearances, resulting from the processes which were the direct cause of death, mask and modify the anatomical indications of recent delivery, accidental or criminal. Thus, septic peritonitis, the most common inflammation after abortion, effectually conceals the most significant evidences of unlawful acts. Its course is usually long enough to obliterate the earlier appearances about the womb. To be sure, the infective process is easily understood. Septic matter from the womb finds its way by the Fallopian tubes or the lymphatics into the peritoneal cavity, where it incites a rapid inflammation. The cycle is in these terms: Abortion, septic metritis, salpingitis, peritonitis, death. All this, occupying days in its duration, so affects the lesions, sometimes very trifling and hardly visible ones at the best, that one is left in a position to say only that what he has found is *consistent* with other evidence of abortion, but he must admit that, standing by itself, it does

not suffice to prove the allegation. What the autopsy reveals is of the greatest value as corroborative and confirmatory evidence in the great majority of cases. It is only rarely that this revelation is adequate by itself to secure a conviction. The examiner in such cases can say that there has been pregnancy terminated by miscarriage; but that the miscarriage was initiated by unlawful means, he can not say.

As a matter of course, the proofs of septic processes within the pelvis and abdomen are themselves suggestive, although they are not demonstrative. They suggest interference with pregnancy from the outside.

Cameron[1] gives some statistics which are significant: "It has been estimated," he says, "that a fatal result occurs in 79 per cent. of all cases of criminal abortion; while in twenty-six cases of abortion carefully induced with antiseptic precautions, none of the patients died." Recognizing sepsis as the greatest source of danger, he states comprehensively that this in turn is due to the ignorance, unskilfulness, uncleanliness, carelessness, and haste of the operators, as well as to their unsanitary surroundings. These cases, therefore, are well named in the popular phraseology—cases of "malpractice."

There is another element to be considered, and that is the agency of the attending physician in obliterating innocently but effectually the anatomical evidences of abortion which the cavity of the womb displays. In the treatment of a case which comes under the care of a physician several days after a miscarriage, the curette is an indispensable instrument. With this, the lining of the uterine cavity is cleansed as thoroughly as possible of the necrosed and septic tissue and, with the aid of douches and antiseptic applications, the residue of chorion, ammion, and placenta, all the deciduous remnants in short, are effaced as fully as may be. So when such a womb comes to the autopsy table, it retains little which can serve conclusively as evidence of recent pregnancy. The few proofs there were have largely disappeared; and again the medical witness is forced to say that what he has found is *consistent* with the presumption of recent unlawful miscarriage—and that is as far as he can go.

What the author has said will serve to explain the infrequency of conviction of accused persons indicted and tried for criminal abortion. The nature of the crime is an obstacle to the discovery of evidence. The operation is done in secret. The advice about the use of drugs is *sub rosa*. If proofs come

[1] Witthaus and Becker, *Loc. cit.*, p., 130.

to the surface, it is a matter of accident. Prosecuting officers are reluctant to push cases of this sort unless the chance for conviction, made clear by substantial proofs, is obvious. And among the substantial proofs, the " dying declaration " of the woman who has submitted herself to the unlawful procedure is dominant.

CHAPTER XII.

THE SIGNS OF DEATH AND THE SEQUENCE OF POST-MORTEM PHENOMENA.

A very large part of medicolegal practice and studies has to do exclusively with *dead* human bodies as its material. Observations and conclusions concerning the bodies of persons *found dead* comprise some of the most important and fascinating of the medical jurist's functions. Some of the questions relating to this branch of the subject are:

1. How is apparent death to be distinguished from real death; or, What are the signs and proofs of certain death?

2. What is the probable time of death; or, How long has the person been dead in a given case?

3. What was the manner of the death; whether by violence, accident, or natural causes?

4. In certain cases, like double homicide, what was the priority of death?

What is this death—this point of departure for our new medicolegal studies? Viewed simply as a physiological fact, it is the final and entire cessation of those vital processes of repair and renewal which in their normally combined operation we say constitutes life. A living body in good health represents a well-contrived balance of waste and repair. Metamorphosis is either constructive or destructive. The equilibrium or balance of these is normal nutrition.

Disease is the partial arrest of the process, and inanition results. Death is *complete* arrest of constructive or reparative changes and the victory of destructive agencies. These latter go on with energetic activity and rapidity. Different ages of life show examples of the same principle.

In youth repair is more than waste and the result is growth. In maturity there is a fairly even balance under natural conditions. In old age waste is greater than repair and the result is decay.

Chambers in his excellent book, *The Renewal of Life*, says: "The human body is like a structure; it needs constant attention to repairs, else steady decline and final ruin is the con-

sequence" . . . "About the same time is needed for the full renewal of the living body (three months and a half) and the full decay of the soft parts of the dead body, judged by the amount of nitrogen in the products of decay."

Bichat defines life as the combined coöperation of functions which resist death. "All the environment of living bodies," he says, "tends to destroy them; and the measure of life is, in general, the difference which exists between external forces and internal ability to resist them. To this destructive influence, this perpetual tendency toward decay, the animal functions of the human body yield before the organic. Whether it be gradual decline, and finally death from natural causes, or a sudden and violent stoppage of the machinery of life, this is the order—the organic life is the last to die."

Besides these distinctions which Bichat makes, other writers speak of death as either somatic or molecular.

Somatic death is death of the body as a whole, in consequence of the suspension of the vital functions. It answers the idea of death as it exists popularly. Breathing has ceased; the pulse is not felt; the subject is unconscious. The man is dead—or he appears so to be.

Molecular death is the final condition in the process of death. It exhibits the consequences of somatic death. Constructive metamorphosis is impossible; decay begins, and the signs of death are no longer doubtful.

Between these two is an interval, longer or shorter in individual cases, wherein resuscitation is possible, and in which apparent death may make it difficult to avoid lamentable error, unless exact methods of observation are used. Hence, we have good reason to study the signs of death and the sequence of post-mortem phenomena with care. It is in this stage or interval, when the vital functions are not in action and the consequences of their suspension have not yet declared themselves, that a medical opinion may be sought to settle the question of the real death. The motives for this appeal to medical aid are various: For example, there is a reasonable popular horror of being buried alive. This is largely based on recorded instances in sensational newspapers. Authentic recorded cases of recovery after apparent death, when preparations for burial are in progress, give emphasis to the popular notion about burial alive. Some wills contain a clause that the testator desires that he shall not be fastened down in his coffin until a medical man has testified that the death is real, and has rendered a certificate to that effect.

The author presumes that much of the modern feeling about

this matter has grown out of certain sensational literature of a more serious sort than that of journalism. In 1742, a writer named Winslow published a book in which he declared that he had been put in his coffin twice for burial, and he recorded in words which were likely to burn themselves into the memory of the reader the anguish that he felt at the time. A little later, Bruhier, a French writer, published a volume which made a great stir; in it he accumulated all the more or less credible stories he could get hold of, and derived some very fanciful statistics therefrom. He gave fifty cases of living burial; four of dissection while the subject was living; fifty-three of persons who recovered while in their coffins ready for burial; and seventy-two of persons falsely considered as dead. Dr. Guenin estimates that two in every thousand burials are burials while the person is still living. Dr. Moore R. Fletcher, in a book called *One Thousand Persons Buried Alive by Their Best Friends*, gives many horrors from American sources. In 1895, Dr. Franz Hartman wrote a book entitled *Buried Alive*, in which he detailed seven hundred instances occurring in all parts of the world.

It is worth remembering that certain morbid states—usually some abnormal condition of the *nervous* system—simulate death and might deceive the careless. For example, trance or catalepsy, lethargy, hysteria, and hypnotic coma are illustrations. Again, prolonged syncope, as in heart disease, and asphyxia, as in drowning and in the newborn, may give rise to error. But all these show signs which are incompatible with cessation of vital functions. The fundus oculi retains its normal aspect, and muscular electro-excitability persists. *Examples* are recorded in the books.

Cousins tells of a man, forty-three years old, who was subject to occasional sudden attacks of long persistent sleep (two days were the average period; five days and nights were the longest), from which it was difficult to arouse him. These symptoms were noted: His skin was pale and warm; his limbs were relaxed; his pulse was slow and feeble; his respiration from 8 to 9 and almost imperceptible. His secretions were suppressed. No food was taken. He usually woke suddenly.[1]

In another case, that of a woman, twenty years old, the cataleptic state lasted eight weeks. Her temperature at one time fell so low that she was thought to be dead.[2]

In a case[3] which occurred in Cochine Hospital, Paris, the

[1] *Medical Times and Gazette*, 1863, i., p. 396.   [2] *Lancet*, 1870, i., p. 12.
[3] *London Medical Record*, 1875, p. 333.

subject, an unmarried woman, aged twenty-four years, lapsed into extreme stupor. Her breathing was imperceptible, but the lips were pink. The limbs and trunk were completely relaxed. When the finger was carried back in the mouth to the glottis no cough resulted, and she felt nothing when the skin was pricked. About the sixth day the patient's muscles became tense and hard. The heart's action was clearly audible throughout.

Hingston[1] records the case of a married woman, twenty-four years old, in whom the cataleptic condition became so profound that she was thought to be dead. At one period there were a death-like coldness and pallor. Her pulse was imperceptible and her limbs were rigid. The eyes were up-turned and the pupils were insensible to light. Her respiration was so slow and slight as not to dim a looking-glass. Recovery followed after four hours.

O'Neill[2] reports the case of a girl of eighteen, who became insensible from catalepsy. Her heart's action was imperceptible; her respiration was noiseless. The muscles were rigid.

The case of Washington Bishop, who died on May 13, 1889, is a further example. He was said to be subject to cataleptic trance. While giving an exhibition of his peculiar mind-reading powers at a club in New York, he was suddenly seized with convulsive paroxysms from which he passed into a state of coma. Presently he appeared to be dead. An undertaker came and took the body, which remained in an air-tight box for an hour. Then an autopsy without permission was held. A scandal resulted and a coroner's inquest was instituted, which attributed haste and zeal to the doctors, but exonerated them from crime. A civil suit was brought against them, and this they won.

O'Sullivan's case is a striking one:[3] A woman eight or nine months pregnant died in Cork. She was buried with her rings on her fingers. Certain covetous servants undertook to rob the grave. The woman's fingers were amputated, blood flowed, and the frightened servants fled. The same night the husband was awakened by his wife's knocks at the door. In due time she was delivered. The baby became an eminent physician.

There are some interesting examples on record of voluntary control of the action of the heart and lungs to such a degree as closely to simulate death. To this class belongs

[1] *Lancet*, 1867, ii., p. 275. [2] *Lancet*, 1877, i., p. 905.
[3] *Bulletin of the New York Medicolegal Society*, March, 1879.

the case of Colonel Townshend. It is told in such a quaint way by Dr. Cheyne that the author quotes it at length:

"He told us he had sent for us to give him some explanation or account of an odd sensation he had for some time observed and felt in himself; which was, that, composing himself, he could die or expire when he pleased, and yet, by an effort, or somehow, he could come to life again; which, it seems, he had sometimes tried before he had sent for us. We all three felt his pulse first; it was distinct, though small and thready, and his heart had its usual beating. He composed himself on his back, and lay in a still posture some time. While I held his right hand, Dr. Baynard laid his hand on his heart, and Mr. Skrim held a clean looking-glass to his mouth. I found his pulse sink gradually, till at last I could not feel any by the most exact and nice touch. Dr. Baynard could not feel the least motion in his heart, or Mr. Skrim discern the least soil of breath on the bright mirror he held to his mouth. Then each of us by turns examined his arm, heart, and breath, but could not by the nicest scrutiny discover the least symptom of life in him. This continued about half an hour. As we were going away, thinking him dead, we observed some motion about the body and upon examination found his pulse and the motion of his heart gradually returning; he began to breathe gently and to speak softly. This experiment was made in the morning, and he died in the evening. On opening the body, nothing was discovered but disease of the kidney, for which he had long been under medical treatment, all the other viscera being perfectly sound."

No auscultation was practised, as the case occurred before the time of the stethoscope.

The behavior of the fakirs of India is an illustration of the same thing. It appears from records well authenticated that they are able voluntarily to suspend breathing and pass into a condition of trance, during which they lose flesh and are apparently lifeless, the heart sound being inaudible. Indeed, they allow themselves to be buried for two or three weeks, and are then resuscitated.

Analogous to these conditions are the instances of the suspension of the organic functions during life, as exhibited by hibernating animals during their winter sleep. They are really in a state of apparent death.

The Infrequency of Living Burial.—Concerning the main question, relative to the chance and frequency of living burial, the writer says that there is no good ground for

believing that such a terrible mishap really occurs often enough in a century, the world over, through carelessness, negligence, or ignorance, to deserve attention. It certainly gives no foundation for popular fear and dread. It belongs chiefly, almost exclusively, to the realm of the romancer and of sensational journalism, not to the sphere of accurate, scientific observation. That it may happen in times of widespread fatal epidemics, such as of cholera or yellow fever, when help is scarce and burials are speedy, is possible, especially among the poor. That it may also happen in the careless and hasty burial of the dead after a great battle, is possible, too. But that it should happen under the ordinary conditions of living and dying in civilized society is incredible and in the highest degree visionary.

Indeed, the usual manner of treating dead bodies between the death and their burial is the best possible safeguard against living burial. If there is any spark of life remaining in the body, the undertaker is pretty sure to extinguish it. For instance, in the majority of cases, the attending physician is not present when the supreme moment arrives for his patient. His first knowledge of the death comes after the undertaker has entered on his work. As soon as the person appears to be dead, an undertaker is summoned. He comes with his tub of ice or his jug of concentrated solution of poison called "embalming fluid," and proceeds to lay out the body and then to "ice" it, or to embalm it by flooding the cavities with arsenic and corrosive sublimate. There is no danger of living burial under these circumstances.

Such precipitancy sometimes occasions much regret. United States Senator Plumb died suddenly in Washington, D. C. The news of the sad event spread rapidly. Within an hour after Mr. Plumb's death, Senator Peffer was at the side of his dead colleague. Sergeant-at-arms Valentine was on hand, and assumed direction of the funeral arrangements. An undertaker was summoned, who proceeded at once to prepare the body for interment, and soon completed the embalming process. His haste gave rise to a distressing incident. News of her husband's death was telegraphed Mrs. Plumb, at Emporia, Kansas, within a few minutes after it occurred. Just after the undertaker had embalmed the body, a telegram was received from one of the friends of the family at Emporia, directing that the remains be not embalmed. Soon afterward came a second telegram, stating that the last summer Senator Plumb was for two or three hours in a state of suspended animation, and to all appearances was

dead. Having that crisis in mind, Mrs. Plumb did not wish the body to be embalmed until it was absolutely certain that her husband was dead. The receipt of this telegram caused much unavailing regret. The undertaker, however, declared that there was indisputable evidence of death in the fact that no blood flowed from the arteries when they were opened in the course of the embalming process.

The authoritative word of the highest pathologist in the world (Virchow) may well re-assure us on this point of living burial. He says: " I have heard of many cases where it has been alleged that persons have been buried while in a state of trance, but in no case thoroughly investigated has this been proved."

Taylor, discussing the general topic of the signs of death, says:[1] " The cases of alleged premature interment that have yet been adduced will not bear a close examination; as they are nothing more than the idle tales of ignorant and super-stitious persons, with the usual amount of exaggeration."

Brouardel, too, is another witness to the same purpose. He says: " None of the cases of recovery after burial in a state of apparent death, reported as such, are very conclusive."

The Utility of Mortuaries.—They do this thing better in other countries—this treatment of the dead body between the death and the burial. The death is verified by appointed inspectors who apply all needed tests. In certain parts of Germany there are public mortuaries to receive dead bodies before their burial. Mortuary houses have beeen built to re-ceive human remains; attendants have been on guard day and night; skilfully contrived apparatus has been so connected with the bodies placed in burial caskets that the slightest movement of any muscle would cause the sounding of an alarm. The conclusion is told in a sentence. Never has there been any indication of life in a case where death was pronounced by medical science to have taken place.

In Austria the body may remain in the residence for two days—if not infectious. In Germany the inspector allows from two to twelve hours for ceremonies, when it must go to the waiting mortuary for three days longer, when the physician there gives his certificate if the case ends in death, and the burial takes place in the adjoining cemetery accordingly.

A waiting mortuary consists of a main hall where bodies lie in open coffins upon tables embowered by plants in the midst of light, warmth, and ventilation. An alarm bell con-nected with the fingers will call an attendant in an adjoining

[1] *Medical Jurisprudence,* i., p. 75.

room at any hour. There is a laboratory equipped with means for resuscitation, a post-mortem room, separate rooms for infectious cases and accidents, a chapel, an office, and quarters for the physician and attendants.

This system of mortuary observation by competent persons, or, at all events, a system of attestation and verification of death, should be in vogue everywhere. It may not be practicable or expedient to remove bodies to dead-houses, but it is practicable and desirable to enforce a rule that no permit to bury a body shall be issued until a certificate of death and its cause has been filed with the proper authority—*after* a *personal inspection* by an appointed medical officer.

Relative to this subject, the care of the dead body between the death and the funeral, the writer has often thought that the example instituted by a well-known physician of Boston had much to commend it. Dr. C. was an aged man and was sick in bed many days before he died. In this last sickness he made known his wishes, and they were fully carried out. His death was witnessed by two physicians. As soon as all was over and these two physicians were satisfied of the fact, they announced it to the family. Then an undertaker was summoned, but he was not permitted to perform any of his gruesome services. The washing, the laying out, the embalming, and all the toilet frills to make the body " look natural" were rigidly neglected by Dr. C.'s orders. The body was placed in a casket in the very condition in which death found it, and thenceforward was not seen by anyone. The usual morbid curiosity was not gratified. It was removed at once from the house to a receiving tomb, and at a little later time the funeral services were held at the cemetery chapel.

One proof of the popular interest in the subject of premature burial is found in the offer of prizes for a reliable sign of death. The Marquis d'Ourches offered 20,000 francs for a simple, practicable method of determining the proofs of death in a certain and indubitable manner—a method which could be used by every one, uneducated villagers as well as persons of great intelligence. He offered another sum of 5000 francs for a scientific test whereby to recognize with certainty the fact of certain death.

Popular Tests.—In response to these and other offers, and to fulfil a popular demand readily understood, many and various suggestions have been offered as useful methods for *domestic* application, with or without medical or surgical help.

The author will mention a few of these without comment. Some of them have reference to the function of respiration : A

mirror is held before the mouth, to see if the vapor of the breath leaves any cloud on the surface. Cotton down is suspended in front of the mouth and nostrils, to ascertain if any expiratory act is to be observed. A vessel of water, or a mirror (Winslow), is placed on the breast; if there is any chest-movement, this will declare it.

Sansom suggested that the observer should attach some cones of cotton wool, finely drawn, to the front of the chest by means of sealing wax ointment; they are supposed to stand out from the skin, so that the slightest motion of the thorax is revealed.

Other tests are designed to prove that the circulation of the blood has ceased: The corpse's hand is held so that light, artificial or sunlight, may shine through it and display the pink tinge of capillaries conveying blood, or the converse condition, absence of translucency.

Foubert cut through an intercostal space and the pericardium, and passed the finger into the opening to ascertain if there was any cardiac impulse.

Leon Davis directed dissecting out an artery, like the temporal, and after testing the vessel with the finger-tip, do an arteriotomy to see if blood spurted.

Magnus suggested applying a ligature around a finger, or the lobe of the ear, in order to note the presence or absence of engorgement.

B. W. Richardson used this test: Tie a fillet tightly around the wrist and watch for turgescence of veins on the back of the hand.

Phlebotomy was formerly regarded as the proper thing to determine the reality of death, in order to make sure that no blood would flow. The effect of *putrefaction* in promoting the flow of blood when venesection is postponed should not be overlooked. But when venesection is performed for this purpose a tight ligature should always be placed on the arm after the operation, and a tight dressing over the wound, so that the blood, which would be expelled by the tension effects of the gases of decomposition, may be retained in the vessels and not appear, requiring explanation.

Middledorf has extolled the following as a certain sign of death; he calls it the " akidopeirastic " test: A needle four inches long, and having a small flag at its upper end, is thrust into the heart. The flag waves as long as the heart beats.

Scarification, cupping, and the application of leeches have been suggested for similar purposes—to determine the cessation of the circulation. Still other methods which do not de-

pend for their effectiveness on either respiration or circulation, and are not easily classified, are the following: If a pin or needle is thrust into the skin and presently withdrawn, a distinct hole is left if the tissues are dead. If a bright steel needle is pushed deeply into the flesh and left a minute, it will be found, on withdrawal, that it is *oxidized* (rusted) if the tissues are *alive;* it will be *bright* and unchanged if the tissues are *dead.* This is Laborde's test. Montiverdi says that if ammonia is injected under the skin, it makes in living health a bright-red spot, spreading rapidly; in the doubtful stage between life and death a darker spot, slowly formed; after death, an ill-defined, dirty spot or stain, very slowly developed.

Vesication of dead skin is next to impossible; if the cuticle is raised at all, in a blister, its contents will consist of air, not serum. If a caustic agent is applied to dead skin, the result will be the absence of an eschar, and the skin turns yellow. On living skin an eschar is formed, which is black or brown.

Josat devised an instrument for which he got a prize from the French Academy. It was a pair of forceps with claws; with this he proposed to pinch the nipples of persons whose vitality was in doubt. An old method was to apply a very hot flat-iron to the soles of the feet of the corpse. Brouardel has improved on this: He suggests that an ordinary hammer be heated very hot with scalding water and, after drying, be applied over the epigastrium. He says it is an excellent way to revive a person in a state of syncope, as well as to ascertain the fact of death. The worst that happens is the formation of a bleb where the hammer touched the skin.

Scientific Tests.—Most of the foregoing are empirical, unscientific, and crude. The sound and scientific practitioner will not rely on these alone, if he uses them at all. He will supplement them by observations of greater accuracy and reliability. He reaches his conclusions upon a clearly determined series of signs ascertained with the same exactness and care with which he would establish facts for a diagnosis of disease. He derives his evidence from the following sources:

Extinction of the Vital Functions is the Chief of These Sources. —Respiration ceases. The popular view is, that if a person has ceased to breathe, he has ceased to live. Sir B. Brodie taught this as the main test. But some cases of doubt cause us to pause; for we may find the minimum of life with entire arrest of breathing. Such was the case of Colonel Townshend, already cited. How shall we determine that this cessation is not apparent but real? We may use the popular methods already mentioned. The alternate movements of the

chest and abdomen on palpation or inspection; the use of the looking-glass, a surface of mercury, a dish of water, or the behavior of down or cotton. We must not forget the stethoscope, however. Auscultation deliberately and carefully studied, under proper conditions of quiet, is the thing. Respiration should be absent five full minutes at least. In doubtful cases, *wait*. Be sure that respiration is entirely and continuously stopped.

Circulation is completely and continuously suspended if the person is surely dead. The heart's action always continues *after* respiration ceases. The usual interval is about *a minute*, during which the heart beats irregularly and intermittingly, with longer and longer intervals until it stops wholly and finally. Duval says he saw the heart of a decapitated criminal beating fifteen minutes after decapitation; the left auricle pulsated for an hour. Regnard and Loye found the heart of a decapitated criminal beating *one hour* after his execution.[1]

Whatever the cause of death, the suspension of the heart's action follows that of the lungs, always. It is the last organ to yield its functional activity. It may even undertake to carry on life by itself, without the coöperation of respiration, as in the case of newborn children unable to expand atelectatic lungs.

Maschka records the case of a newborn mature child. There were no signs of life and the body was laid aside as being still-born. It was left in a dead-house fourteen hours; then the chest was opened, but no blood flowed in this operation, but the heart was beating at the rate of 20 a minute. The lungs were fetal.

In cases of doubt it is not enough that the radial pulse should be lacking. In many cases of disease, in deep narcosis and the like, the radial pulse is absent. Cardiac auscultation is the only reliable method, and it should be practised with great care, in a quiet room, all over the chest, to avoid the error of an abnormal situation. How long should this be continued? Rayer says that six or seven seconds are the longest interval known between cardiac pulsations; hence, if five full minutes are allowed, we use fifty times this interval.

Andral declared that five minutes' absence of the cardiac pulse was long enough to determine death. But, later, he was ready to acknowledge that even this length of time was inadequate, after he had come across the case of a woman who returned to life "some hours" after the action of the heart had ceased to be perceptible. Bouchat recommends

[1] Brouardel, *Signs of Death.*

continued auscultation for half an hour in a case of doubt. The best rule is, it appears from all the authorities, to make repeated, careful, and deliberate auscultations, of five minutes duration each, extending through a full hour at the least.

Eye-changes.—Simultaneously with or immediately following cessation of respiration and circulation, but preceding other changes, presently to be noticed, certain changes in the eye are noteworthy. These are physical and physiological. The eye's expression becomes noticeably altered. It loses luster, as a general rule, as we all know, although there are some exceptions; for instance, after poisoning by prussic acid, cyanid of potassium, and carbon dioxid, and after asphyxia and death by electric shock. It sinks in its socket and becomes flaccid. Larcher's sclerotic stain is another sign of death; it is caused by cadaveric imbibition, and is a dark discoloration of the conjunctiva outside and inside the cornea, showing outside first as an oval or oblong deposit between the lid edges.

The pupils are unaffected by the usual stimulants; they are insensible to touch, light, or atropin, except in a few cases immediately post-mortem; and to electricity, eserin, or duboisin. The iris is made oval by pressure on the cornea. The changed ophthalmoscopic appearances are all due to cessation of circulation. The yellowish-red of the fundus of the living eye changes to gray or white; the retinal veins show interrupted columns due to beads of gas; the papilla, rosy red in life, is not to be distinguished after death; the central artery of the retina is gone.

The Muscles.—The muscles all over the body become relaxed meanwhile; the jaw drops; the eyelids droop; the sphincters open. Parts of the body which are subject to pressure are flattened, or if the corpse is on an *irregular* surface of slats, bars, or rods, an imprint is left; even irregularities of clothing result in marks.

Changes in the **expression** of the **face** are noticed. It is either placid, without any suggestion of pain, or the features are drawn and contracted, and the Hippocratic facies makes identification difficult.

Close upon these several indications of actual death, drawn from the cessation of the so-called *vital* functions, there follows a second series of phenomena, the consequence of an extinction of organic life, and indicating the initial stage of molecular death.

Muscular irritability or **contractility** is wholly lost. This change is something more than mere relaxation of the muscles. Muscular contractility continues after death, even after the

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heart has stopped for some time, and may be demonstrated through a considerable interval by the passage of the faradic current or by a sharp blow over the muscle. It is intermediate between somatic death and muscular rigidity. Thus, if it is entirely absent, the person is dead. On the other hand, its presence is not conclusive that there is enough life left to warrant a belief that restoration is practicable. In other words, its absence affords a presumption, not a demonstration. If its absence is established and continuous, the presumption is against resuscitation.

Luff[1] states that the interval during which muscular contractility continues after the cessation of the heart's action is from three to ten hours; although, under exceptional conditions, it may disappear in a few moments, the body almost immediately taking on cadaveric rigidity.

Rosenthal cites a case in which the muscles responded to electrical stimulation thirty hours after the supposed death, and in forty-four hours the patient awoke.

As to the conditions which promote continued contractility in muscles, it has been found that this phenomenon endures longest under general conditions of good muscular nutrition and integrity, and under certain special, though not easily understood, relations favoring it, such as death by apoplexy, low fevers, pneumonia, yellow fever, and cholera.

On the other hand, muscular contractility demonstrated under stimulus is much shortened or perhaps wholly lost after death when there has been great muscular exhaustion or fatigue; after death by paraplegia, peritonitis, and phthisis; after death by poisons of certain kinds, such as strychnin and nitrite of amyl; after chronic lead-poisoning; after death from long exposure to cold or heat; after death by hemorrhage; or after death from exposure to certain gases, such as sulphuretted hydrogen, carbonic oxid, and ammonia.

Ogston argues that muscular contractility persisting after death to an unusual degree may explain some extraordinary post-mortem phenomena that have been recorded, like post-mortem delivery, the discharge of urine and feces, the flow of blood from wounds, and changes in the position of bodies in coffins.

With reference to the usefulness of this condition of the muscles as an indication of the presence of vitality, Tidy remarks: " The contractility of a muscle by electrical and other stimuli is no certain test of life. The *non*-contractility of a muscle under stimulation is not a certain sign of death. But,

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[1] *Text-Book of Forensic Medicine,* i., p. 47.

summing up all the facts observed and admitting great variations, depending on season, temperature, age of the person, cause of the death, and its manner, it may be laid down as a general rule that if the muscles are flexible and contract under the influence of the interrupted current, death probably occurred within three hours, but most certainly within twenty-four hours of the time of the experiment, there being no recorded case in which, after death, flaccidity and contractility continued beyond this period."

Loss of Animal Heat.—As soon as death stops the vital machinery, and circulation, respiration, and nutrition cease, the body usually behaves like other inert matter and more or less rapidly cools to the temperature of the surrounding atmosphere. As a scientific study, this loss of body-heat should be determined by the thermometer, not by the hand, although the trained hand is by no means to be despised as a witness. A thermometer of special design is required, not a *clinical* thermometer which registers to 94° F. only. The cooling is progressive, but not uniform. It is fastest, under normal conditions, in the earliest period after death; especially is this true if the temperature at death was high. Wilkie Burman from a great number of observations made the average hourly rate of cooling 1.6 degrees F. His rule is stated thus: " Given a body found in bed in a room with a temperature of the air at from 50° to 70° F., with ordinary bedding on the bed, we may fairly estimate the time of the death by dividing the difference between the average normal temperature and the present axillary temperature by 1.6. This will give us approximately the number of hours since death."

This rule gives an approximation only, because the conditions under which the cooling goes on are so various and tend so much to modify it. This fact is shown in the many estimates made by medicolegal writers as to the time required for complete cooling. To illustrate this diversity the time of cooling is placed by various authors as follows:

Taylor (*Manual*), from fifteen to twenty hours.

Taylor (*Treatise*), from twelve to twenty-four hours. Cooling not complete, he says, under twenty-four hours.

Reese, from fifteen to twenty-four hours.

Guy, complete cooling is possible in two or three hours; it is usual in from fifteen to twenty hours, and it may take four days.

Dixon Mann, from fifteen to twenty hours.

Hofmann, from eight to seventeen hours.

Seydeler, twenty-three hours for full cooling.

Tidy, from four to five hours under exceptional conditions; from fifteen to twenty hours under ordinary conditions; from two to three days under rare circumstances.

Durand and Linas, from eighteen to twenty-four hours.

Casper, from eight to twelve hours.

Ogston, from eight to twelve hours.

Woodman and Tidy, from four to twelve hours.

Wharton and Stillé, from eight to twelve hours.

Witthaus and Becker, from fifteen to twenty hours.

Luff, from fifteen to twenty hours.

The author is convinced by his own observations on the dead body that the cooling process is a much longer one than the writers of text-books have usually allowed; and that the time at which the *whole* body reaches the temperature of the surrounding air is considerably later than is commonly stated.

These observations were made in preparation for a murder trial in 1894, in which the immediate question was whether the dead body of a fat woman lying on a bed, in a small room, in midsummer, with her throat cut, would require more than five hours to cool, so that the abdomen felt nearly as cool as the limbs, and both abdomen and limbs retained scarcely any warmth perceptible to the hand.

Observation I.—Male of medium weight. Observation in January, seventeen hours and ten minutes post mortem. Rigor mortis was complete. The body was clothed. The temperature of the outside air was 20° F., and that of the morgue, 22° F. The abdomen, to the hand, felt cold; 45° by the thermometer, but it retained some warmth. The leg, to the hand, felt cold; 24° by the thermometer.

Observation II.—Male, stout, seventy-one years old. Observation in midwinter, fourteen hours post mortem. Rigidity was complete. The temperature of the room was 13°. The epigastrium, to the hand, felt less cold than elsewhere; 40° by the thermometer. The axilla was 33°. The thighs and legs were very cold; 24° by the thermometer.

Observation III.—Male, stout. Observation, seventeen hours post mortem. There was a sheet over the body. The temperature of the room ranged from 16° to 27°. The breast, to the hand, felt warm; 70° by the thermometer. The thighs were cold; 54° by the thermometer. The axilla was 46°.

Other similar observations in the same series were to the same effect.

The cooling process is promoted or retarded by certain definite conditions which may be easily understood and con-

cisely stated. But it is to be remembered that in all these relations, although there is progressive cooling of the body as a whole, there is much diversity when the different parts are considered. Those regions which are thinly protected, like the hands, feet, and forehead, will cool long before the parts which are well covered, like the abdomen. Indeed, as a physiological observation, the former parts are often cold and clammy long before the moment of death. Therefore, the estimate of the time required for the body to become cold should refer to the parts which are the last to yield their animal heat rather than to those which are the first.

Cooling is promoted by favorable surroundings of the body. If it is uncovered, in the open air, exposed to currents of air, in water, as in drowning, in a large room, lying on a cold surface, or if the death has occurred in winter, the cooling will proceed rapidly. The same result will follow certain physiological states, such as old age or infancy, or if there is a natural spareness of body. Relatively rapid cooling is advanced by emaciation due to disease; by certain causes of death, such as hemorrhage and chronic wasting disease. On the other hand, cooling of the dead body is retarded by conditions in contrast with those above noted. These need only the briefest mention without comment: When the body is that of an adult, and fat; when the surroundings retain heat and prevent its dissipation, as, for example, if the body is fully clothed or covered in bed, or lies in a small, warm room, out of currents of air, or on non-conducting material, or if death occurs in the warm seasons, when death follows certain diseases, such as apoplexy, when death is sudden and speedy, as by electric shock, when death is violent, as by hanging or suffocation, when death occurs from any form of asphyxia or acute disease.

This matter of the cooling of the body has more than once been utilized in murder cases to estimate the time of the death and to contradict false statements by suspected persons. For example: At the trial of a man named Spicer, in Edinburgh, in 1846, upon a charge of murder by throwing his wife downstairs, the prisoner declared that he had seen his wife alive at a quarter to 5 in the afternoon. The medical evidence was that her body was found at the foot of some cellar stairs, cold and rigid, at 9 o'clock in the evening, with her skull broken and her neck dislocated. It was shown by medical experts that four hours and a quarter was altogether too short a time at that season for the cooling to occur.

Observations on body temperature are probably the *safest*

guide in determining the priority of death where two bodies are the subject of the inquiry. Such was the case in the Borden affair, in 1892, wherein the difference in the temperature of the bodies of the two victims left no doubt as to the priority of the wife's death.

But in this matter, as in all medicolegal inquiry, one should make himself master of all the facts. He should study all the conditions in any given case before he gives a positive answer about the time that has elapsed since the death. One caution in this direction comes from the occasional extraordinary departure from the normal rule, and the occurrence, not of post-mortem cooling, but of a post-mortem rise of temperature for a considerable time and without regard to surroundings. It is apparently due to rapid decomposition in some cases. In others it seems to depend on the cause of the death in some way not understood.

In death from cholera, Dowler found a post-mortem temperature of 109°. In smallpox, Simon found a temperature of 113°. In yellow fever, it has been found at 113°. In acute rheumatism and in sunstroke some extraordinary observations have been made.

Taylor gives a case which illustrates the need of caution in interpreting post-mortem phenomena :[1] In October, 1840, a servant girl who had gone to bed in apparently perfect health was found the following morning, as it appeared, dead. A surgeon was called in, and pronounced her really dead. A coroner's inquest was appointed for 4 o'clock in the afternoon, and an examination was ordered. At 2 o'clock medical inspectors came to make a necropsy. The position was easy, and the face was pale, but placid, as in deep sleep. The body was naturally warm. After two hours' wait the jury became impatient. The body was still limp and warm. On internal examination the cavities were found to be very warm and steaming. The explanation was offered that it was the heat of incipient decomposition which had set in before the body-heat had disappeared.

The skin after death is interesting to study in two directions. One of these is the characteristic cadaveric pallor due to the cessation of the circulation. This pallor may be modified by diseased or traumatic conditions existing in the last moments of life. Thus, of the former, we may cite icterus and septicemic sallowness. Of the latter, the discolorations due to contusions—the so-called ecchymoses.

But of greater interest and value as a sign of death are

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[1] *Principles and Practice of Medical Jurisprudence.*

cadaveric lividities or suggillations about the skin, which result from a cessation of the circulation, and from other forces to be mentioned presently. These livid stains form as the body cools and before the blood in the vessels has coagulated. Some degree of cadaveric lividity is found after every cause of death —even hemorrhage, but the change is most marked in the plethoric. Its extent varies with the amount and fluidity of the blood. It is found typically and chiefly developed in the dependent parts of the body. The color of the skin which is the seat of this change is violet under the usual conditions, but it may be more or less changed to a reddish tinge by advancing decomposition or by exposure of the corpse to cold.

The real seat of this manifestation is in the *rete mucosum* and vascular layer, outside the true skin, but inside the cuticle. Its outlines are irregular, but are quite well defined on the surface. It is the result of gravitation, the blood really settling in the superficial capillaries. It is a true hypostasis. If the body's attitude is changed, a corresponding change in the region of the lividity will follow, provided the alteration in the attitude is made early. If the surface on which the body is lying is irregular, portions of the skin receiving pressure from these irregularities remain pale. The same result follows if pressure is exerted by tight bands of clothing, or even by the creases of a skin plentifully padded with fat.

The formation of post-mortem lividities begins presently after death, and continues while animal heat continues and while the blood remains fluid. In general, this period is between the fourth and the twelfth hour. Livid staining may rarely begin earlier than the fourth hour; it is rarely continued beyond the twelfth hour. When the blood is coagulated, the formation of the stain necessarily ceases.

But the greatest interest attaches to the appearances under consideration, because, to the careless observer, they resemble the discolorations which result from bruises—the true ecchymoses. In some instances recorded in the books some lamentable errors have been made by medical men who mistook these perfectly natural lividities for the effects of violence. In color they do indeed look alike. But there the resemblance ceases. If in any case a doubt of the true nature of the cadaveric stain remained, section of the part would readily remove the doubt. In the hypostatic stain this section of the skin would show the following features: The blood is found in the vessels of the skin and subcutaneous connective tissue, and not outside of them. When the cut is made, the divided capillaries and venous radicles simply show a minute drop of fluid blood;

there is no clotting of blood in the parts, in the tissues outside the vessels. There is no infiltration. There is no swelling. There is no injury to the *surface* of the skin. The depth of the color is uniform; the margins are well defined and do not fade away into adjacent parts. There is the sharp contrast, in a word, between the extravasation and the infiltration which a blow causes, and the staining of the skin by the injection of its distended minute vessels as the result of gravitation.

CHAPTER XIII.

RIGOR MORTIS AND PUTREFACTION.

FROM a study of those phenomena and conditions in the recently dead human body which distinguish death from that which *resembles* death, we pass, appropriately, to another variety of post-mortem changes which are organic in character and are absolutely incompatible with life. The first of these to be considered is cadaveric rigidity, rigor mortis, or post-mortem rigidity. A short time after a person's death his limbs stiffen very nearly in the position in which they happen to be lying at the time. This stiffening is called by Louis the master-sign of death, short of putrefaction. Its seat is in the muscular fibers, both voluntary and involuntary. Section of the muscles around a joint shows this in the case of the voluntary muscles, for after such section the joint is free. Of the involuntary muscles, the heart is one which shows the change best. Cadaveric rigidity always follows the loss of muscular irritability or contractility ; and it lasts, as a rule, until putrefaction begins.

It is *simulated* in the stiffness which characterizes certain neurotic states, like hysteria, catalepsy, and trance. But the differences are easy to make out. In catalepsy, for example, if a limb is placed in any new position it immediately becomes rigid in that posture. It is not so with cadaveric rigidity. This fact, with attention to other details—loss of animal warmth, absence of respiration and circulation, etc.—ought not to leave any doubt.

In other words, we have in rigor mortis an objective evidence of the death of the contractile tissues. It marks their irreparable loss of irritability. A rigid muscle in this sense is a dead muscle. It can not be stimulated back to life. So far as the muscular tissues are concerned, it marks the onset of molecular death. But it is *peculiar* to the molecular tissues, since there is no such subjective proof in the case of other tissues. It is a muscle-change solely. It is independent of atmospheric conditions. It occurs equally in an atmosphere of pure oxygen, or in a vacuum, or in the ordinary atmosphere. It is independent, too, of the body temperature. It frequently

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supervenes while the body is still warm and the blood is fluid. No doubt rigidity generally develops as the body is growing cold, but this progressive cooling is by no means an essential requisite—it is a coincidence only. It is measurably independent of the nervous system, but not wholly so. Paralyzed limbs will become rigid, but more slowly than their normal associates. Brouardel insists that these limbs stiffen even more rapidly than their normal fellows after death.

What is the real cause of this change? This has been a subject of much discussion. Kühne was the first to suggest that it was probably a chemical phenomenon; that it was due to the coagulation of the *myosin* or muscle-plasma, the albuminous principle of muscular tissue. Myosin coagulates when acted on by weak acids, a 10 per cent. solution of hydrochloric acid, for example. Kühne considers that, during life, acid products are being constantly formed in the system and as constantly removed. But after death these acid products accumulate and effect, in the muscles, the coagulation of the myosin, thus bringing about post-mortem rigidity. As putrefaction proceeds, however, the azotized matters of the body undergo a change and develop ammonia, which dissolves the coagulated myosin, neutralizes the stored-up acid matters, and causes the disappearance of the rigidity. To the acid product formed or stored in the muscles the name **sarcolactic** acid has been given. Certain physiological observations on muscle seem to lend support to this view: 1. A living muscle at rest is faintly alkaline. 2. Immediately after contraction a muscle is faintly acid. 3. During rigor mortis, muscles show well-marked acid reaction. 4. When rigidity passes off they show a distinct alkaline reaction.

To this view of Kühne's, regarding the coagulation of myosin as a cause of rigidity, it is fair to add the statement that the latest writers on the subject have favored the idea that, somehow, in a way not yet made clear, the *nervous system* also exercises some influence on the onset of rigidity. This is supported by the observation that some cases of the very early development of rigor mortis—called cadaveric spasm— can not be accounted for by the coagulation of muscle-plasma, and must have some controlling cause which acts rapidly. Kühne's theory has met with some obstacles from another point of view. The explanation that decomposition evolves ammonia which dissolves the coagulated myosin is objected to on the ground that there are said to be many cases of the disappearance of rigidity before putrefaction comes, and other cases in which rigor mortis persists after putrefaction is well

under way.   Hermann and Bierfreund state that cadaveric
rigidity begins to disappear before any putrefactive changes
are declared—certainly before the muscles become alkaline.
It is urged that in order to produce sufficient ammonia to dis-
solve the coagulated myosin an advanced stage of putrefaction
would be required; whereas, as a rule, rigidity generally dis-
appears before any important degree of decomposition is
present.   Halliburton believes in the action of an unorganized
ferment as the agent causing rigidity to disappear.

These varying theories are stated to show that the true cause
of rigor mortis is by no means clear in the minds of physiolo-
gists, although Kühne's theory has the most believers in its
acceptability.

Brouardel[1] writes: " The causes of rigidity are still almost
unknown to us ;" and he adds the purely speculative sugges-
tion, " It is probable that the muscular tissue is invaded after
death by micro-organisms, to the secretions of which rigidity
is due."

Muscle rendered rigid by this change presents certain char-
acters beside stiffness, which distinguish it from living muscle.
Previously translucent, it now becomes opaque.   Living muscle
is extensible, elastic; dead muscle requires considerable force
to stretch it, and when the force is removed it does not return
to its natural length.   To the touch it has lost its softness.   It
is shortened and contracted if left to itself in position, but if
opposed by counter-extension, it is found to be controlled.
The limbs, if left to themselves, assume an appreciable degree
of flexion; therefore, as a matter of experiment, it has been
found that a muscle undergoing the change into rigidity can
lift a light weight, showing that actual contraction to some
extent does occur.   Some physiologists declare that something
besides *myosin-coagulation* is involved here, and that rigidity is
accompanied by a genuine muscular contraction.   Tourdes[2]
believed he demonstrated this by placing disks of stearin
between the jaws of persons just dead; when rigor mortis
became established, the teeth dented the two surfaces of these
disks and left marks from an eighth to a fifth of an inch deep.

Many conditions and circumstances modify and control this
manifestation of rigidity with regard to its period of develop-
ment, its degree, and its duration.   It is developed early after
death by long-continued, exhausting diseases, such as phthisis
and cancer; after poisons of a convulsive type, like large doses
of strychnin; after wounds or violence when the muscles were
tired; after cholera and hydrophobia, and some other diseases,

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[1] *Death and Sudden Death*, 1894. p. 78.   [2] Brouardel, *Loc. cit.*, p. 70.

the reasons being unrecognized; in childhood and in old age (Louis).

Taylor says: "The slow access of rigor mortis depends less on the mode of death than on the condition of the muscles, whether or not their nutrition is perfect."

Brown-Séquard lays down the rule that: "The greater the degree of muscular irritability at the time of death, the *later* does cadaveric rigidity set in and the longer it lasts." Thus, the conditions interfering with muscular irritability (exhaustion and fatigue) promote the development of rigidity in time and degree.

The usual time of appearance of rigor mortis under ordinary conditions is about the third or fourth hour post mortem. Occasionally it is manifest in as many minutes. Rarely, cases of rigidity are observed before the heart stops. It is completed about the sixth or seventh hour after death, and it is always begun within twenty-four hours. Niederkorn found that in 103 cases two-thirds showed it between the third and sixth hour. It was developed long before the body was fully cooled. The process probably begins at once after death, but its manifestation is not apparent for a longer or shorter period.

The degree of rigidity manifested after death is found to be various according to various conditions. The age of the subject modifies it. It is *slight* in infancy; it is *marked* in adult maturity. As to old age, authorities differ; probably it is under the general rule as to nutrition of the muscles. After certain diseases the degree differs. After death from phthisis and other wasting diseases it is slight; after peritonitis and other infections it is also slight. Poisons show their effects in different ways. Narcotics as a class and sulphuretted hydrogen result in slight cadaveric rigidity. Strychnin, irritant poisons, and alcohol produce marked rigidity. Certain forms of violence, such as death in battle, toward the end of an engagement (fatigue), cause a marked degree of the change. Kussmaul declares, and Casper and others agree, that some degree of rigor mortis occurs after every form of death. Death by lightning was, for a long time, on the authority of John Hunter, supposed to be a conspicuous exception to the rule. It is now known that it is not an exception. Many cases, carefully observed, show that rigidity is developed. Its short duration is perhaps explained by exhaustion of muscular irritability by the electric shock. The writer's cases of death by electricity have shown rigidity present in the usual degree.

Finally, as to its duration. It is *shortened* by any causes that promote the advent of decomposition, such as heat and

moisture, as in summer; by causes that produce fatigue and exhaust muscular power; by certain diseases, such as typhoid fever, peritonitis, phthisis, cholera, scurvy, hydrophobia, and cancer.

It is *prolonged*, on the other hand, in muscular and strong subjects who are not exhausted from any causes; in dry, cold air, as in winter; in cold water, as in drowning; in death by suffocation and by hanging; in fatal diseases of short duration; after poisoning by strychnin, alcohol, and veratrum viride; when its advent is late.

With reference to the influence of seasons and temperature on the duration of rigidity, Devergie had a useful saying, worth remembering, if it is not applied too closely : " Winter and summer alike, the figure remains the same; only, in winter, it stands for days; in summer, for hours."

The average duration, taking all conditions of season, cause of death, age, etc., into account, is from twenty-four to forty-eight hours (Brouardel).

When rigidity is fully developed, if it is forcibly broken up by passive motion of a limb, it will not reappear in that limb. If, however, it is but partially developed, in process of manifestation, but not yet complete, it is probably practicable to undo the rigidity already developed and to place the limbs in new positions in which they will assume secondary stiffness. This is chiefly interesting as an experimental observation, however, and is not likely to give embarrassment as a practical matter.

It is important to remember that the body left undisturbed stiffens almost exactly as it lies at the moment of death, with scarcely appreciable changes. It fits itself to the surface and surroundings. So, when a dead body is found under circumstances of suspicion, the observer asks, Has it been moved since death, or since rigor mortis developed? Does it fit the surface on which it lies? This observation may be of help in deciding between homicide and suicide.

Does the phenomenon of post-mortem rigidity aid us any in answering the question, How long a time has elapsed since death? The answer must be in the negative. The numerous conditions controlling and modifying the time of its appearance, its duration, and its degree leave us in a position where guessing is our only resource; we can only approximate. The disappearance of body heat is a better guide.

With regard to the order in which the muscles are involved, there is a lack of agreement among the authorities. Each writer states his notions in his own way and makes a classifi-

cation more or less different from that of his predecessor. It will, the writer thinks, serve medicolegal purposes sufficiently, if we remember the general statement wherein all agree, namely, that rigidity affects, first, the muscles above the level of the clavicles, the neck, face, and lower jaw ; then, the muscles of the upper extremities and the trunk ; then, the muscles of the lower extremities ; and that it passes off in the same order. But whether the eyelid, the lower jaw, or the neck, takes precedence must be left to the future to settle.

Brouardel says : "The duration of rigor mortis is nearly the same in each of the members invaded ; and the part which is invaded last will keep it last." He further states that the muscles of the fingers preserve their rigidity latest.

As has been stated, the involuntary muscles are included in the changes wrought by post-mortem rigidity, not less than the voluntary. So, too, the *cutis anserina* is an illustration of this. The vesiculæ seminales are emptied by it. It will be interesting to allude for a moment to the effects produced on the most important of these involuntary muscles—the heart.

According to Luff,[1] this organ enters into the condition of cadaveric rigidity in an hour after death, and remains so for from twelve to thirty-six hours. It not only stiffens its muscular fibers, but it undergoes sufficient contraction to alter entirely the relative capacity of its cavities. This has led sometimes to mistakes, the walls being erroneously described as thickened, and the cavities diminished in size. Experiments on animals (Straussmann) indicate that the heart, at a postmortem examination made several hours after death, gives no certain proof of its state at the time of the death—that if the heart is examined immediately after death, the left ventricle is found often to contain more blood than the right ; but when the examination is postponed until rigidity has developed, the left ventricle is almost invariably found firmly contracted and empty. These observations should be borne in mind when we are studying hearts at the autopsy table, the interval after the death being sufficient for the full manifestation of cardiac cadaveric rigidity.

Cadaveric Spasm or Instantaneous Rigidity.—This is rigor mortis immediately developing at the moment of death, so that the body stiffens in the very position of the last act of life. It is the last act of life crystallized in death. Physiologically, it is regarded by some as the same thing as rigidity as ordinarily observed. Its true nature and causation are still subjects of research. It is seen most characteristically

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[1] *Medical Jurisprudence,* i., p. 32.

in sudden death by violence, but it may occur after any kind of death. Its best examples are seen on the battlefield. Brinton counted on the field of Antietam forty cases of the sort. It occurs most completely after prolonged and exhausting activity.

Weir Mitchell, in his book entitled *Characteristics*, wrote: " Men killed instantly by bullets sometimes preserve for a time precisely the expression of the moment; and no doubt you have all seen those photographs of the dead at Gettysburg, where some of them remain in exactly the postures of their last act. . . . One of four great generals (Sherman) relates that at a spring in Georgia he halted to water his horse and called to a man kneeling, with his head at the water-level, to move or make way for him. As he did not stir, an aide dismounted and spoke to him. He still remained motionless, and it was then seen that, while in the act of kneeling to drink, a bullet had crashed through his brain, and he had stayed, as if made of stone, in the attitude in which the deadly messenger of fate found him."

Concerning cadaveric rigidity, Brouardel[1] gives some pertinent examples: An English colonel, charging with his troops at Inkerman, was beheaded by a cannon-ball; nevertheless, he continued at the head of his regiment, firmly seated on his horse, which bore him into camp with the rest of his force."

A cavalryman in the Army of the Potomac, in the act of mounting his horse, was hit by a ball which injured the spinal cord in the neck; he remained upright and motionless in the position in which he was struck, with one foot in the stirrup and his hand on the horse's mane.

A French soldier was found, in the Franco-German War, sitting on the edge of a stream, with his hands holding a canteen, as if in the act of drinking. He had been beheaded by a cannon-ball, and the lower jaw hung down in front of his neck.

Falk and Schroff have demonstrated experimentally that lesions of the medulla oblongata can produce this form of instantaneous rigidity.

Instantaneous rigor may be of very great value in a postmortem differential diagnosis of homicide and suicide. It can not be simulated. Hence, what the hands contain and how they hold it may be of the greatest significance. Thus, revolvers or knives held in the dead hands with a grip that requires some force to loosen it, if held in a natural manner as in the act of using, indicate beyond a doubt a suicidal act. Such a grip can not be produced in a dead hand, after a homicide, with a view to *simulating* suicide.

[1] *Death and Sudden Death*, p. 54.

Instantaneous rigor has served a good use in diagnosis under other contingencies. Thus, if a person is found dead in the water, with substances *grasped* in the hand, these aid in determining where and how the death occurred; whether, indeed, the death was in the water at all. So, too, observations on what the hands of a dead person have grasped in the last act of life help in solving questions of the circumstances under which homicides have been committed.

Putrefaction.—We come, now, to consider the last of the post-mortem changes to which the dead human body is subjected—putrefaction. This is the reduction of the dead body to shapeless inorganic remains. It always follows post-mortem rigidity in the order of succession. But rigidity may sometimes be found to continue for a limited period after decomposition has declared itself. Under favoring conditions, its advent may occur in a few hours. And, indeed, exceptionally, we come across cases of surprising rapidity in its development. For example, in 1879, Dr. William G. Porter presented the following case[1] which has a medicolegal interest in its relation to the question of decomposition as a means of determining the time of the death in any given case:

"The patient, an Englishman, fifty-eight years old, was of stout build and of temperate habits, though a large eater. He was a healthy man, so far as was known, until his last illness attacked him. Dr. Porter was called at 5 A. M., October 4th, to prescribe for the relief of excruciating epigastric pain which had supervened after several days of nausea, with occasional vomiting. Morphin given hypodermically controlled the pain; and other measures were adopted to palliate the attack and to prevent its recurrence. Moderate fever developed, and in the course of the day several large, soft bilious stools were passed. At midnight there was more pain, still referred to the epigastrium; the skin was warm, but the patient was pulseless at the wrist. Full collapse developed presently, and death ensued at about 1 A. M., October 5th. An undertaker was immediately summoned, and the body was placed on ice within two hours after death. At 8 o'clock in the morning, that is to say, seven hours after death, the body had swollen "enormously"; at 9, the corpse by its distention had lifted the lid of the ice box several inches, carrying with it a layer of ice that covered it. The whole surface of the body was jaundiced. The features were distended beyond recognition, and the face was smeared

[1] *Transactions of the College of Physicians of Philadelphia*, third series, iv., p. 79, 1879.

with clotted blood which had been forced from the bloated mouth and nostrils.

" When, at this time, the usual post-mortem incision was made in the median line of the body, air without appreciable odor escaped from the cellular tissue ; the tissues receded from the knife as if they had been stretched to the utmost. A large amount of air, also without odor, escaped from the peritoneal cavity, although there was no peritonitis. The liver, kidneys, and spleen were emphysematous and buoyant. The heart was empty, and its tissue was friable. There was no odor of putrefaction."

A bacteriological and wholly reasonable explanation of these cases of rapid change has been made by Welch (1892) : [1]

" With his assistant, Dr. Nuttall, Professor Welch discovered a bacillus which develops rapidly in the blood-vessels after death, and whose development is accompanied by the production of gas. The presence of gas in blood-vessels at post-mortem examinations has frequently been reported, and its existence has been a puzzle, occurring as it may but a few hours after death, unaccompanied by other signs of decomposition. This new bacillus, which has been named by the authors " *bacillus aërogenes capsulatus,*" has been cultivated in agar-agar and other media, and grows only if oxygen is excluded. The growth of the cultures is accompanied by the appearance of bubbles of gas. Cultures of this bacillus are not pathogenic for healthy rabbits under ordinary conditions ; but if the animal is killed after intravenous injection, the bacilli develop in the blood-vessels, tissues, and organs with an abundant formation of gas. When the animal is killed shortly after the injection into the circulation, and is then kept at a temperature between 30° and 35° C., a development of bacilli and gas goes on with almost startling rapidity. Of all the organs of the body, the liver offers the most favorable conditions for the rapid development of the bacillus, but they first grow in the course of the circulatory channels into which they have been introduced. If the animal is killed one or two minutes after the injection of the culture into a blood-vessel, the development is quicker than when the animal is allowed to live for one or two days. If the bacilli are introduced at one place in the vascular system soon after death, they develop in the course of the vessels into which they are introduced, and the time required for them to appear, with gas formation, throughout the vessels is at least two or three times as long as when the bacilli have been distributed

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[1] *Bulletin of the Johns Hopkins Hospital,* July and August, 1892.

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throughout the circulation just before death. The bacillus may be introduced antemortem as a result of a surgical operation, or in any other condition in which a blood-vessel is opened. They probably do not multiply if the person remains alive, and in a few days disappear. The authors consider that it is probable that many cases reported from the autopsy, in which the patients are said to have died from the admission of air into the circulatory system, have in reality died from some other cause, the gas produced by this bacillus having been mistaken for air."

On the other hand, decomposition may be hindered and postponed to an extreme degree under favoring circumstances; temperature, especially if low, acts to retard putrefaction. Thus, Erman states that the body of Prince Menchikof, a favorite of Peter the Great, was exhumed in 1821, after a burial of *ninety-two* years in Siberia. The body had undergone little change. The heart and some other organs were removed and sent to his descendants for re-interment. A still more striking instance of the preservative power of cold was the discovery, at the mouth of the River Lena, in a mass of ice, of the well-preserved body of an elephant belonging to a race of prehistoric animals.

The beginning of putrefaction is announced externally by an extension of the cadaveric lividities to other parts of the body from the dependent parts where they are first to appear. At the same time a greenish discoloration appears about the front of the abdomen and flanks and groins, and this presently spreads over the surface generally. This olive-green color is due to the alteration and decomposition of the hemoglobin, the coloring-matter of the blood, in the presence of sulphuretted hydrogen. In bodies whose upper portion contains an excess of blood because of the manner of death, or position after death, the green color is most marked, as an initial change, over the sternum or in the face and neck. Coincidently, the subcutaneous veins appear as a series of dirty blue lines and marks about the neck and upper regions of the chest.

Internally, the tissue that shows the changes due to putrefaction the earliest is the mucous membrane lining the trachea and primary bronchi.

The author has given some illustrations of both the rapid and the slow advent of putrefaction and has hinted at the conditions governing these extremes. These conditions may be formulated in a general rule: That the processes of putrefaction are promoted and accelerated by the exposure of the body to heat, moisture, and free access of air. But this threefold action

must be a combined action. If, for example, a body is exposed to a *warm* though *dry* air, the result will be, not putrefaction, but desiccation or mummification. The desert victims are examples of this. As to the time required for complete mummification by natural processes, it is impossible to be exact.

For the acceleration of the processes of decay, a temperature of from 70° to 90° F., with frequent changes of the air or free exposure to moist air, is the most favorable condition. Putrefaction is arrested at 32° or below, and at 212° or above. Certain false *popular* notions about keeping a dead body illustrate these facts. The retention of the corpse in a large room, freely ventilated, is the usual way. The use of a small room, tightly closed, with the body lightly covered, is the better way. In passing it is proper to refer to a suggestion made by B. W. Richardson : " In cases of doubt, as to whether a person is really dead or only apparently dead, place the body in a warm room ; if living, the warm temperature will aid in restoration ; if dead, the warmth will hasten putrefaction and solve the question fully."

Moisture promotes putrefaction by *chemical* action in part. Of great importance in this relation are the body's own fluids which amount to more than two-thirds of its weight. This condition, of course, hastens the process. Hence, dropsy and drowning offer favorable conditions for early putrefaction. Hence, too, different degrees of water in different organs affect the change. The brain and the eyes putrefy long before the bones and the hair. A moist, hot, sultry air is the combination that best favors decomposition. A dry, cold air brings about a desiccation and mummification like a dry *hot* air. This result is seen in the dead-house of the Hospice of St. Bernard ; it is found, also, in certain tombs. It is illustrated, too, in the cold-blast method of preserving meats, and in the new City Hospital mortuary in Boston, where dead bodies are kept weeks with little change.

The action of air as an agent of putrefaction is obvious and well understood. The domestic process of preserving meats and fruits by canning, with complete exclusion of the atmosphere, owes its success to this. Similarly, the effects of such exclusion in retarding the putrefaction of the human body are seen in the cases of royal personages buried in marble sarcophagi in leaden coffins hermetically sealed. These tight receptacles, opened years or even centuries afterward, are found to have kept their cadaveric contents surprisingly well. The same thing has been demonstrated experimentally. In 1854, Pasteur, using all antiseptic precautions, placed blood and

urine, the most fermentable and putrescible of all organic fluids, in sealed tubes, in the course of some experiments on spontaneous generation. Those sealed tubes were examined forty years later, in 1894, and their contents were found unchanged.

We should not forget the part which bacteria have to perform in the destructive processses of putrefaction. Their agency is recognized and acknowledged, and their usefulness as sanitarians should help to offset the obloquy which attaches to certain members of their large family as agents of disease-extension. For their fullest activity free access of air is required.

Brouardel[1] describes these micro-organisms as working in three groups or cycles. First comes a colony which requires oxygen to sustain life—the aërobic organisms. These produce carbonic acid, and disappear. They are followed by "an amphibious" colony, able to survive with or without oxygen. These make carbonic acid, hydrogen, and hydrocarbons. Last, the anaërobic family takes up the work; these do not live in oxygen. They make hydrogen, nitrogen, and more or less compound ammonias.

These several groups or colonies themselves create the substance in which they are unable to live. And their activities are displayed more or less rapidly, according to media and environment, just as in the bacteriological laboratory. The condition of the culture-soil,—the dead human body,—may be so changed by artificial means as to put a stop to their proliferation altogether, and thus to exterminate them and interrupt what we call decomposition. For example, when the cadaver putrefies in the open air, it is very evident that the micro-organisms in the atmosphere, settling on the epidermis, can penetrate through this and begin their work. But if the body is protected in such a way that the bacteria can not gain entrance, their performances are postponed. Brouardel insists that it is through the alimentary canal that putrefaction proceeds most quickly. At death, the vibrios in the intestines swarm into the intestinal glands, come into contact with dead epithelium, which they destroy, find their way into the blood-vessels and peritoneum, and produce gases there, and secrete diastase, which liquefies the tissues.

The quantity of the gas sometimes equals in tension one and a half atmospheres. It pushes up the diaphragm. It drives the blood from the deep vessels toward the periphery and so sets up what is called the posthumous circulation. It causes the liquefied blood to transude through the walls of the

[1] *Loc. cit.*, p. 80.

vessels and diffuse itself in adjacent tissues. It promotes those stains on mucous surfaces (as in the stomach) which are sometimes mistaken for disease or poisoning. It helps to form the hypostatic lividities sometimes described as bruises. It causes recent wounds to bleed anew.

Moreover, the agency of the various larger forms of insect scavengers, the cadaveric fauna, in consuming putrefying remains, is a matter of some interest. Mégnin, of Paris, and after him, Wyatt Johnston and Villeneuve, of Montreal, and Hough, of Massachusetts, have studied the various genera and species of insects which attack and destroy dead bodies—whether exposed above ground or buried in the ground. The result of all the observations is that the various flies and beetles, the diptera, coleoptera, acari, and the rest do not work together, but follow each other in a regular, well-ordered succession of industry, one family taking up the work when its predecessors have finished, until in the last or eighth period of Mégnin's scheme, when nothing but dried ligaments remain on the bones, two forms of coleoptera appear and devour these final remnants. As a medicolegal matter, an attempt has been made to use this succession of fauna as an aid in determining the time since the death of the subject devoured. Thus, if we find on the body or in it, the lepidoptera (dermestes), we may be certain that the death occurred from three to six months previously, because the dermestes never are known to attack a dead body until the fatty acids are formed. And so on with the other genera. But the weakness of this deduction is the fact that we must know the data as to season, temperature, exposure, and all the conditions under which decomposition began and has progressed before we should rely very much on the help which a certain kind of fly or beetle can give us in determining when the death occurred in a given case. We need many more observations before we reach firm ground in this matter.

As to the relative influence of the three media—earth, air, and water—in promoting putrefaction, we can only approximate in our conclusions. It is conceded that, all other things being equal, decomposition proceeds fastest in air, slowest in earth, and moderately fast in water. Casper puts the ratio in these terms: "At an average temperature, the degree of putrefaction present in a dead body after lying in the open air for one week, corresponds with that found in a body after lying in the water two weeks, or after lying in the earth in the usual manner eight weeks." Hoffmann says: "Putrefaction is twice as rapid in the air as in the water."

In addition to these conditions of *general* application favoring putrefaction there are certain other *special* conditions which influence and promote the process. Among these, the cause of the death has a dominant place. All victims of infection, typhoid fever, pyemia, and septicemia decay rapidly after death. So, too, do the bodies of those dying of chronic diseases attended with *dropsy ;* and those who have perished by certain *poisons*, such as prussic acid, opium, and strychnin. Also those who have succumbed to mechanical violence. Again, decomposition attacks the bodies of the young more rapidly than it does the mature or older. The subjects of *chronic alcoholism*, with attendant degeneration of tissue, putrefy rapidly.

On the contrary, putrefaction is retarded by physical conditions of leanness and dryness, as in old age. After certain kinds of death, such as chronic wasting disease, without dropsy and with emaciation, fatal hemorrhage, and cancer, decomposition is slow ; also after death from certain poisons, like arsenic (with exceptions), phosphorus, chlorid of zinc, sulphuric acid, corrosive sublimate, antimony, and chloroform.

Putrefaction is slow according to the surroundings and burial conditions. By heat, if above 100° F. and the air is dry ; by cold, if below 32° F.; in water, if cool; and in dry cool air. It is retarded in a deep grave ; in a dry absorbent soil ; in a tight coffin ; if the body is covered with thick clothing ; if the death is followed by speedy burial ; if the body is covered under privy soil. Charcoal and lime prevent decomposition.

Putrefaction is promoted also by certain other conditions under which the *burial* of the body is performed. For example, lateness of the burial, with increased chance for larvæ to get a foothold ; burial in loose soil with free access of air ; burial in a shallow grave with daily alternations of temperature ; burial in a loose-jointed coffin, or in none at all ; burial with the body lightly covered, or uncovered. In all these respects the peasant has the advantage of royalty in the rapidity with which his dead body returns to its native elements.

Without stopping to consider the physical effects of the formation of gases upon putrefying bodies, or the changes which are wrought in the tissues by decomposition, a word or two will be said about *one* of the products of decay, and that is, *adipocere.*

This substance is an exceptional and occasional product of putrefaction—or, more exactly, a change, which the tissues take on in the course of decomposition. It was first de-

scribed by Fourcroy in 1789, at the exhumation of bodies buried during the Revolution in the *Cemetière des Innocents.*

It is an impure ammoniacal soap, chemically; physically, it is intermediate between fat and wax. Its color is brownish or yellowish white. Its odor is like that of old cheese. To the touch it feels soft, unctuous, and soapy. It melts at 200° F. When heated, it gives off an ammoniacal odor. Alcohol is a partial solvent. It is a permanent body, and has retained its structure after being kept seventeen years. In its formation palmitic, stearic, and oleic acids of the body combine with ammonia in the presence of moisture to form a soap. It represents saponification of the fatty acids. Excess of lime in the tissues gives it a harder and firmer character.

Any part of the body may be changed into *adipocere ;* but not all parts alike. The required conditions are fat, water, and ammonia from decomposition. Once changed into *adipocere,* the part of the body so altered retains its form indefinitely. The first part to undergo the change, according to Devergie, is the female breast; next the cheeks. The bodies of children become readily adipocerous. Fat subjects are especially prone to the change. There is something in the water of privies or cesspools which promotes its formation. In brooks, deep graves, and moist earth, dead bodies more rapidly assume *adipocere* than in opposite conditions. In other words, excess of humidity and exclusion of air are among the favoring conditions.

As to the time required for the change, authorities differ somewhat. Devergie says it begins in from six to eight weeks. Casper declares that it requires from three to four months in water, and six months in earth. Hoffmann states that from two to six months comprise the period. Ogston places the time at from four to six weeks.

In hot climates experience has found the change to go on rapidly. After it has once begun, the least time in which it will be fully developed in any given part of the body is a month. For the change to be complete in the whole body, so that there will be no further transformation in any part, one year in water and three years in earth, according to Devergie, is the time required. Mann states that complete conversion of the soft parts into *adipocere* requires many years.[1]

The importance of carefully studying adipocerous changes has an example in the case of a man named Meecham. He left home on November 3d, insolvent. His body was found five weeks and four days later, floating down a river, three miles from his home. The lower abdomen and glutei were

[1] *Forensic Medicine,* 1893, p. 58.

adipocerous.   A commission in bankruptcy was taken out against him a few days after he left home, the presumption being that he was still living.   But bankruptcy proceedings were stopped and administration proceedings substituted, on the ground that the *adipocere* would require all the interval since the day of the disappearance to explain its degree of formation as observed at the autopsy.

Regarding the question, whether from the appearances of a dead body putrefied, the time of death can be satisfactorily determined, the answer must be negative.   The many and various conditions under which the body resolves, as has been shown, can at best lead only to an approximative guess. Devergie is the only author who tried to be dogmatic about it—he assumes a greater uniformity of putrefaction in water, and is guided by that.   But all other authorities are against him.   Orfila says that it is beyond the reach of science to determine the question.

Casper states that he examined the bodies of fourteen men, of nearly the same age, from twenty-four to thirty years, occupying the same social position, lying together in the same dead-house, and killed at the same time in the same manner, in a riot—thus presenting identical conditions throughout; yet in no two cases were the putrefactive changes alike.   " No general rule is applicable, and each case must be judged by its individual merits and circumstances." [1]

Briaud and Chaudé come to the same conclusion after relating, as an illustration, the fact that when in 1840, ten years after their death in the revolution of July, 1830, the remains of those victims were exhumed for removal, it might have been expected that after such an interval only dry bones would be found, and these even, perhaps, greatly crumbled.   It was not so.   The bodies of these persons, who had met the same manner of death, been buried in the same kind of soil, exposed, accordingly, to the same causes of destruction and decay, presented *all* degrees of decomposition, from complete desiccation of the bony parts up to a preservation of the muscular parts so entire that the relations of the muscles were recognizable.

With such testimony before us we may well exercise the utmost caution and deliberation in answering the question concerning a putrefied dead body, When did this person die? We must give our guesses a very wide margin for possible error.

Orfila says that bodies become reduced to skeletons in from fourteen to fifteen or eighteen months, even in coffins and partially protected by bedclothes.   Shakespeare undertakes to

[1] *Forensic Medicine*, i., p. 16.

help us as an authority. In *Hamlet*, Act v., Scene 1, the graveyard scene has this expert discussion:

First Clown. " I have been sexton here, man and boy, thirty years."

Hamlet. " How long will a man lie i' the earth ere he rot ?"

First Clown. " Faith, if he be not rotten before he die (as we have many pocky corses nowadays, that will scarce hold the laying in), he will last you some eight year or nine year; a tanner will last you nine year . . . his hide is so tanned with his trade that he will keep out water a great while; and your water is a sore decayer of your whoreson dead body. Here's a scull now; this scull hath lain you i' the earth three-and-twenty years."

Casper gives the following order of decomposition :[1]

PRIMARY GROUP.	FINAL GROUP.
1. Larynx and trachea.[2]	8. Lungs and heart.
2. Brain of infants.	9. Kidneys.
3. Stomach.	10. Bladder.
4. Intestine.	11. Esophagus.
5. Spleen.	12. Pancreas.
6. Liver.	13. Diaphragm.
7. Brain of adults.	14. Large blood-vessels.
	15. Uterus.[3]
	16. Muscles, ligaments.
	17. Bones.

The writer's own observations on exhumed bodies afford some testimony upon these matters:

Observation I. Patrick D., an adult, died of gangrene, and was buried December 8, 1880, in an ordinary casket, and grave-clothes. There was nothing unusual in the nutrition or habit of the body. It was exhumed October 26, 1881, nearly a year after the death, because the widow insisted that an autopsy had been made without her consent at the hospital just after his death. The coffin was much warped, but entire. The grave-

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[1] *Gericht. Medicin*, i., p. 44.

[2] In recently dead bodies the mucous membrane is pale from three to five days in summer; from six to eight days in winter; and before any other part shows decomposition the larynx and trachea are discolored, of a uniform dirty red or brown.

[3] A young and pretty servant disappeared on March 21st. Scandal explained her absence with a story that she was pregnant by her master, a married man, who had killed her and disposed of the body. In December of the same year the body was found in a cesspool or privy vault, wholly putrid, except the uterus, which was bright red, firm, and unimpregnated. Casper pronounced her a " virgin."

clothes were covered with mold,.and a horrible stench of putre-
faction was exhaled. The skin of the face was nearly black,
and much wasting of the subcutaneous tissues of the face was
apparent. The hair had not changed since death. The eyes
had nearly disappeared. The chest and abdomen were still
entire, and had not fallen in; the skin was quite sound. No
stitches appeared as evidence of the widow's allegation.

Observation II. Isabella B. H. She died of strychnin-poison-
ing, in Boston, on August 1, 1884. She was buried on August
3, 1884, in a distant town, in a dry, sandy, porous soil, after a
public funeral and exposure of the body in church. She
was very stout. The body was exhumed on October 27,
1884, eighty-seven days post mortem. The hands and face
were a slaty black, shrunken and dry. The mouth was open
and the lips were fully desiccated. The eyes were sunken, but
the cornea and conjunctiva were still distinct. There was a
stench of old cheese—not positively intolerable, less loathsome
than in many recent cases. There was mold on the grave-
clothes. The skin of the chest and abdomen was of a yellow-
ish brown. The cuticle was in shreddy masses, readily de-
tached in large areas. The abdomen was shrunken to the
spine. There were no larvæ visible. Much slimy material
was in the casket under the body. Section of the abdominal
wall showed the fat and muscle in fair condition, the color of
the muscle being fresh and red. The abdominal organs had
shrunk to small volume, but could be distinguished and iso-
lated. The liver was four times its normal volume, a shapeless,
dark brownish-red mass, lying close under the diaphragm and
against the spine. The kidneys were very soft and their
volume was not much diminished. The heart and lungs were
more changed than the other organs. The heart was a flat-
tened, empty sac, lying close to the spine; the lungs were
one-fourth their volume; they were partially dry and of a dark
red in color. The brain had settled into the posterior two-
thirds of the cranial cavity, a pultaceous gray mass without
remnants of its structure, leaving the anterior third empty.

Observation III.—Julia G. was murdered by her husband
on September 11, 1891, by breaking in her skull. After the
homicide he concealed the body in the cellar of a lonely
vacant farm house, and disappeared. On October 15, 1895,
four years and one month later, a new tenant came to the
house, which had been vacant through the entire interval
from 1891, and, while attending to some repairs in the cellar,
he found the body completely skeletonized—a collection of
dry bones, without a particle of the soft parts; even the carti-

lages had disappeared. The cellar was not a tight one, the stone wall being loose and open, admitting air and insects freely.

Observation IV.—Wilhelmina Z., aged forty years, died of consumption on September 24, 1877, and was buried in a cemetery near Boston. On November 10, 1897, the body was exhumed for cremation. The casket had entirely disappeared. The remains of the body consisted of dry bones, disarticulated, and without ligaments or cartilages. The cranial bones were all separated. The hair had disappeared. There were some black leathery masses which may have been clothing remnants. The two ear-rings were in a perfect state of preservation. The silver plate, though corroded and out of shape, showed the inscription legibly enough to determine identification.

The gaseous fluid products due to putrefaction deserve a word of mention. The gases which result from decomposition offer some variety according to the stage of putrefaction and the nature of the contents of the hollow viscera. In the earlier stages, the first five or six days, sulphuretted hydrogen, carburetted hydrogen, ammonia, with varying proportions of carbon dioxide, phosphoretted hydrogen, and nitrogen are the gases which result. Later the proportions of sulphuretted hydrogen and ammonia diminish, the carburetted hydrogen and carbon dioxide increasing.

The gases of putrefaction are *inflammable*. This is tested by lighting a jet let out through the skin. The rapidity of formation of the gases will depend on all the conditions which promote putrefaction. In some instances the gases produce a visible phosphorescence about the body.

CHAPTER XIV.

SUDDEN DEATH DUE TO NATURAL CAUSES.

FROM a consideration of the proofs of death as a factor or condition exhibited in the various characteristic post-mortem phenomena and changes, we may pass properly to a study of the causes of death and the modes in which life is brought to an end.

This matter of the post-mortem diagnosis of the cause and manner of death is of obvious importance, since it involves so much of the practical work which forensic medicine undertakes.

Its relations medicolegally are apparent. A person is found dead. The first thing thought of and done is to call a physician. His first question is: "Is this person really dead?" That query settled, the problem of identity arises. Then a series of inquiries is presented which it is the function of legal medicine to solve. The State demands it, and has supplied the proper machinery. What was the cause of this death? Was it the result of natural causes? Was it a case of death by violence? If by violence, what was the manner of it, homicide, suicide, or accident? The answers to these questions may involve the liberty, perhaps the life, of a suspected person. There is ample justification, then, that the law, in describing the qualifications of the person who shall represent the State in such an investigation, requires that he shall be "able, discreet, and learned in the science of medicine," for the practice of medical jurisprudence calls for all these characteristics.

Obscure and suspicious deaths are the most trying ones to investigate. Gossip lends its aid, and unfounded insinuations readily spring into life like mushrooms. Newspapers representing sensational journalism seize the opportunity, and make the most of it. In such an emergency it is essential that the physician acting as a medical jurist should not contribute to the sensation. His caution, prudence, and tact applied to the determination of the real question at issue will allay excitement, and remove the occasions for false theories and assumptions. His reticence may be a real public

blessing. A garrulous physician under such conditions is a nuisance, and the more he talks with reporters the greater nuisance does he usually prove himself to be.

It is not, however, always possible for even the best observers to reach conclusions which are so demonstrative as to be wholly acceptable. Exceptional cases occur in which the most exhaustive, painstaking investigation, including the autopsy, fails to find sufficient evidence to determine the actual cause and manner of the death. These instances are by no means unique, and they are very puzzling. How are they to be managed so as best to serve the public needs? The conclusions may be formulated in two ways:

1. "The cause of this death can not with certainty be determined." This is objectionable, though true. It leaves the matter so loose that for judicial purposes it is useless.

2. "The investigation and autopsy revealed no evidence that this person died by other than natural causes;" or, "The investigation and autopsy failed to discover any reason for believing that the death in this case was by violence." These latter forms, though negative, are valuable because they exclude and eliminate the element of crime, and satisfy the demands of public order.

Although the classification of deaths into those by violence and those resulting from natural causes is sufficient for most practical purposes, medicolegal authorities have usually gone much farther in distributing the causes of death according to a more precise and specific basis.

It is generally agreed among French, English, and American medicolegal writers that the causes of death may usually be referred to a limited number of generic operations—to the failure of one or another of the three great vital functions: respiration, circulation, or innervation. These three are called the tripod of life. They are interdependent. Their united, harmonious action is essential to health and life. Their co-operation is imperative. Failure of either one embarrasses the others. Hence, for medicolegal purposes, authors speak of death beginning at the lungs—asphyxia, or apnea; at the heart —syncope; at the brain—coma.

For our present purpose, however, we need not try to apply and utilize this method of analysis, which Bichat first described in 1798, and which has retained its favor with the authorities in literature ever since. A simpler scheme will amply suffice for our needs. From the point of view of legal medicine, all deaths fall readily into two classes: 1. Those which result from natural causes. 2. Those which result from violence,

homicidal, suicidal, or accidental. Under the former head come those sudden and sometimes shocking deaths which, on account of their very suddenness, seem so different from the mortal change which is wrought by fatal disease, acute or lingering. These sudden catastrophes have always been deemed worthy of the State's concern, and have justified investigation. Although the element of crime is lacking, there is often a tragic character about them which appeals to public interest.

As to the frequency of these cases there can be no doubt. One can hardly open his morning newspaper without happening upon a new instance in which all the incidents are familiar except the name of the person who has " dropped dead " or has been found dead in bed or elsewhere. And then the astute chronicler adds, " the death was due to natural causes, probably heart failure." One common feature of these stereotyped stories is that the person who has passed out so suddenly was not known to have any ailment of any sort.

Before proceeding to consider the various **causes** of sudden death, the writer will limit the subject somewhat. The sudden deaths from natural causes, in which legal medicine takes an interest, are such as strike down their victim unexpectedly and without warning. Although the word " sudden " implies that there is a startling celerity in the process, it does not necessarily imply instantaneous results, as in a lightning-stroke. There may be, and almost invariably is, an appreciable interval between the attack and the end, even in instances where the suddenness is most marked. On the other hand, strong resisting power, unusual vigor, may hold the mortal enemy at arm's length while the struggle, sure to end in one way, goes on. An hour, more or less, may thus pass in a death struggle, and in this hour symptoms may be observed. Yet the death is fairly to be called " sudden."

It is clear, however, that, for present purposes, we should further bound our subject. Legal medicine does not concern itself with *all sudden* deaths. It has no interest in the unexpected catastrophes which sometimes end disabling disease under the immediate continued observation of an attending physician. For example, diphtheritic paralysis, typhoid fever with perforation, and post-partum pulmonary embolism may all terminate with startling suddenness; but with these crises legal medicine does not meddle. We have rather to consider the cases in which the person dying suddenly is not disabled by recognized disease, is about his usual vocation, and is in enjoyment of his usual pleasures when the summons comes, and death closes the scene in the presence of startled witnesses.

The Rev. S. F. Smith, the author of the national hymn, *America*, on November 16, 1895, had just seated himself in a railroad car to go out of town to visit a friend. He turned to speak to his companion, changed color, gasped a few times, and was dead.

Mr. William T. H., on November 17, 1896, complained a little of pain in his right hypochondrium. He had eaten his dinner within the previous hour. He had no known disability. There was no recognized lesion. His head fell back, he gasped once, and all was ended.

Dr. Thomas L. J., in good health, was in a court-house in Boston, in one of the Civil Sessions, November 1, 1899, listening to the evidence in a case in which he was interested. He toppled over without warning and died at once, before those immediately near him could carry him from the room.

More especially are we interested in the cases of persons found dead in bed, who retired at their usual hour and in their usual condition of health, after pursuing their customary duties. Or of persons found dead in places other than their homes; in situations out of view of others, and under conditions quite unknown.

Attempts have been made by various writers to determine the relative frequency of the several causes of sudden death, but the attempts show much diversity in their results, and are not very satisfactory. For example, Ferrario and Sermonie, of Milan, made observations in 1043 cases of sudden death, with the following result:

Causes.	Cases.	Proportion.
Head (apoplexy, coma, etc.)	879,	$\frac{4}{5}$;
Heart (valvular disease, angina pectoris, etc.)	150,	$\frac{1}{7}$;
Lungs (suffocation, catarrh, pulmonary apoplexy)	14,	$\frac{1}{75}$.

Wynn Westcott, coroner for Middlesex District, London, reported 1000 consecutive deaths which were the subjects of inquest. Of these, 303 were sudden deaths from natural causes, the observation of which showed the following results:

Causes.	Cases.	Proportion.
Various cardiac disabilities	134,	nearly $\frac{1}{2}$;
Brain affections	64,	about $\frac{1}{5}$;
Pulmonary breakdown	37,	" $\frac{1}{9}$.

The remainder were explained in a variety of ways, such as hematemesis, uterine bleeding, Bright's disease, excitement, anger, and the like.

Lesser declares that of every 100 cases of sudden death,

66 are due to cardiac lesions. Brouardel makes this rather remarkable statement: "Death due to the kidneys is the most frequent form of sudden death."[1] They are the result of auto-intoxication by poisons generated in the system of the subjects of chronic nephritis whose kidneys do not remove the unwholesome toxins as in health.

The writer's own cases of sudden death from natural causes, from July 1, 1877, to March 3, 1903, show the following figures:

Disease.	Autopsy.	No autopsy.	Total.
Heart disease	84	723	807
Alcoholism	101	278	379
Cerebral hemorrhage	59	171	230
Pneumonia	86	33	119
Hemoptysis and other phthisical causes	22	75	97
Pancreatic hemorrhage	16	6	22
Bright's disease	31	11	42
Cerebral congestion	20	11	31
Epilepsy	1	21	22
Pulmonary embolism	2	1	3
Pulmonary apoplexy	2	. .	2
Aneurism	24	2	26
Meningitis	12	9	21
Pneumothorax	1	. .	1
Sunstroke	2	30	32
Cardiac thrombosis	4	1	5
Diphtheria	. .	2	2
Ruptured bladder	1	. .	1
Peritonitis (perforation)	2	. .	2
Tumor of the brain	2	. .	2
Diabetic coma	. .	1	1
Basilar thrombus	2	. .	2
Pericarditis	1	. .	1
Total of all cases	475	1375	1850

These data, reduced to percentages in the autopsy cases, give the following:

Disease.	Cases.	Percentage.
Heart disease	84	18
Cerebral hemorrhage	59	12
Pneumonia	86	19
Pancreatic hemorrhage	16	3
Bright's disease	31	6
Aneurism	24	5
Alcoholism	101	21
Other causes	74	16
Total	475	100

These cases of sudden fatality from causes purely intrinsic, having no connection with traumatic or toxic factors, comprise

[1] *Death and Sudden Death*, page.244.

a most interesting group for medicolegal investigation. As has been intimated, such investigation is justified by the startling suddenness of the death; by the suggestion to the popular mind that unlawful violence may be involved; by the idea, quite commonly entertained, that poison may be the destructive agent; by the desirability of excluding the element of crime. For these reasons the custom of including these deaths among those which call for an official inspection and post-mortem examination is a good one. It has always prevailed and is likely to continue as a part of the inquest system.

What data have we to enable us to make a post-mortem diagnosis of the causes of these sudden deaths? Our purpose will be served best if we interrogate the various organs, or groups of organs, in the same functional system, rather than to attempt to apply any arbitrary classification like asphyxia, coma, and syncope, or that of the German school. We can thus ask the organs of the circulatory system, of the respiratory system, and of the nervous system to deliver up their secrets to us, and to explain to us how they kill the human subject suddenly and without the intervention of external agencies.

Alcoholism is excluded from the scheme because the changes which eventuate in sudden death from alcoholic intemperance are the result of using an agent introduced from without.

Deaths from Heart Disease.—At the head of our list of witnesses we may properly place the central organ of the circulation—the heart.[1] " To say that anything which interrupts the continuous circulation of the blood through the lungs and systemic apparatus brings about sudden death is to state a truism familiar to every intelligent person. Why is it that the heart beats with its normal sequence and rhythm is still a problem for physiological determination. For a long time it was believed that the regularity of the heart's action depended on the integrity of the *nervous ganglia* which supplied to the muscle of the heart the necessary nervous impulses or stimuli. More recent views of physiologists have tended to modify this explanation, and have looked to the condition and integrity of the *cardiac muscle* itself, independent of the nervous supply."

" However this may be, we know that any agency or condition which interrupts the continuous passage of the blood menaces life immediately and profoundly. These conditions are of two kinds: 1. Those arising *within* the heart which obstruct the flow of the blood. 2. Those conditions of the heart itself which affect its functional powers, no impedient to

[1] Councilman, *Transactions of the Massachusetts Medicolegal Society*, ii., p. 133.

the passage of the blood being present. 3. Provisionally, wherein the two conditions just mentioned are associated."

" A good illustration of the first group of causes,—those in which obstruction to the blood-current exists,—is found in **cardiac thrombosis.** We may have, as a well-recognized, though rare condition, thrombi of such size formed in the heart's cavities as to prevent the passage of blood. More commonly the thrombi are smaller. They are found in either of the cavities. The most common location is within the auricular appendages; these cavities may be wholly occluded by clotted blood. The thrombi formed in the ventricles are, as a rule, small, and are seated usually in the trabecular meshes at the apices. These may not give trouble in the heart itself, although when portions of them are carried away from the heart in the blood-current they cause various consequences and even sudden death by occluding arteries leading to organs essential to life. Thrombi formed in the auricles are more extensive usually than the ventricular variety. Thrombi are frequently associated with chronic endocarditis and stenosis of the mitral valve. This condition is, indeed, important in the determination of thrombosis. The dilatation of the auricle and its imperfect emptying lead to the stagnation of blood, especially in the appendices."

Mural thrombi may be formed at the openings of the heart, and like ball-valves may prevent the entry and exit of blood.

In the case of Joseph G., aged twenty-five years, who was found dead on the floor of his bedroom, on August 13, 1893, there was no history of any disability, beyond the fact that he had been heard to say his " heart troubled him." What symptoms led up immediately to his death are not known. At the autopsy the only organ found to be at fault was the heart. Here there was an acute endocarditis with vegetations on the aortic valve. In the sinus of Valsalva, behind the anterior segment of the aortic valve, a thrombosis had formed which terminated in a large globular movable clot. This probably floated freely in the aorta. At the autopsy it was found below the valves and within the ventricle. It is possible that it was forced into the ventricle at the close of the systole; at the next contraction it got in front of the aortic orifice, thus closing the orifice and stopping the circulation instantly.

" Sometimes the thrombi are free, having no attachment to the cardiac structures. They may be detached portions of adherent clots. They are always round, due to their motion in the blood-current. They gradually increase in size by the addition of new fibrinous layers. They are associated with

stenosis of the mitral valve. They become a cause of sudden death by closing as a ball-valve the narrow auriculoventricular slit."

"Another cause of cardiac stoppage has been described by Terrillon. According to him, **emboli** carried to the right heart from the **systemic circulation** may lodge in the heart and thus obstruct the stream. Extreme cyanosis, with failure of the pulse, results. In such a condition, the obstructing clot must be a large one, and it is probably caught in the right ventricle, takes on new accretions of blood-clots, and occludes the orifice of the pulmonary artery. The source of these clots is found sometimes in an inflamed varicose vein; sometimes they are derived from the phlebitis of parturient women; sometimes they come from the lateral sinus of the dura, as the consequence of otitis."

"Concerning cases in which the **mechanism** of the **heart** itself breaks down, we may consider two varieties: 1. Cases in which the muscular tissue is at fault. 2. Cases in which the valves are impaired. A very large number of cases of sudden death is due to conditions affecting the integrity of the myocardium and its power to contract. Many of these cases have as their fundamental cause a pathological change in the **coronary** arteries. It has been shown by numerous observers that a normal circulation in the coronary arteries is essential to the function of the heart. It is, further, the belief of pathological authorities that, in so far as the cardiac walls are concerned in sudden death, it is the diseased state of these arteries to which the sudden stoppage of the heart is to be chiefly referred."

"The two coronary arteries have few, if any, anastomoses with each other; and each is distributed to definite areas of the heart, being in this sense terminal arteries. The capillaries are their only connection. Now the coronaries are, among the arteries, those which are found to be liable to disease. They may be occluded by thrombosis or embolism, or have their lumen narrowed by arteriosclerosis or atheroma. If this occlusion or narrowing occurs, the supply of blood to that part of the heart to which the vessel leads, and is distributed, will be cut off. This will produce necrosis of the tissue elements and of the walls of the artery. The area affected will be anemic and pale, and we have the condition of white infarction. In other cases the stasis will result in capillary hemorrhage, and a *red* or hemorrhagic infarction will result. These results of occlusion, however, are less common than are the changes in the myocardium due to a gradual narrowing of the arteries. These changes represent imperfect nutrition and a resulting

degeneration of the muscular tissues. The condition is known pathologically as **fibroid** or **chronic myocarditis.** It is characterized by the presence of whitish, opaque masses of fibrous tissue displacing the muscle. In most cases it may be seen in the endocardium and extends from this outward. It is rarely found in the right ventricle, but is usually limited to the left side of the heart, because the anterior or left coronary artery is more often affected than the right. It may be demonstrated by making sections through the muscular substance of the left ventricle near the apex and through the columnæ carneæ."

" Two results of the condition described are : 1. Aneurism in the wall of the heart. 2. Rupture of the heart following aneurism. The so-called spontaneous rupture of the heart is not very rare ; but it is certain that it never occurs if the cardiac muscle is sound, even under great pressure. The fibrous tissue resulting from coronary stenosis may be denser than muscle, but it is also less resistant and gives way readily under strain. To this state of the coronary arteries much of the weakening of the cardiac walls is to be ascribed. Indeed, it is stated that the only condition of the heart's walls, not connected with disease of the coronary arteries, which may be followed by rupture, is fatty infiltration, an unusual change due to the penetration of fat from the surface of the heart in among the muscular fibers beneath. And a degree of fatty infiltration capable of determining rupture must be very rare."

" As to the frequency of rupture of the heart, Devergie considers that it causes 2.5 per cent. of the cases of sudden death. The male sex is more subject to it than the female. This may be explained by the fact that men are more disposed than women to diseases of the blood-vessels. As to the seat of the rupture, authorities tell us that the left ventricle is the point of election in most cases. Statistics show that in 76 per cent. of the fatal cases of ruptured heart the rupture was in the wall of the left ventricle. Brouardel insists that the rupture extends from within outward, invariably. The ages between sixty and eighty are the periods of life most attractive to this sudden catastrophe, for the good reason that degenerative changes are most common then."

" In most instances the rupture is a perfectly direct, straight, though ragged, passage through the wall of the heart. This is especially true if the rupture is preceded by an aneurism. In other cases the rupture does not take place directly through the cardiac wall, but the blood burrows, making a fistulous passage in the muscular tissue and breaking out into the pericardium at some distance from the primary tear. The rupture,

in whatever manner it may occur, sometimes takes place when the subject of it is quiet and there is no physical or mental excitement to provoke it. In other cases the fatal event seems to be due to a sudden increase in the blood-pressure, the result of muscular exertion or some unusual excitement. George II. suffered cardiac rupture while he was at stool ; and Philip V. of Spain died from the same cause on hearing of his defeat at Piazensa."

" A much greater number of cases of sudden death is due to disease and occlusion of the coronary arteries without rupture of the heart. We are told by authorities in pathology that death from this cause may be the most sudden of any. The individual falls as if struck by lightning. As in rupture of the heart, the fatal issue may be preceded by some muscular or psychical disturbance, or it may come without recognizable exciting cause. The cases are those of persons over forty, who have been free livers. All the conditions which favor the development of general arteriosclerosis favor the degeneration of the coronary arteries. Sometimes death is heralded by repeated attacks of angina pectoris, but this is by no means constant."

In regard to the part played by **valvular** disease of the heart in cases of sudden death, it is probably less important than is popularly believed. Even medical men are rather apt to fall into this error. As a matter of fact, however, the cases of valvular disease of the ordinary type are attended with symptoms of impairment in other organs (especially the lungs), and this goes forward progressively through a series of distressing conditions easily recognized. That these conditions may end in a sudden and fatal crisis is true ; but the crisis has been anticipated, possibly longed for, and it is very different from the sudden collapse without warning which interests legal medicine. It is the *aortic* valve which is especially exposed to this unanticipated disaster, and even here it is rare. When it occurs, it is due to stenosis of the valve through obstructive thickening and to regurgitation of the blood.

Unless the rent in the heart is a large one, and a considerable hemorrhage occurs at once in the myocardium, death is not instantaneous. A number of cases have been reported in which an attack of fainting was the first symptom of the injury to the heart's muscle ; and an interval of an hour or more preceded the death. It is to be remembered that the death in these cases is not due to the amount of blood lost out of the circulation, but rather to the overfilling of the pericardium and to the mechanical pressure resulting, preventing the

entry of the blood into the heart and the pulsation of the heart itself.

The following case may properly be set down in the list of sudden and unexpected deaths under somewhat impressive circumstances: F. W., forty-five years of age, a master mechanic, muscular, vigorous, active, working at his trade up to the day of his death, and having no disease recognized by his family or friends, went to church and Sunday-school on the day of his death. After a hearty dinner he sat down in an easy chair and read a book. Pretty soon he was found dead in his chair, in a perfectly easy attitude. his book on his knees. The autopsy revealed marked hypertrophy of the heart with atheromatous and chalky degeneration of the aortic valves, causing distinct obstruction; also, incompetence of the mitral valve and narrowing of the iliacs and other main arteries by atheroma. The stomach was distended by the gases of digestion resulting from his generous dinner. It was a pleasant way of leaving the world, without any distressing incidental symptoms.

Brouardel[1] says: "When there is aortic incompetence the left ventricle becomes hypertrophied." For a time the cardiac muscle struggles successfully with the obstacle which impedes its functions, but soon, as in all muscular hypertrophies, the muscular fibers undergo fatty or fibroid degeneration; they are larger than normal, but weaker. The anemia of the heart, indeed, lessens the vigor of its fibers, but there is likewise degeneration of those fibers. The blood is thrown forward intermittently, and into more or less relaxed and empty arteries. Some parts of the body fail to get their allowance of blood from this cause, and certain organs, the brain especially, suffer from the failure. Sudden death in aortic incompetence is, therefore, a product of three factors: Anemia of the heart; degeneration of the heart's tissues; and anemia of the brain. The deaths due to this cause, however, can hardly be called unheralded.

Sometimes during the operation of paracentesis pericardii, to relieve the pressure set up by an effusion, a fatal syncope from sudden stoppage of the heart may occur. This suggests the great desirability of having a number of good medical counsel present at an operation of this sort. Brouardel ascribes to the adhesions formed in the pericardium as the result of an acute inflammation a distinct importance to the etiology of sudden death.

Turning, now, to affections of the arterial blood-vessels

[1] *Loc. cit.*, p. 132.

which eventuate in sudden death, it is obvious that the lesion of chief importance in this connection is **aortic aneurism**. This consists in a local dilatation of the aorta, caused by a weakening of the arterial coats and the formation of a tumor resulting from a sudden strain. Naturally and habitually, the physiological burden of the aorta is a strain with every cardiac pulsation. This tends toward degeneration of the arterial tunics. Then, given a weakened spot in the arterial walls, any added strain may be the starting-point of the aneurismal formation. In the majority of cases it occurs after middle life, when degenerative changes are most common. It occurs, too, more frequently in men than in women, in the ratio of from 7 or 8 to 1. Occupation has a decided influence in its etiology, those vocations in which much physical effort is used being especially liable. The one characteristic in every case of aneurism is the adventitious development of a sac outside the arterial wall into which the blood-current enters through the orifice originally opened in the vessel's coats. With the various forms of aneurism, the so-called true, false, dissecting, and returning types, we are not now concerned. So far as our present study is related, all forms of aortic aneurism are alike. The same may be said of the various situations of the disease.

Of greater interest is the fact that a large number of aneurisms make no sign of their existence, and, clinically, never declare themselves by symptoms sufficiently severe or explicit to give warning of their presence, or to demand treatment. The person who is the subject of these latent growths goes about his usual duties or pleasures, conscious, perhaps, of something wrong in his chest—pain, dyspnea, or dysphagia, but he does not seek medical advice. He continues his habitual course until one day an unusual effort or an extra strain brings on the sudden crisis which very quickly ends his life. This crisis consists in the rupture of the aneurismal sac and a speedy death by hemorrhage, which is the result to which all aneurisms tend, recognized or unrecognized. The seat of the rupture and the organs receiving the escaping blood will vary according to the location of the sac. Aneurisms of the ascending aorta burst most frequently into the pericardium, the right auricle, the right ventricle, and the right pulmonary artery, rarely externally. Aneurisms of the transverse portion break into the trachea, the left lung, the left bronchus or the left pleural cavity, or into the esophagus externally. Aneurisms of the descending aorta discharge into the pleural cavity, the esophagus, or the abdominal

cavity. Most frequent of all, the pericardium and pleural cavity receive the escaping blood. The bursting of an aneurism is almost invariably attended with immediate death. When the hemorrhage is into a closed cavity, the pleura or the pericardium, nothing appears externally to give a hint of the cause of death. The autopsy alone declares the nature of the case. The amount of blood lost will vary according to the cavity receiving it, whether the pleura or the pericardium, and the strength and the plethora of the person.

Deaths due to Brain Emergencies.—If we inquire of the central nervous system concerning the idiopathic conditions affecting it which bring on sudden death, we shall learn that, before all other causes, hemorrhage within the cranial cavity is the most important. Popularly and familiarly it is called apoplexy, or " stroke," or " shock." But this is a result or symptom only. But all intracranial hemorrhages are not attended with apoplexy ; nor are all such hemorrhages equally dangerous to life, either immediately or remotely. There is a wide variety in the *amount* of the blood extravasated. All degrees present themselves at the autopsy table, from multiple, punctate, and capillary hemorrhages in the substance of the brain, to great, excavating, lacerating masses of blood many ounces in amount.

The situation of the hemorrhage is, however, of more consequence to the question of sudden death. There is only one part of the brain, hemorrhage into which causes the symptoms that may be described as fulminating or lightning-like. That part is at the base of the brain, the medulla. This must be exceedingly rare, as a solitary focal lesion. More common is hemorrhage in the vicinity of the medulla, the cerebrum, the pons or the cerebellum, with immediate secondary effects growing out of compression of the medulla.

Hemorrhages into the brain in regions above the pons result rather in speedy death (if presently fatal) than in sudden death. There is a period of unconsciousness, with stertorous breathing and the other well-known symptoms, in the interval between the onset, of the attack and the end. This interval varies from a few minutes to as many days. This applies to hemorrhages into the ganglia at the base, rupturing into the lateral ventricles. This is the state of things observed quite frequently in the cases of persons, men and women beyond adult life, found dead in bed. They have retired at night in usual health, and they are found dead in a natural, easy posture in the morning. The autopsy reveals a great excavation

of brain substance, the ventricles (one or both) being flooded with blood.

Meningeal hemorrhage does not usually give rise to sudden death. In fourteen cases of peripheral surface hemorrhage, Dana found the limits within which death occurred to be from one to eight days. If, however, the hemorrhage is due to rupture of a large artery at the base, especially the basilar, for example, the resulting pressure on the medulla will, of course, cause very sudden death, sometimes within two or three minutes.

Concerning other cerebral lesions, only a word is needed. **Embolism of a main artery** supplying blood to the brain may quickly compromise the cerebral functions and cause sudden death; but the fatal issue is not so sudden as in some forms of hemorrhage. The interval between the attack and the result is measured by hours. Not so, however, if the **basilar artery** is suddenly obstructed by a clot. Here, because of the situation and need of the vessel, symptoms are sudden in their onset, and death is immediate.

Thrombosis is a slower process, and may present premonitory symptoms. Death in such a case is speedy rather than sudden.

In **meningitis,** even the fulminating varieties, sudden death is rarely the result. There is opportunity to observe symptoms. The shortest recorded instance is five hours, in a case of cerebrospinal meningitis. Such a sudden and rapid development of cerebral symptoms is enough, however, to bring it within medicolegal interest.

Lesions of the **spinal cord,** inflammatory or hemorrhagic, if below the medulla, never give rise to sudden death in the sense we are considering. There is always an interval for clinical observation. Death may be speedy in some cases, but not sudden.

In a certain class of "neuroses" the termination may come suddenly and unexpectedly. This is true of **epilepsy,** for example. The epileptic seizure may come when its subject is alone. He may fall in such a way as to bring about asphyxia and quickly fatal consequences. In such cases the autopsy may disclose punctate ecchymoses of the conjunctivæ, a bitten tongue, froth in the mouth, trachea, and bronchi, and minute spots (like flea-bites) in the skin of the neck and shoulders, but nothing noteworthy in the brain or spinal cord. Convulsions symptomatic of other conditions than the epileptic belong in the same class of observation. For example, gross cerebral lesions, tumors, or multiple sclerosis. Raynaud reports a case

of death from spasm of the larynx and pharynx, in what he believed to be an hysterical convulsion.

The **respiratory organs** are not very productive of lesions causing sudden death. Of all conditions affecting the lungs, **pulmonary embolism** is the one in which the termination in death is the most speedy. And *this* depends on antecedent conditions in other parts which are usually the subject of medical observation and care, acute rather than chronic disorders. The clot of blood which obstructs the pulmonary artery must have come from elsewhere in the circulatory system : An inflamed vein, a womb undergoing involution, or a cardiac thrombus. When the crisis does come, it is one of the most startling and tragic possible. The sudden closure of the blood channel to the lungs appears to break down the whole vital mechanism with extraordinary celerity, and lungs, heart, and brain engage in the struggle for life.

Hemoptysis is to be included in the list of causes of death which we are studying. It is due to the erosion and rupture of a weakened artery in a phthisical cavity of the lung. The writer refers now to the cases in which the escape of blood is so abundant as to cause death very quickly by suffocation from hemorrhage ; not to the cases of blood-spitting, which is an early symptom of phthisis and never causes fatal consequences. The picture presented when a person is found dead under such circumstances is not soon effaced. The face, clothing, and surroundings of the patient are plentifully spattered with blood, and the whole incident is one of ghastly goriness. The antecedent history is convincing, and the diagnosis generally easy.

Another accident peculiar to phthisis and sometimes causing instant or very speedy death is **pneumothorax**. This is caused by a minute rupture in the periphery of the lung and the escape of air into the pleural cavity. The previous history is one of progressive phthisis.

Pneumonia explains a certain number of sudden catastrophes. They are usually ambulant cases, in which there has been no opportunity for clinical observation or medical treatment. Brouardel[1] observes : " An attack of pulmonary congestion is quite enough, even in a young man, to bring about sudden death." He also relates cases of sudden death in which the autopsy demonstrated the presence of general pulmonary tuberculosis ; cases of cancer of the lung, and still others of emphysema. He says, furthermore, that " of all pulmonary affections, pleurisy causes the greatest number of sudden and unforeseen deaths,[2] due to effusion, serous or

[1] *Loc. cit.*, p. 135.   [2] *Loc. cit.*, p. 189.

purulent, or to the congestion of the sound lung in conse-
quence of the disability of its fellow."

Of the organs engaged in digestion, only one is of interest to
us with relation to the subject of sudden death. That is the
pancreas. Modest, reserved, and out of sight, it occasionally
asserts itself in a sort of protest for clinical and anatomical
neglect. This assertion takes the form of hemorrhage within
and around the organ. And when this occurs, the owner of
the organ is in the greatest peril and usually succumbs quickly.
Pancreatic apoplexy gives rise to few symptoms, and these are
obscure and difficult of interpretation. Pain at the epigastrium,
nausea and vomiting, mental depression and apprehension,
restlessness, coldness of the surface, a weak and rapid pulse,
tenderness in the abdomen, and steady failure are observed,
and they represent the general symptoms of shock or collapse.
All these, coming on in a person previously perfectly well, are
sufficiently demoralizing, and when death closes the case, as it
usually does within an hour, the bystanders say the man was
"poisoned." In most instances of this class, however, there
are no bystanders. The person is found dead and the diag-
nosis is made upon the anatomical appearances only. What
are these appearances? The reddened color, increased size,
its aspect on section, and extensive effusion of blood in the
subperitoneal tissue are characteristic anatomical appearances.
Fat-necrosis may be present also. It is caused, according to
Zenker, by pressure of the swollen, hemorrhagic gland on the
semilunar ganglion.

Cases are also reported of sudden death in which the
stomach was the only organ at fault. It showed ulcerations
at the autopsy—and this without any suspicion of the action
of poisons. These have been known to kill, although the
lesion did not perforate the gastric wall. Brouardel uses these
words as to such cases: "Simple ulcer of the stomach is a
very common cause of sudden death."

The **pelvic viscera,** like the abdominal, are a barren field in
which to glean the causes of sudden death. The only condi-
tion which deserves medicolegal attention in this connection
is ectopic (tubal) pregnancy. Here the disaster presents itself
as a totally unlooked-for collapse, the result of hemorrhage
from the ruptured fetal sac in the Fallopian tube. Some
remarkable instances of the saving of life by very prompt sur-
gical interference by laparotomy are on record. But usually
the catastrophe is too-short lived to admit of such relief, and
the patient sinks rapidly under the effects of uncontrolled

hemorrhage into the peritoneal cavity. The following case is related by Brouardel:[1]

"A celebrated actress came to Paris with her maid and two American travelling companions who did not know a word of French. They went for a walk in the Bois de Boulonge. During the walk the actress felt unwell. She was taken to the Pré Catalan, where she drank a glass of milk. As she became worse, she was obliged to stop at another pavilion, where she died.

"An Englishman of high social position had time to reach Paris before the autopsy. He found me at the morgue, and the first words that he said to me were: 'It is not possible for this woman to be pregnant; I have very good reason to be certain.'

"The actress had a three months' tubal pregnancy, and the fetal cyst had ruptured into the peritoneal cavity, and the young woman had died of intraperitoneal hemorrhage."

In this review of the causes of sudden death, it can not have escaped attention that changes and conditions in the **vascular system** are responsible for nearly every catastrophe with immediately fatal termination. In whatever organ we trace the mortal process, we find either leakage or stoppage of the blood-vessels, as the lethal lesion, in most cases. Even the heart comes within this rule. Its coronary arteries must have integrity, or direful results ensue.

[1] *Death and Sudden Death*, p. 228.

CHAPTER XV.

DEATH BY DROWNING.

A DEATH by drowning is a death by asphyxia. A person is drowned, therefore, when access of the air is cut off from his air-passages by water or other fluids in which his lips and nose are submerged a sufficient time for fatal asphyxia to occur. A person found dead in the water suggests the presumption that death was by the water. But this presumption must be established by full and accurate investigation, and must not be too hastily adopted. For the death may have come from causes wholly distinct from asphyxia, and so be something quite different from death by drowning. For example, the person may have perished by a hemorrhage within the skull, the result of fright, excitement, and struggling. That is not drowning. Or, by a fracture of the skull and injury to the brain in the act of falling into the water. *That* is not drowning. Or, he may die *in* the water, not by submersion, but by sudden overwhelming shock, suspending respiration and the heart's action by inhibition.

Such was the case of Captain Webb, who tried to swim through the Niagara whirlpool rapids. He was taken out dead, and the physicians found the body in an active state of decomposition, but no bones were broken, and none of the injuries, except the wound, three inches and a half long, in the cranium, was sufficient to cause death. The cranial wound, they decided, was produced after death. All the blood presented a distinctly red color, showing that it was not deoxidized by asphyxia in drowning, but that death ensued prior to that condition. None of the characteristic signs of death by drowning was present, and there was no local injury sufficient to cause death. It was, therefore, concluded that death resulted from the action produced by the waves of the whirlpool rapids buffeting him so violently as to cause a degree of shock sufficient to destroy life. The shock was of sufficient intensity to paralyze the nerve-centers, partially desiccate the muscular tissues, and forestall death by drowning. The conclusion was therefore reached that no living body can, or ever

will, pass through the rapids alive. The river bed at the whirlpool rapids is much narrowed and suddenly assumes great precipitancy. The water strikes the unyielding banks with great violence and by reaction meets with such resistance as to form in the center a mountainous ridge of encroaching water from twenty to thirty feet in height. Into this Captain Webb was submerged after passing the first breaker, and instantly subjected to the immense pressure indicated upon his body. This caused his death.

The jury returned the following verdict: "We find that Captain Matthew Webb came to his death while attempting to swim the whirlpool rapids of the Niagara River. The immediate cause of his death the jury is unable to determine."

The distinction, then, between death in the water and death by the water is to be kept in mind, and is just as relevant to-day as when the gravediggers in the time of Hamlet discussed the matter while they dug Ophelia's grave. And it is well to remember that a typical and uncomplicated case of drowning is an example of death by asphyxia or apnea. If the reader bears this in mind, it will help him to clear away some difficulties.

One or two preliminary points should be stated at the outset. The medium in which drowning occurs need not necessarily be water. Mud, privy soil, cesspool liquid, are equally efficient. Some authors describe drowning under the head of suffocation, and insist that the submersion may be in dry as well as in wet media. In 1892 a Norwegian physician described a fatal case of "submersion" in flour. Again, for complete, fatal asphyxia by submersion to occur, it is not requisite that the entire body should be submerged. If the face, or, indeed, only the nostrils and lips are covered,—the gateway to the organs of respiration,—it will be quite enough. In October, 1892, a man was found drowned in three inches of water in an open cellar, having fallen in while drunk, face downward, and being too intoxicated to help himself.

Upon the finding of a dead body in the water, three important medicolegal inquiries at once occur for solution: 1. Was this death by drowning; or, in other words, did the deceased enter the water alive? 2. Was the death by accident, by suicide, or by the act of another person? 3. How long an interval has elapsed since the death?

The Phenomena which Belong to Death by Drowning.—Before proceeding to a description of the anatomical appearances which characterize a death by drowning and enable us to make a post-mortem diagnosis of this variety of

asphyxia, let us see what happens when a person meets his death in this manner. In a drowning emergency, when any-one falls into the water, he sinks to a depth greater or less according to the height of the fall, and according to his own buoyancy. He rises to the surface under the influence of this buoyancy. He is helped more or less by air in his clothing and by his own exertions. Then one of two things happens: 1. If he is a swimmer, he strikes out toward a point of rescue; he swims until his exhaustion causes him to succumb and sink again. 2. If he can not swim, his unavailing efforts to save himself waste his strength more quickly and bring him to the death struggles common to every victim of drowning, whether swimmer or not.

These struggles consist of irregular movements of the arms and legs, and grasping at everything within reach, whether floating on the surface of the water, fixed at the bottom, or growing on the banks. Meantime, in consequence of these irregular motions, he rises and sinks again and again. Three times is the popular rule, but this is not uniform. At the moment the head comes to the surface, air and water are in-haled together. The water may be partly swallowed, to be found later in the stomach, or it is partly ejected by violent fits of coughing, caused by contact of the water with the larynx. These efforts cause the expulsion of the inspired air, and the desire to breathe makes itself imperatively felt. If the drown-ing person has been able to reach the surface of the water again, his first act is to try to satisfy this desire, but in doing so, he can hardly avoid taking in more water, a portion of which is drawn into the air-passages, and indeed into the air-cells themselves. This struggle for life may continue a long time or may end speedily, according to the age, sex, and strength of the person. But the result is the same—the blood in the lungs is imperfectly aërated and renewed. The drown-ing person becomes exhausted and insensibility follows. The mouth then sinks wholly below the level of the water, and air can no longer enter the lungs; a portion of that which they contain is expelled and rises in bubbles to the surface. An indescribable but not painful feeling of delirium ensues, with a ringing in the ears. All consciousness is now lost and the person sinks asphyxiated. A few convulsive movements of the limbs may occur as the effect of the circulation of unoxy-genated blood in the brain. Vomiting is sometimes an inci-dent. Finally, all movements cease, a few bubbles of air com-ing to the surface to tell of the last act of the walls of the chest and of the diaphragm.

The buoyancy of the living body in water has some evident interest in connection with the more or less rapid sinking of a person drowning. Is there a difference in different individuals in their power to float, without regard now to their voluntary efforts, but simply having in view the specific gravity of the body?

The specific gravity of the human body in the healthy living state is made up of the combined specific gravities of its different parts. In the first place, about 75 per cent. (more or less) of the body is made up of water; hence the question of specific gravity can refer to the remaining quarter only, the dry solids. The only solid part of the body that is lighter than water is the fat, which is 92 per cent. Fat is 5 per cent. of the weight of the adult; muscle is 1.085 per cent.; brain, 1.04 per cent.; soft organs, 1.05 per cent.; lungs (with air), 94 per cent.; bone (the heaviest part of the body), 2.01 per cent. The lightness of the fatty parts is more than counterbalanced by the weight of the skeleton, so that the naked human body placed on the water has a slight tendency to sink. This tendency diminishes just in proportion to the proportion of the body immersed; because all those parts of the body that are out of water, not being supported in the water, become so much dead weight to the portion submerged; hence a frequent cause of death. An inexperienced or frightened person exhausts himself by exertion, raises his arms continually out of the water, and as often as he does so he sinks, because their weight has just the same effect as if a quantity of lead had been suddenly fastened to his feet. When the whole of the living body is immersed, the specific gravity, owing to the expansion of the chest, differs so little from that of the water that a very slight motion of the hands or feet under water will suffice to keep the body from sinking.

From all this it appears that there are two circumstances that determine variations in the specific gravity of the body. If the amount of fat is proportionately large, the specific gravity will be diminished, and so a fat person will float more readily than a lean one. On the other hand, a large proportion of bone renders a person's specific gravity relatively greater, and he will therefore sink more readily. Therefore, women will float more readily than men, and infants and children, whose skeletons are lighter and whose fat is abundant, will be more buoyant in water than either men or women.

Certain modifying conditions exist in different persons. In regard to respiration, for instance. With the lungs full of air floating is easy. Rising and sinking with respirations is

another obvious result. Different conformation of the chest in different persons is another modifying condition. A scream empties the chest, and the person more readily sinks. Clothing helps to keep the body afloat, or, on the other hand, to sink it, according to the character of the clothes. Women are sometimes saved from drowning by their clothing retarding their sinking.

However the behavior of a person in drowning may be affected by his specific gravity with reference to the medium in which he is submerged, there is a close approach to uniformity in the way dead bodies behave in the matter of rising and sinking. The generation of a small amount of gas as a product of decomposition will overcome quite speedily the natural tendency of the dead body to sink. If not held down by any restraining force (stakes, grass, weights, or weeds), the body will rise to the surface, discharge its accumulated gas, sink, rise again, and so on until the soft parts no longer supply gas enough to float the body. This process is modified by all conditions modifying putrefaction and buoyancy in the body, such as season, depth of water, dress, mechanical impediments, subjective conditions of the body, kind of water, currents in the water, etc.

It must be apparent from this that there can hardly be formulated a constant rule as to the time at which a body will float. In a general way, we may say that during the warmer season, from April to October, a drowned body will float in from four to eight days, other things being equal. In a colder season the time is indefinite. It may be well to bear in mind that a *dead body* thrown into the water may not sink at all, owing to the gas of decomposition already developed; especially would this happen in warm weather with a stout person.

It is a popular notion that death by drowning is not an unpleasant form of death, considered subjectively. If we may trust the reports of those who have been resuscitated after apparent death by submersion, this notion is true. Take, for example, the following graphic account given by Admiral Beaufort. He fell overboard in Portsmouth Harbor, and had sunk before relief reached him. Two minutes did not elapse before he was rescued, but in that short interval a good deal happened of psychological interest:

" From the moment that all exertion had ceased, a calm feeling of the most perfect tranquillity superseded the previous tumultuous sensations. . . . . I no longer thought of being rescued, nor was I in any bodily pain. On the contrary,

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my sensations were now pleasurable, partaking of that dull but contented feeling which precedes sleep. Though the senses were thus deadened, not so the mind; its activity seemed to be invigorated in a ratio which defies all description, for thought rose after thought with an indescribable rapidity. These thoughts took successive courses: My fall overboard, the awkwardness which had caused it; the bustle it must have occasioned; the effect it would have on a most affectionate father, and a thousand other circumstances minutely associated with home; these were the first series. They then took a wider range: Our last cruise, a former voyage and shipwreck; my school, the progress I had made there, and the time I had misspent; my boyish pursuits and adventures. Thus travelling backward, every past incident of my life seemed to glance across my recollection in retrograde succession. Not, however, as here stated, but the picture filled up with every minute collateral feature. . . . Indeed, many trifling events which had long been forgotten then crowded in with the character of recent familiarity."[1]

It is proper to state that the hypermnesia illustrated in Admiral Beaufort's story is not uniformly experienced by drowning persons. Other witnesses have testified after their resuscitation and, although the majority concur in experiencing this remarkable mental activity in a not unpleasant form, so that their whole previous conscious existence took on a panoramic vividness in the one hundred and twenty seconds of submersion, a few state that they had none of this, and that they had *no* recollection of what had passed through their minds while drowning. But the experiences incidental to resuscitation are almost always unpleasant, however great the variety of mental activities previously.

The Symptoms of Death by Drowning.—Hofmann states that death by drowning is divisible into three stages: 1. The stage of suspended respiration. 2. The stage of dyspnea. 3. The stage of asphyxia.

The **suspension** of **respiration** which marks the first period generally occurs instinctively. Falk has found that the sudden effect of cold water on the skin may cause an arrest of respiration through reflex action. If exhaustion from any cause precedes the submersion, the suspension of the respiration may be final and fatal right here.

In the second stage, **dyspnea** occurs, in which deep but short inspirations are followed by quick expirations at first; then, a little later, by tetanic expiratory efforts, as in other

[1] *British Medical Journal*, October 13, 1894.

forms of asphyxia. At the beginning of this second stage, consciousness and reflex movements are preserved. The rapid expirations which follow the first inspirations are evidently due to the irritation of the water touching the vocal cords. Convulsions, if they occur, come in this stage.

In the third stage, that of **true asphyxia,** there is loss of consciousness and suppression of reflex action. The inspirations are deep and at long intervals; the mouth is opened widely; the body is bent forward.

Such is the sequence of events in drowning. The next inquiry is, How long a time is required for its completion? How long will a man be in drowning? The question is sometimes asked in court. With the mouth and nose so submerged and covered under water that air cannot enter, full asphyxia supervenes in a little less than two minutes. The time does not vary greatly with different persons. Perfect insensibility has been reported in consequence of one minute's complete submersion.

On the other hand, habit and practice in remaining under water may enable one to prolong his submersion beyond the usual limits. Divers for sponges stay under the water two minutes at the longest, the average being seventy-six seconds. Among professional performers, James Finney in London, in 1886, remained under water four minutes and twenty-nine seconds and a quarter and was none the worse. One of his feats was to pick up seventy or eighty coins from the floor of the tank with his mouth, and come up when he had all. " Professor Enochs " stayed under water four minutes and forty-six seconds and a fifth, and this is the longest time on record. But these exhibitions are very different, in their conditions, from the experience of persons in the act of drowning, with fear, fatigue, danger, and excitement facing them as their foes, in addition to the water. Under these conditions we may conclude, from all the data, that fatal asphyxia is probable at the end of *two* full minutes' submersion of the head.

Measures for resuscitation are not to be withheld, however, because of evidence that, in any given case, the submersion has extended over an interval of two minutes or even more. Perhaps the evidence is at fault. Moreover, there are exceptions to most rules; and although a person has been under water long enough to drown by the two-minute rule, it may still be true that he is an exception and demands your zealous care accordingly. Devergie tells us that some persons within his knowledge, who had been rescued after one minute's submersion were not saved from death; while, in other cases, in

which the submersion probably extended to five minutes the subjects were resuscitated. Dr. Woolley, Medical Officer of the Royal Humane Society, a man of long experience, reported only two instances of restoration after five minutes' full submersion.

In July, 1902, the life-saving service in Washington, D. C., received the following report on what is probably the best authenticated case of resuscitation in the history of the bureau:

" Stanley S. Holmes, five and a half years old, was thrown into the salt water from an overcrowded rowboat at Anglesea, N. J., during a squall, and remained under water for fully twenty-five minutes. On the recovery of his body there was no perceptible breathing, but his jaws were clinched, and had to be opened by force. Artificial respiration was maintained for an hour and a half, and it was forty-five minutes before he showed any sign of life."

Resuscitation.—This is a good point at which to consider very briefly the proper management of the apparently drowned with a view to their resuscitation. The indications for treatment are: 1. To restore animal heat. 2. To stimulate the action of the heart. 3. To carry on artificial respiration until the natural action is resumed. 4. To rouse the nervous centers. 5. To combat tendency to death by secondary consequences of the submersion.

Begin treatment at once, on the spot, in the open air. Avoid all rough treatment and popular methods of emptying the body. In order to empty the mouth, turn the body for a few seconds face downward with the head a little lower than the body, by holding up the shoulders. In this process depress the chin and draw the tongue forward. This done, turn the body on the back again with the head and shoulders slightly raised. Use an inclined plane on a board or door or shutter.

Meanwhile, have the clothing taken off and the body rubbed dry. Keep the froth wiped away from the mouth and nostrils. Begin artificial respiration at the earliest possible moment. Use Sylvester's method. Be careful not to make the motions too fast—sixteen times a minute, or once in four seconds, are enough. Use a watch rather than overdo the pace. In 1892, Laborde's method of jerking the tongue was devised and has authoritative advocates.

In the meanwhile send for hot bottles, hot flannels, hot bricks—*anything* to apply heat—to be placed to the chest, legs, and feet. Cover the body with blankets, leaving the arms and face out. If help is plenty and skilful, use galvanism to the phrenic nerve, applying the poles at the epigastrium and

the nape of the neck. But be cautious about too long application. Look out for the first gasps of returning respiration; then inject brandy or ether under the skin. As soon as the patient can swallow, give hot coffee and brandy, or aromatic spirits of ammonia. Rectal injections may also be used.

Keep up artificial respiration until natural breathing is restored, and the lips are of good color. Rely more on artificial respiration than on other methods of treatment, which are supplemental. Continue it an hour in cases of doubt, unless the patient breathes sooner. Watch the case carefully after apparent recovery, for relapses are common enough. Avert danger of secondary effects (congestion, pneumonia, exhaustion) by careful stimulation, application of heat, inhalation of oxygen, and plenty of fresh air.

Anatomical Appearances after Drowning.—From this study of the phenomena of drowning and the proper measures to adopt to resuscitate the apparently dead, we can properly consider the appearances, external and internal, which enable a medical man to make a diagnosis of death by drowning upon his inspection of a dead body recently taken from the water.

Ogston says that in order to obtain the usual signs in a characteristic form, it is essential (1) that the body has been wholly submerged in the water; (2) that the person submerged has not at once sunk to the bottom without coming to the surface at least once; (3) that the body has been recovered and examined without loss of time after the death.

Now it is plain that, practically, a concurrence of these conditions will rarely be found. Many deaths by drowning occur in shallow water in which entire submersion of the body is impossible, the mouth and nostrils, the gateway to the lungs, alone being covered. Then, it is not unusual that, from various causes, the person drowning in deep water *sinks* at once not to rise again while living; and thus the opportunity for the full development of what we shall see to be an important significant sign of death by drowning will fail. Moreover, of the total number of deaths from this cause, only a small proportion of the bodies are recovered and examined so promptly that the signs alluded to, some of them very evanescent, are discovered; while the longer the delay, the more· uncertain will it be whether the appearances are due to asphyxia or decomposition.

Attention is called to these peculiarities in the examination of the bodies of the drowned, not to magnify the difficulties of such examinations, but to indicate the importance of a

familiarity with all the signs of this mode of death, not only in their individual relation, but in their collective significance; with their relative values; the fallacies to which they are subject; and the way in which the advent of decomposition may obliterate, mask, or resemble the signs of death by drowning. But it is worth while to remember that although, as we shall see presently, there is no single, infallible, constant sign which belongs exclusively to death by drowning, yet we have the evidence of so experienced an observer as Devergie, confirmed by Casper, that he could with a clear conscience declare in nine-tenths of all the cases observed by him whether the body went into the water living or dead. Difficult and complicated cases undoubtedly occur frequently enough; but by considering the signs and appearances in their entirety, carefully determining whether the negative significance of some of these exceeds in value the positive worth of all the rest, or the reverse, one can generally reach definite conclusions.

External Appearances.—The color of the skin is pale, both of the face and of the body generally. Lividity is absent or *slight*. But this pallor does not persist; it belongs to the bodies of those recently drowned. After an interval of several hours, more or less according to the season, but before decomposition is announced, the face, without any swelling, takes on a uniform red color, more or less bright in tint, resembling brick red. Ogston explains it as oxidation, due to the exposure of the face to the oxygen of the air. This remarkable change in the color of the face, the rest of the surface remaining unchanged (pale), is quite diagnostic. The skin is not swollen as in beginning decomposition; and the redness is to be distinguished from the lividity of the upper parts of the body, caused by congestion about the head and supervening somewhat earlier than the peculiar change above described, from sixteen to twenty-four hours after death. To this condition of the skin of the face and neck—this uniform redness— there presently succeeds a distention of the tissues of those parts, the rest of the body still remaining the same. Long before decomposition attacks other parts of the body, especially if they are covered with clothing, the face has become hideously swollen, the tongue protrudes, the lips are puffed out, the eyelids are distended, and identification by means of the features is next to impossible.

Cutis anserina is another condition of the skin which drowning causes. It is to be found at all seasons. It is seen or felt best on the anterior surface of the extremities. It is due to contraction of the *arrectores pilorum*, and is a true post-mortem

rigidity of those muscles. It is generally attributed to the sudden contact of the warm body with the colder water. Casper regards it as due, rather, to nervous or mental shock, wholly independent of the temperature of the water. He says it is seen in other forms of violent death and that it is not peculiar to drowning. Taken alone, of course, *cutis anserina* is not to be considered as demonstrative. It is one of the signs which the dead body of the drowned presents, and it is to be included in the list of observed data. Wagner says: " If the body of a person recently dead from natural causes, with the skin still warm, was placed in cold water, *cutis anserina* would probably form." The general testimony, however, of authorities is that this manifestation means an act of the living muscle, and that therefore it has a significance among the post-mortem signs of drowning.

Another condition of the skin observed in the bodies of the drowned is the blanched, wrinkled, and sodden state assumed by the palms of the hands and the soles of the feet. Later the same change is seen on the knees and elbows. It is not found about the recently drowned whose bodies are rescued early. It requires from twelve to twenty-four hours for its manifestation. It is caused by the physical effect of the water on the thickened skin, so that it is a purely cadaveric phenomenon and does not belong in the specific data of death by drowning. A dead body lying in the water, whatever the cause of death may have been, would show this result of imbibition in the parts covered with thick skin. It is analogous to the condition of such parts in the *living* subject after an interval of soaking. Illustrations are found in washerwomen's hands and in the action of poultices.

Cadaveric rigidity develops early in the bodies of the drowned and is pronounced in degree. The attitude of drowned bodies in the water in consequence of the early advent of rigidity is something striking. Occasionally a convulsion as the latest act of life is suggested. Observed from the surface of a clear body of water, a drowned person is sometimes seen in the attitude of swimming or leaping, with knees and elbows slightly flexed, and the hands thrown forward.

It has not been the writer's fortune to observe that sign of drowning, described by authors—the presence of substances grasped in the hand. When this evidence exists, it is doubtless a very valuable aid to diagnosis, if the matters found in the hands are identified with the water (weeds, grass, or mud), and if the grasp of the hands upon these substances is the grip of cadaveric spasm indicating a vital act. The same rule holds here

as in other cases of instantaneous rigidity, namely, that the closure of the hand upon its contents shall be more than a mere flexion of the fingers. It must be a true death-grip to give it value as a post-mortem sign.

The eyes show injection of the conjunctival vessels; the pupils are dilated; and there are phlyctenulæ on the conjunctivæ.

Finally, of the external appearances, there is one which, when present, is conceded to be of more value than all the rest; this is froth at the mouth and nostrils. It appears *early* after recovery of the body, and is found in fresh bodies only. It is evanescent, passing off in four days, in winter, and in sixty hours in summer. Pressure on the thorax may bring out a new discharge of it, if the primary froth has vanished. Its characteristic appearance is that of fine lather; its color is generally white, and sometimes pink from the admixture of a small amount of blood. It is in contrast with the coarse bubbles of decomposition. It is found after every form of drowning. The author has seen it fully developed after submersion in privy soil. It is, in effect, an overflow from the air-passages, and the manner of its development will be described later.

Internal Appearances.—Passing now from the external appearances, we ask, What are the appearances which we expect to find upon an internal examination of the body of a person drowned? Upon raising the sternum, the increased volume of the lungs arrests attention. They are fully expanded—filling the thorax. This result is thanatognomonic, according to Casper. The lungs appear to be artificially inflated. The cause of this is two-fold: In part, it is an actual hyperemia from violent inspiratory efforts when coming to the surface. In part, it is due to the inhalation of water as well as air, making the lungs water-logged. This latter gives an edematous appearance and feeling. The lungs are spongy and doughy, and they pit on pressure.

Their color is generally red or purple with a gray tint, quite uniformly manifest. Sometimes they are normal anteriorly, and purple posteriorly. Sometimes peripheral emphysema is present; ruptured lobules are found, or overdistended vesicles without rupture, giving an irregular, uneven aspect to the lung surface. Subpleural ecchymoses are common; their situation is chiefly under the pleura, between the lobes and at the base; in size they vary from mere points to dots as large as a pin's head; their number varies from few to many; their cause is rupture of the capillaries.

Section of the lungs displays a surface red in color from the hyperemia, and exuding a fluid at once watery and bloody. This artificial edema is regarded as of great value among the signs of drowning. It indicates that the fluid in which the drowning occurred has been drawn into the smallest bronchioles and, indeed, into the air-cells. Some doubt has been expressed by medicolegal writers as to whether such deep penetration were possible. That it is possible has been shown experimentally. Animals have been drowned in water holding chalk in suspension. Then to the cut surface of the lung an acid solution was applied, with the effervescent reaction. To this the objection is raised that if dead bodies are placed in water and allowed to remain there, the water will find its way to the air-cells. Orfila proved this with colored water. It follows, then, that the value of the appearance is increased if the interval between the death and the autopsy is a short one.

Whatever differences of opinion there may be about the presence of water in the air-cells as an indication of death by submersion, the appearance, condition, and contents of the air-passages—the larynx, trachea, and bronchi—afford most interesting and significant evidence.

Hyperemia of the mucous membrane of these parts is to be expected. The contents of the trachea and bronchi are equally noteworthy; and of most interest is froth. Its character is, as before stated, like lather; it is different and coarser in suffocation; its amount varies; its evanescence is a marked feature. Ogston says that it disappears in fifty-five hours and a half in summer and on the fourth day in winter. But it appears sooner in winter than in summer. In situation it is most abundant in the smaller bronchi, but it may be found, too, in the larger bronchi and in the trachea.

The mechanism of its formation and the conditions of its development have given rise to some difference of opinion among authors. Some (Devergie, Orfila, and Ogston) insist that the drowning person must rise to the surface once at least, in order to show this phenomenon in its characteristic form. On the contrary, Casper, with his usual disposition to incredulity, states that he has observed it on persons known to have sunk without rising again. A committee of the English Medico-Chirurgical Society made experiments on animals, and concluded that "the presence of froth in the air-passages does not depend on the fact that a person rises to the surface after submersion, although this may increase the quantity."

It is clear, however, that the presence of froth in the air-passages is an indication of vital action. It is impossible to

manufacture it by any manipulation of the dead body. It means violent, spasmodic efforts to breathe under circumstances permitting some water to enter the lungs, to mingle with the air there. It implies an agitation or churning of air and water within the respiratory organs. Experiments prove that only a brief submersion of the head is needed to produce it; animals held under water for only *two minutes* show it post mortem. That it is a valuable proof of drowning, because it is a demonstration of violent efforts to breathe during the act of drowning, is the belief of medicolegal authorities. The following emphatic statement, quoted from Bergeron and Mentano,[1] represents the generally accepted doctrine : " The presence of a frothy foam in the pharynx, larynx, and bronchi is a constant sign of death by submersion . . . . whether the individual was free in his movements, or was thrown into the water narcotized, or partially suffocated, or after being fettered in his action." This absolute constancy of the presence of foam, whatever the special conditions in which the submersion occurred, is, according to these authors, the single, sure, uniform sign proving death by drowning.

Other foreign bodies are found in the air-passages besides the froth. Some water is to be expected, and with this, sometimes, are matters held in suspension in the water of drowning, such as sand, mud, decayed leaves, seaweed, and the like. These serve to identify the water, and so are very corroborative. The microscope is useful in this relation. When the medium is other than water, as when children are drowned in privy vaults, or as Metzger reports, in slaughter-house drains,[2] or the fetus in process of birth is drowned in liquor amnii and meconium,[3] or a person perishes in chamomile tea vomitus,[4] the microscope is indispensable as an aid in demonstrating the material in which the submersion occurred. It should be remembered that these media are not so deeply penetrating as water, being more viscid and thicker.

Water in the pleural cavities is sometimes present as one of the internal signs of drowning. Occasionally, the amount is considerable. More often, if it is present at all, it is present in only small quantity. It is usually clear, watery fluid, and is derived from the lungs by transudation. Ogston goes so far as to explain by its presence the pressure of the lungs forward, against the costal cartilages and the sternum—a conclusion that the author's own observations do not justify.

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[1] *Annales d'hygiène*, Second Series, xlviii.
[2] Wharton and Stillé, *Medical Jurisprudence*, Section 950.
[3] Casper, *Vericht Medicine*, ii., p. 244.   [4] Casper, *loc. cit.*, p. 252.

The heart shows the appearances attributable to asphyxia. Its right cavities are distended with blood; its left auricle and ventricle are relatively empty, but not wholly. There is nothing noteworthy about the myocardium. The blood in the heart is usually fluid and of a dark color. This is the result of asphyxia. If clots are present, they are small, shreddy, and imperfectly formed. Brouardel counted the blood-globules after death by drowning, and he found that the number of these was diminished by from four to three. He called this an artificial hydremia, due to the imbibition of water into the blood, by way of the lungs and to some extent, possibly, of the stomach.

Appearances about the abdominal group of organs are less characteristic and valuable than are those of the thorax. They are such as are common to all forms of asphyxia. There is hyperemia of the peritoneum, the mesenteric vessels, and the solid viscera, the spleen, kidneys, and liver. Lacassagne states that he is able to distinguish a death by drowning by the hydremic engorgement of the liver; that it is uniform and characteristic, and affords sufficient proof.

The presence of water in the stomach is deemed by some authors a sign of drowning which is of considerable importance. Ogston found it present in about 37 per cent. (36.9 per cent.) of all his cases; while in 10 per cent. of the rest of his cases he found the fluid, though absent from the stomach, present in the abdominal cavity outside. The author's own experience has been less satisfactory in this regard. It has been exceptional in his observation to find water in the stomach; and when found it was in such small quantity, and was so intimately mingled with the other contents of the stomach, that he has not felt willing to regard it as of great significance and value. When we find in the stomach of a person taken dead from the water fluid or material like that in the liquid in which the body was submerged, dock mud, salt water, bits of sea-weed, or sewage, the presumption is that it reached the stomach through the act of swallowing, and in the course of submersion, and we may regard its presence as a valuable sign of drowning. In considering this matter we have to eliminate two possibilities: 1. The possibility that the fluid found in the stomach (assuming now the *absence* of the foreign organic matter) was swallowed to satisfy thrist, and so before the submersion. 2. The possibility that the fluid entered the stomach *after* the death, and not by the act of swallowing.

The second possibility was for a long time denied on anatomical grounds; but the latest writers teach differently.

Hofmann says that he has proved experimentally that the penetration of fluids into the stomach after death is possible. He states, however, that a little mucus on the walls of the esophagus is quite sufficient to make it very difficult for water to enter, and he admits that the quantity which enters is very small. Fagerlund concludes from his experiments that liquids can not penetrate to the stomach by their own force *post mortem*. But Obolousky placed the bodies of eighteen children in colored water, and found the colored fluid in five of the stomachs after an experimental post-mortem submersion of seventy-two hours.

The experiments show that it takes time for the post-mortem entry of fluid by way of the esophagus. So that we may at least adopt this rule: The longer the body has been in the water, the less valuable as a sign of death by drowning is the presence of water in the stomach. Another point worth remembering is this: The quantity of fluid found in the stomach after submersion will be greater in proportion to the number of times the person drowning came to the surface, thus promoting deglutition.

The blood-vessels of the scalp, meninges, and brain are generally injected. We must not forget, however, a possible explanation of this in another way. The condition of the deceased person when he entered the water may have favored just this hyperemia. Intoxication, excitement, prolonged struggling before submersion, individual plethoric habit, may all be invoked as possible explanations. Casper and Taylor regard cerebral congestion as the exception and not the rule in death by drowning. It certainly has a relatively insignificant value as a proof of this manner of death. It is not constant or uniform, and it may be interpreted variously.

The Manner of Death.—Following closely on the solution of the primary question, the diagnosis of a death by drowning based upon the post-mortem appearances, comes the question: What was the *manner* of the death? Was it by accident, suicide, or homicide? The mere inspection of the body and its surroundings affords only partial data for deciding this problem. We want a knowledge of the circumstances preceding and accompanying the death, and this knowledge lies outside the immediate scope of the medical expert's province. Yet he must be prepared to say whether the anatomical evidence corresponds with the moral or circumstantial evidence. The difficulty lies mainly in the fact that the body is often found after an interval of time so long that many of the anatomical signs are effaced. And the place at

which the body is found may be at a distance greater or less from the spot where the drowning occurred. It is obvious that the signs of death by drowning are the same whether the victim fell into the water by accident, jumped in with suicidal intent, or was thrown in by others. We must, therefore, depend largely on all available collateral evidence in addition to the post-mortem appearances significant of asphyxia under water.

For example: A body naked, in summer, with no signs of physical violence, but having the anatomical evidence of drowning, suggests an accident while bathing.

A body clothed, the hands tied clumsily in such a way as to suggest that it was the work of the deceased to prevent efforts to save himself; in the pockets of the clothing there are heavy objects, and a weight tied to one leg or about the neck; this means suicide.

A body clothed and the clothing torn, showing bruises and excoriations, especially on the neck, or on parts not readily accessible, indicates homicide.

But these tolerably clear and positive indications are not always present. The rules are subject to a great variety of exceptions. No two cases are precisely alike, and each instance must be studied on its own merits. Too often the medical inspector will have to content himself with the conclusion that the anatomical appearances are consistent with facts otherwise proved, but they do not demonstrate those facts. But it is wise above all things to avoid dogmatic emphasis in reaching conclusions, and to admit that many things are possible. It was formerly held that suicide in shallow water was impossible; that a suicide's courage would surely fail. But Devergie tells of a case wherein a man drowned himself by immersing his face in the water of a shallow stream not more than a foot in depth. In June, 1895, a widow was found dead in her room, in a city adjacent to Boston, with her face submerged in six inches of water in a washtub.

On the other hand, murders have been accomplished by drowning without immersing the whole body. Children have been killed by holding their heads in a pail of water. Many years ago an Italian boy was made drunk by a pair of English dissecting-room foragers, and in that state was held, head down, in a well, with his mouth just below the water, until he drowned. In January, 1895, a woman in Boston, acting under the insane delusion that her two children, aged four years and a half, and three years, respectively, would enter into eternal bliss if they were killed, held them in turn in a washtub of

water until they were drowned. The bodies showed all the signs of drowning.

Evidences of violence on the body must not be interpreted off-hand as meaning homicide only. Suicides have cut their throats, taken poison, and shot themselves before jumping into the water to drown themselves. A drunkard may get some blows about the head in a quarrel, and while later wandering home intoxicated may tumble into a gutter or shallow pool and drown there by accident; or, with suicidal purpose, he may jump into deeper water and there perish by drowning. Then, in regard to such appearances of violence as the body presents, care must be taken to eliminate those injuries which may have been received in the act of drowning, in falls from heights, or in attempts at self-preservation, from such as could reasonably be incidental to a struggle with an assailant. This discrimination is often difficult and sometimes impossible. So, too, injuries inflicted after death sometimes suggest or resemble wounds given in life.

Thus, a body driven against rocks in a stream, or the abutments of a bridge, or striking floating logs, or hit by paddle-wheels, or torn by hooks in recovery, may show injuries hinting at homicide erroneously. The loss of soft tissues may be the result of the erosive action of water, or the attacks of water rats, or fish, or crabs. These attacks are often very early, and they may create wrong conclusions.

Statistics afford a basis for a presumption, and this presumption based on recorded data is, that murder by drowning is exceedingly rare. The author finds in his own records, comprising the interval from July 1, 1877, to March 3, 1903, statistics of 467 deaths by drowning as follows: 4 by homicide; 96 by suicide; and 367 by accident. The 4 deaths by homicide were the following:

In 1878, a man under the intoxicating effects of liquor, was pushed off a pier into deep water and was drowned. In 1889, a young woman reduced to desperation because she was unable to find shelter and nourishment for her illegitimate baby, took the child to a bayside beach at low tide and left her there to be submerged by the next flood tide. In 1895, a demented woman, under the delusion that her two children would be better and happier in heaven, held their heads under water in a washtub until she was assured that life was extinct.

Determination of the Length of Time between Death and Recovery of the Body.—One of the first questions asked by bystanders when a body is recovered from

the water is, " Doctor, how long do you think this person has been dead?" It is an inquiry which is naturally attended with difficulty in its answer. The conditions under which dead bodies are found in the water are so numerous and varied that it is well-nigh impossible to formulate data by which anyone can determine this point in a given case. Individual physical conditions, season, temperature, the clothing of the body, the nature of the material in which the death occurred, the length of time during which the body was exposed—all these and other considerations enter in to modify the simplicity of the problem in all except very *recent* cases. It is a question of the advance of putrefaction of the human body under peculiar surroundings. The chronology of decomposition is never a simple matter. Here it is greatly exposed to variations because of the agent in which the disorganizing process occurs. The difficulty increases in proportion to the time that has elapsed since the death. It may be said to increase in a geometric ratio.

Nevertheless, authorities have attempted to describe with something like precision this chronology, and thus to supply a standard by which, in any case arising in practice, one might be enabled to say, " this person has been dead so long." Thus Devergie, out of his really immense experience with the subject and his very numerous observations on the bodies of those taken from the river Seine, has set forth with considerable minuteness what one may expect to find about the body of a dead person at various stated intervals after the drowning. These rules are regarded by Woodman and Tidy as the most reliable yet formulated.

Whether Frenchmen putrefy differently from Americans, or whether the waters of the Seine modify the process differently from those of the Charles or of Boston Harbor, the author does not know, but his own observations on the bodies of the drowned do not correspond in all respects with those tabulated by Devergie. To mention only a single point—the disappearance of the soft parts from the face and cranium. In the cases which the author has observed, this loss has occurred at a much earlier date than that stated by Devergie. He makes the interval three months and a half. In repeated cases the author has found the head and hands denuded of the soft parts in as many weeks, so that he is not ready to accept Devergie's estimate as a true one. As an illustration : Frederick A. was one of the crew of a schooner which was run down and sunk off Castle Island in Boston Harbor, on October 20, 1899. His body was recovered on November 3, or fourteen days later.

The scalp was all gone, leaving the skull entirely bare; much of the soft tissue of the hands was also gone.

In fact, none of the phenomena of the post-mortem conditions usually relied upon as guides to determine the period since death will be of much avail. Any one of these changes is so subject to exceptions in the case of the drowned as to lose much of its significance. Post-mortem rigidity; loss of animal heat; the loss of muscular contractility; and everything that antedates putrefaction, is attended in death by drowning by such special and various circumstances as to require careful correction on account of the disturbing physical influences under which the death occurred—influences of temperature, motion of the water, clothing, and age of the person.

Mr. Harvey Littlejohn[1] states that he has found the progress of maceration and of the disappearance of the soft parts to be materially more rapid in salt water than in fresh water; the soft parts disappearing quickly by the action of fish attacking the head and hands; while the rest of the body is comparatively slow in taking on the changes of putrefaction in ocean water.

Take, for example, the beginning of the changes due to decomposition—marked by the accumulation of gas within the body, and by a consequent buoyancy which compels it to rise to the surface of the water and to float there. The authorities declare that this change is to be expected in from four to five days after the drowning. This is true under ordinary conditions of temperature, surroundings, etc. Yet one would be puzzled to say, in a given case, that these ordinary conditions *were* present, and that a body found floating had been dead so many days—no more and no less. Taylor tells of bodies found floating eight hours and a half after drowning; and of others which did not sink at all; while in other instances bodies have failed to rise to the surface until many months have elapsed.

We must bear in mind the incidental circumstances which will turn the matter of buoyancy one way or the other. Clothing to drag down the body or to help to float it. Hot weather to hasten decomposition, or cold weather to retard it. Stakes to keep the body near the surface, or to hold it near the bottom. A light-boned, young, and fat body of a woman, floating readily, or a muscular, heavy-boned man, requiring much inflation with gas to raise it. Salt water promoting buoyancy, or fresh water having a contrary effect. These are some of

[1] *Edinburgh Medical Journal*, February, 1903, p. 123.

the manifold considerations which lead one to a conclusion that he ought never to make a positive, dogmatic answer to the questions, When was this person drowned? How long has he been dead?

If any answer is given, let it be guarded by such limitations as belong to possibilities, remembering that the longer the interval between the death and the inspection, the more difficult the problem.

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CHAPTER XVI.

DEATH BY HANGING.

HANGING is an act of violence in which the body, suspended by the neck by a cord and abandoned to its own weight, exerts upon the cord a traction sufficient to bring about very quickly loss of consciousness, arrest of respiration, and death. In other words, the constriction of the neck is due to the weight of the body. It is always a matter of suspension in which the weight of the body is the efficient force.

When a dead human body is found suspended by the neck, three questions are suggested: 1. What is the proximate cause of death in such a case, and what are the phenomena attending it? 2. What proofs have we that the suspension occurred during the life of the victim and was the cause of his dying? 3. Was the hanging a matter of accident, suicide, or homicide?

With reference to the first question, What is the proximate cause of death in hanging? We might readily answer that, air being cut off from the lungs by a mechanical hindrance to respiration, asphyxia is the constant and invariable consequence, and must be regarded as the real cause of death, perhaps the only one. This would be an error, however, for other causes besides asphyxia enter, and of these, coma, due to a congestion of the brain, the result of pressure on the vessels passing to and from the brain, is the chief.

Hofmann dwells upon the very obvious fact that, in hanging, the blood-vessels in the side of the neck, especially the carotids, must invariably be subjected to a marked degree of compression. One evidence of this is found in the rupture of the internal coat of the carotid beneath the groove where the ligature presses. Experiments, frequently repeated and always with the same result, prove that it is impossible to force liquids through the carotids of a cadaver suspended by the neck. It is clear that the jugular veins are also frequently compressed, so as to be impermeable. Now, this forcible compression of the blood-vessels must necessarily result in graver symptoms. The sudden arrest of the intracranial circulation

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produces instantaneous effects. The brain reacts with extraordinary rapidity if any interference with its nutrition occurs, and coma is the speedy and natural consequence.

Hofmann believes, also, that compression of the pneumogastric nerves, situated as they are in close relation to the great vessels of the neck, must play an important part in the phenomena of a death by hanging. The physiological function of this nerve as a moderator of the heart enables it to have an important influence in connection with this form of violence. Waller employed compression of the vagi for anesthetic effects. Thanhöfer and Czermak have demonstrated immediate loss of consciousness by such compression. And it is by this pressure on the pneumogastrics, as well as by occlusion of the carotids and jugulars, that death probably arrives more speedily in hanging than in other forms of mechanical asphyxia. Coutagne has reached the same conclusion experimentally. He has found that, when one dissects out the pneumogastric nerves in the neck of a dog, and then passes a ligature beneath them around the neck and tightens it, death results much more slowly than when the nerves are included within the noose.

That hanging is a composite process, and that death by suspension does not depend on asphyxia alone, is exemplified by a fortunate observation in 1897, by Dr. Reineboth, of Halle: A man had a sarcoma of the neck, threatening suffocation. Tracheotomy was done and a canula was introduced to enable the patient to breathe comfortably. He became despondent, however, and got tired of life, and finally determined to put an end to it by hanging. He placed the rope above the thyroid, and so, well above the artificial opening in his trachea. Respiration could thus go on in spite of the cord. But death appeared to have taken place rapidly, as rapidly as if there had been no tracheal aperture. He could have saved himself by standing upright, but it seemed to be demonstrated that unconsciousness came on very promptly. At the *autopsy*, anemia of the cerebrum, fulness of the arteries at the base, hyperemia of the pons and medulla, and some congestion of the vessels of the pia were the prominent appearances.

These three factors, then, are the data or elements which we have to study in reaching our conclusions as to the proximate cause of death in hanging: 1. Obstruction to the entrance of air to the lungs by the natural passages. 2. Compression of the blood-vessels in the side of the neck. 3. Pressure on the pneumogastric nerves.

It must be obvious that of these three factors the first pre-

dominates; it is the one to which the others are subsidiary. Mackenzie has analyzed 130 cases of suicidal hanging which came under his observation. Of these, 119 were cases of death by asphyxia; 8 were deaths in which asphyxia and coma were associated; 2 were cases of syncope; and 1 was a case of coma alone.

The Phenomena of Death by Hanging.—Regarding the phenomena of death by hanging, What occurs as *subjective* effects of a suspension by the neck? The answer is largely speculative because of the diversity of resuscitated witnesses who can testify. Some observations, however, experimental, and in cases of suicide or accident, with timely rescue and resuscitation, give us some light. For example, Fleischmann tried some experiments on himself to elucidate the subject. He placed a cord around his neck, between the lower jaw and the hyoid bone, and tightened it moderately. Breathing was embarrassed, but not wholly stopped. His face was red, the eyes somewhat prominent, the head hot; there was a sense of weight, with some feeling of stupor, then distress. Finally, a hissing noise came in his ears which warned him of danger and of the propriety of desisting. The time was two minutes.

Again he placed the ligature across the larynx; the same effects followed, but in less time, a minute and a half. In the third experiment he placed the ligature over the cricoid cartilage; almost at once breathing became so disturbed that the observation could not be continued.

Foderé relates an incident concerning one of his fellow students: After arguments about the cause of death in hanging, the young man resolved to demonstrate his view of the contention in his own person, up to a certain safe point. He passed a ligature around his neck; he fastened it above his head to a hook, standing on tip-toe while doing so. He came down on his heels and lost consciousness almost immediately, but was fortunately cut down before harm came.

Gosse related before the International Congress of Legal Medicine, in 1889, some experiments which he had tried on himself, relating to suspension. On two occasions he carried the suspension to the point of loss of consciousness. The cord did not compress the neck so as to stop the breathing entirely, but only in part. Where the ligature pressed laterally, on the carotids, there was not much pain, but a disagreeable buzzing sound in the head. When the rope pressed in front over the trachea, the struggle to breathe was distressing. Gosse states that convulsions occur most readily in hanging

when the lungs are empty of air. If then, he says, the subject of a judicial hanging would only fill his lungs with air by a deep breath just before the noose tightened, he would suffer less than he would without this precaution. But this is largely speculative, and no witnesses are present in its favor.

We may, with Tidy, divide the phenomena of hanging into three stages.

First Stage.—There is partial loss of consciousness, with stupor. The subjective initial symptoms described by those who have been resuscitated are an intense heat in the head; brilliant flashes of light in the eyes; deafening sounds in the ears; and a heavy, benumbed feeling in the lungs. In many cases ineffectual efforts to breathe are made after the air-passages are closed. These several symptoms belong to those cases in which the death is not instantaneous through injury of the spinal cord in the neck. This primary stage may last from thirty seconds to three minutes.

There is no good reason for the belief that after the first or initial stage of the suspension (the tightening of the noose) the subject of the experience suffers any genuine pain. Some observations made by Brown-Séquard upon the peripheral nerves of the neck support this view. He found that any mechanical irritation of the larynx or trachea, or of the skin covering these parts, is able to cause inhibition of the heart's action, of the function of respiration, and of the action of the brain very quickly. And he declared that one might find in these facts an explanation of the cases of death by hanging wherein, at the autopsy, one finds no appearances of asphyxia, the death having been too sudden for the processes of asphyxia to supervene.

Second Stage.—The person suspended is entirely unconscious, and convulsions usually occur, although these may be wholly lacking. Urine, feces, and semen are expelled at times in this stage, if at all. The hands are clenched. The diaphragm and intercostal muscles act spasmodically. The muscles of the face are contracted in sympathy with the general spasm, and a twitching of the lower limbs is also observed.

It is a common and popular belief that pleasurable erotic sensations are experienced by those who die by hanging. This is a mistaken view. The ground for this error is found in the post-mortem condition of the sexual organs, which are sometimes observed to be more or less turgid in cases of hanging; the penis is erect and shows a discharge of a mucilaginous fluid more likely to be prostatic than seminal;

and in the female the clitoris is found swollen, and the adjacent parts are injected.

These appearances, however, are far from proving that sexual sensations correspond on the part of the person suspended. There is entire lack of authentic observations to demonstrate this relationship. In cases of resuscitation after suspension, and timely rescue, there is no record of the erotic symptoms referred to. And no one so restored has avowed such sensations as a part of his experience during the suspension.

Third Stage.—The only remaining sign of life which marks this stage is the continued beating of the heart. This persistent action of the heart has been observed long after death has closed the scene otherwise. As a rule, the pulse may be felt for ten minutes after the drop in a judicial hanging. But there are many extraordinary exceptions. Blankensip reports an execution by hanging. Death was by strangulation ; the neck was not dislocated. The pulse beat once in the nineteenth minute. Tardieu reports a case in which the heart was found beating at the rate of 80 per minute, an hour and a half after the supposed death of the man by suspension.

A case occurred in Boston, in 1858, which attracted much attention. A condemned murderer, named Magee, twenty-eight years old, weighing 130 pounds, was executed by hanging. The drop was from seven to eight feet. There was no struggle or convulsion. Seven minutes after the drop, the cardiac impulses numbered 100 ; at nine minutes, they were 98 ; at twelve minutes, they were 60 (fainter) ; at fourteen minutes, the heart-beats were not audible and the body was lowered. At the autopsy, a little over an hour after the drop fell, the right sternomastoid muscle was found torn ; the hyoid bone was fractured, but the spine was not injured. Ninety minutes after the hanging, the heart was beating 80. The thorax was opened, and the heart was exposed. The right auricle showed full and regular contractions and dilatations. The spinal cord was divided by the pathologist, yet the heart persisted. Two hours after the drop the heart-beats numbered 40. The pulsations of the right auricle continued at intervals for three hours and a half longer. They were readily excited by the scalpel point. The heart was normal in structure.

The duration of the suspension sufficient to cause fatal results—that is to say, the minimum time within which death follows under this condition of things—has been found to offer considerable variety, on account of the diversity of the data.

Averaging results, we may say that resuscitation is not to be expected when a body is cut down after five minutes' full

suspension. The extremes stated in the books extend from a second or two at one end to half an hour at the other, although one finds difficulty in recognizing under what possible circumstances a true suspension for thirty minutes could occur with survival at the end. It is not difficult, however, to understand that actual differences in the time may be explained quite readily.

For example, the situation of the noose may not be such as absolutely to annihilate respiration. There will be some difference in effects whether the ligature tightens above, below, or across the thyroid. Then the length of the fall, the weight of the person, his strength, natural vigor, and power of resistance are important considerations. Instantaneous death in hanging is determined by the damage done to the spinal cord. This result is most frequently seen in judicial executions, in some of which decapitation by the rope is accomplished unexpectedly, the head being torn off. Louis made the observation that this instantaneousness of death was most readily brought about if the executioner gave the body of the condemned a violent twist when the body dropped, thus fracturing the odontoid process—dislocating the upper cervical vertebræ —and either compressing, bruising, or stretching the spinal cord in its upper and most sensitive region. Dislocation of the spine is most apt to occur in those cases in which the knot is placed anteriorly under the chin.

Resuscitation is difficult in even the relatively favorable cases. That it may be practicable at all, there must be absence of any considerable injury to the neck, and few or none of the graver phenomena of asphyxia or coma must have occurred.

Brodie's[1] case is an example of this difficulty: A boy of seventeen was found hanging, and when he was cut down he was insensible. His face was livid; his lips dark purple; his pulse imperceptible; and his pupils dilated and immovable. Artificial respiration was practised for fifteen minutes; then the diaphragm acted perceptibly, and breathing with stertor was observed. The pulse returned, but lividity persisted; insensibility also continued. The skin was cold; there was frothing at the mouth. The boy died twenty-four hours after the rescue. There were no anatomical changes, except meningeal cerebral hyperemia.

The following case, reported in the *Lancet*, September 6, 1884, by Mr. White, senior assistant medical officer at Kent Lunatic Asylum, offers another example: A woman, fifty-three years old, a subject of melancholia, had several times

[1] Taylor, *Principles and Practice of Medical Jurisprudence*, ii., p. 35.

attempted suicide, by drowning, hanging, etc. One afternoon, eight minutes after she was last seen alive, she was found hanging by the neck from a ladder in a bath-room, by means of portions of her skirt and underclothing. She was cut down at once and seen within three minutes by the medical officer, and artificial respiration was begun. The eyes were prominent, the corneæ glassy, the pupils dilated, and the conjunctivæ insensible. The lips were livid, the tongue swollen, the skin ashy pale. There was an oblique depression on the neck, deepest on the left side. The small veins and capillaries of the surface of the body were turgid. There was no radial pulse, and no definite beat of the heart by stethoscope. All natural respiration was wholly suspended. There was complete unconsciousness; no reflex action was found, nor any reaction to galvanism. Urine and feces had passed involuntarily. After artificial respiration for ten minutes, a very feeble attempt to gasp was noticed. At the same time, distant, weak, reduplicated cardic impulses, 150 per minute, were observed. Fair respiration was presently restored. In two hours a weak radial pulse was noticed. Great restlessness and jactitation followed. Consciousness was not restored for more than twelve hours. The lungs threw off much fetid matter. General rheumatism-like pains were complained of. She remembered the impulse to hang herself and the act of suspension, but all other events for two days were obliterated. She began to be convalescent from the time of resuscitation.

Another similar observation was reported by M. Terrien, an interne of the asylum for the insane at Nantes, in 1887.[1]

Regarding the rational treatment for resuscitation, in many ways it is similar to that in cases of drowning. First cut the patient down; this is not superfluous advice, for the first thing generally done is to run for help, a matter of secondary consequence. Remove all tight clothing, especially from the neck and chest. Artificial respiration should be entered upon at once. If the body is warm, cold affusion to the head and chest is indicated. Ammonia, or other stimuli, should be applied to the nostrils to provoke sneezing. If the patient is plethoric and livid, bleeding might be useful. Galvanism, too, should not be forgotten. Friction of the limbs and hot bottles and blankets should not escape attention. Enemata of brandy and subcutaneous injections of brandy, ammonia, or ether, are useful. The indications are (1) to keep up respiration or to restore it; (2) to keep the heart in action and to relieve the overloaded blood-vessels; (3) to keep up animal heat.

[1] *Progrès médical*, September 17, 1887.

It is not necessary for the feet of the hanging person to be off the ground or floor in order to produce the characteristic appearances and fatal effects of suspension. In suicidal cases such complete suspension is rare. Far more common is it to find the suicide in a half-sitting or kneeling posture, the feet and legs extended in front in the one case, with the heels resting on the floor; or, in the other, with the knees flexed and the toes on the floor or ground under the nates. Asphyxia and insensibility may be effected in a short time, and the weight of the body is quite ample, even supported, to do the rest. The elastic material of the rope allows stretching.

Tardieu's notes of 261 cases of hanging showed the following observations: In 168 cases the body rested on the feet; in 42 cases it rested on the knees; in 19 cases it rested on the nates (sitting); in 29 cases it was extended and lying down; in 3 cases it was huddled, or squatting.

Anatomical Appearances Proving Death by Hanging.—The important medicolegal question arises: Was the suspension in any given case during the life of the victim? Or, in other words, What does the autopsy give us, as characteristic post-mortem appearances, by which we may determine, independently of other evidence, that the death was caused by the suspension? The exaggerated notions and descriptions laid down in their books with much precision of detail by the older authors are certainly lacking the advantage of verification in these days. These details are borrowed largely from the experiences of criminal executions. The horrible pictures of swollen and livid countenance, distorted features, projecting eyeballs, protruded tongue, and clenched jaws are largely the gruesome products of vivid imaginations.

In ordinary cases of suicidal hanging, which comprise nearly all the modern material for this sort of study, very few of these repulsive and horribly suggestive features are observed. It is only when the suspension is attended with unusual violence, or there is a fall of several feet, or a sharp twist is given to the body, in judicial executions, or murder by hanging in other words, that we may find the external appearances like those alluded to, or the marked local violence about the neck, or fracture or dislocation of the cervical vertebræ, or even entire decapitation. It is rather startling to one whose ideas upon these matters have been shaped by tradition or by popular misapprehension growing out of sensational newspaper details, to find, upon being called for the first time to a case of suicide by hanging, how surprisingly

negative and how unsuggestive of pain and distress the appearances about the body are.

Bearing this fact in mind, we ask now, What are the proofs presented by a dead body found hanging by the neck, that the suspension was begun while the body was living? In the first place, the signs of a general nature which belong to all cases of sudden death by asphyxia or coma, or both combined, are present externally. Livid discoloration of the dependent parts will be pronounced. The lower limbs and the hands show this condition most fully. It is the result of gravitation upon the blood in the vessels. The face is more often pale than red or livid. Of 49 cases observed by Roth, 43 showed pallor instead of turgescence or lividity.

Internally, the most striking evidences of the kind of death involved in the case, considered now in its general relations, pertain to the blood and its distribution. It will be found of fluid consistence and dark in color, and filling the right cavities of the heart to distention. Moreover, in common with all forms of death by apnea, a death by suspension determines venous engorgement in various other directions. Thus, the lungs are congested; the spleen, liver, and kidneys, too, contain an abnormal supply of dark fluid blood. As for the brain, hyperemia is by no means a constant appearance, in spite of what one might expect to the contrary. That organ, indeed, is often found pale and exsanguine; yet the rule is that the brain shows an over-supply of blood in its meningeal vessels and its substance.

These are the usual appearances of a general nature to be looked for in a case of death by hanging, but it is fair to say that they are not absolutely uniform or constant, and that some cases are quite negative in this regard.

As regards the local signs, if the generic signs of asphyxia or coma, or both combined, sometimes disappoint us by their equivocal character or their absence, and are of little or no avail in our post-mortem diagnosis of death by suspension, we are not in the same position regarding the special local manifestations of this form of violence. These give us trustworthy data, and of them all, the most important, as they are also the most interesting, are the local lesions left about the neck in the act of hanging. These will differ according to the nature of the material used in the noose; the weight of the body suspended; the height of the fall or drop; the kind of knot; and the length of time during which the body is left suspended.

Character of the Ligature.—It is surprising what

versatility the suicide's disposition will show in the choice of methods. The hangman's half-inch hemp rope is not common with these melancholy self-executioners. They take what comes handiest, provided it will make a noose and promise to hold them up long enough to bring the lethal release they yearn for. It thus happens that the most singular variety of means is resorted to: Ribbons, cravats, handkerchiefs, sleeves of shirts, legs of drawers, garters, suspenders, strips of skirts, curtains, and quilts, as well as the more accessible common-place clothesline, have all figured in these experiments.

The following case came under the author's observation, in which a shawl strap was the medium used: A married woman, twenty-one years of age, was a victim of suicidal melancholia. She got out of bed when her husband was asleep and hung herself to a chandelier above the foot of the bed. When her husband awoke she was suspended there before his eyes. She had used a shawl strap half an inch wide; it was passed twice around her neck and buckled to make a loop; the free end was tied to the gas-fixture while she stood on a chair; she then stepped off and tipped the chair over.

Another case from the author's own notes illustrates how quietly and speedily suicide by hanging may be accomplished, even under difficulties: On November 4, 1890, a man in adult life was arrested for drunkenness and placed in a cell in a police-station. At 2.25 P. M., he was seen in his cell, quiet and peaceable. At 2.35 P. M., the same day, he was found hanging from the upper cross-bar of his cell door. He was dead beyond resuscitation. He had used his suspenders, making a single loop, not a slip-noose, and when it was adjusted about his neck and had been fastened above his head to the cell door, he settled down by bending his knees, and let the weight of his body do the rest.

It is obvious that of the lesions which the neck shows after death by suspension, the appearances in and about the groove left by the cord are of the greatest interest. In situation, this groove will be found, in the majority of cases, above the thyroid cartilage, and under and behind the angle of the jaw. There will be some variety in this regard, according to the situation of the knot, whether it is at the back, or at one side (under the ear), or in front (under the chin). It is comparatively rare to find the groove across the larynx and rarer still, a curiosity, to find it below the larynx.

In 299 cases collated by Tardieu and Hofmann, the following observations were made: in 244 cases the cord was above

the thyroid; in 49 cases the cord was across the thyroid; in 6 cases the cord was below the thyroid.

In direction, the groove follows the line of the lower jaw, and it is thus oblique, being lowest in front. It thus offers a mark to distinguish it from the circular constriction which usually characterizes strangling. True, the situation of the knot may be such as to make the depression circular. If, for example, the slip-knot is in front, directly under the chin, the projection of the lower jaw would prevent the knot from rising up before tightening. But the most frequent and, therefore, the typical, effect, is a marked obliquity.

The depth of the groove will be greater or less according to the material and the size of the ligature used, and especially the time during which the body remains suspended. If the body is cut down promptly after the hanging, the groove may be a scarcely perceptible reddish line, without any depression. If many hours elapse, the furrow will be a deep and distinct one. As to the ligature, a soft material, like a silk handker-chief, twisted into a clumsy coil, will, of course, leave a shallower mark than a small, dense cord, like clothesline. The breadth of the depression will, in general, correspond quite closely with the ligature, being, if in any way different, a little wider than the ligature.

Certain effects left by the cord on the skin, in the bottom of the furrow and at either side, have been described as significant data for the post-mortem diagnosis of death by hanging. Some of these, formerly regarded as characteristic, are now known to be of little value as evidence, inasmuch as they may be produced by suspending dead bodies by the neck. For example, a desiccated or mummified state of the skin in the bottom of the groove was once included among the valuable indications that the hanging was during life. It is understood now, however, that this dried, parchmented state is a purely physical effect, which may be produced experimentally on the cadaver by drawing the cord tightly around the neck, and especially by superficial abrasions of the cuticle. The same result is aided, of course, by the effect of the noose on the vessels in the neck—squeezing out their liquid contents, and leaving the compressed tissues to dry faster.

So, too, as regards the *color of the skin* in the furrow and at either side of it. It was formerly taught that a bluish-red mark left by the cord around the neck was an unequivocal proof of death by strangulation or suspension; while the absence of such discoloration was as certain a proof that the cord had been placed upon the neck after death. This notion

is erroneous. Mere lividity, or settling of the blood, is no test. It may be observed experimentally by suspending by the neck the recently dead body before the blood has changed in the vessels. Here it is simply post-mortem staining.

On the other hand, many cases are recorded wherein the constricting cord has left nothing in the shape of discoloration to mark its situation. This is especially true of cases in which the body was cut down quickly after the hanging. Ogston found in two-thirds of his cases that the skin at the bottom of the groove was quite white and natural in color.

Exceptionally, the inner coat of the carotid artery is ruptured. It is attended with some hemorrhagic infiltration of the sheath of the vessel, and decided injection of adjacent capillaries. The lesion implies a considerable degree of violence in the suspension. It most readily occurs in old subjects whose arteries have been altered by degenerative changes (atheroma), and so rendered fragile. The seat of the injury is generally just below the division of the main trunk into the external and internal carotid. It is caused by compression and stretching combined. It presents itself as a transverse rent of the inner coat. Sometimes it involves the entire lumen. Generally it is only partial. If it extends all the way round, the edges of the lesion are rolled on themselves or everted. When one has this injury among the anatomical appearances, in connection with some degree of adjacent capillary hemorrhage, it is good proof of hanging during the life of the subject. But without this hemorrhagic infiltration, it should not have too great stress laid upon it as a sign.

Certain other lesions of relatively great variety in the neck are of interest. Fracture of the thyroid cartilage is among these. So, too, is rupture of the muscles (the sternomastoid, sternothyroid, hyothyroid, sternohyoid, and pharynx).

Dislocation and fracture of the hyoid bone, or its separation from the thyroid cartilage; fracture of the laryngeal cartilages; rupture of the cervical ligaments; dislocation and fracture of the cervical vertebræ; decapitation by the rope are all admitted to be rare; they never occur in suicides. None of these were ever seen by Casper; he could not produce them experimentally on dead bodies. He admits, however, that if with any of these appearances there should be found evident traces of vital action, like genuine extravasation and hyperemia of the tissues, they must of necessity be regarded as acceptable proof that the hanging was during life; though their absence would be no proof to the contrary.

Besides these appearances found about the neck, the bodies of those dying by hanging present other effects more or less constant, many of them different from what might have been expected. I have already mentioned the state of the features— their placidity in cases of suicide; their expression of distress and mental horror in cases of judicial hanging or homicide. Plethoric and strong men, also, may show considerable turgescence of the head after death by hanging. The ears are livid, the face swollen and purple, and the lips full.

The manner of the death, whether slow or speedy, will largely influence this matter. Prolonged suspension after death will also have an effect in causing swollen features and a change of color from pale to mottled purple. Swelling and discoloration of the features cannot be brought out by suspending the dead body if the cause of death is something other than suspension.

The position of the head has some value as a sign of suspension during life. It varies according to the part of the neck to which the rope or ligature is attached, and the position of the knot. The commonest position is a marked flexure forward, the chin resting on the front of the upper sternal region. The head will always be found inclined toward the opposite side to that of the knot. This forward and lateral inclination of the head may be called typical. Its exceptional position in other directions will mainly depend on the manner in which the noose is applied. If, for example, the knot remains under the chin, that part will be tilted up and back, with marked flexure of the back part of the neck.

The position and condition of the tongue are not sufficiently constant and uniform to be of diagnostic value. Sometimes it is swollen and protruded; more often it is in its normal state and place. If it is found to be enlarged and its tip caught between the teeth, in a case of hanging, it proves the presumption that the hanging was during life, and not a suspension postmortem. It has been determined that the position of the tongue after death by suspension has no relation to the situation of the cord, whether above or below the larynx. Saliva sometimes dribbles from the corners of the mouth, or over the lips, of a person hanged, and by some authorities it is regarded as a sign of some value—indicating that life was in the body when the suspension occurred. It cannot be produced in a dead body.

The eyes fail to offer any uniformity of appearances having noteworthy significance. Injection of the conjunctivæ is pretty common, and Maschka and Lacassagne place some value on

this as a sign of death by hanging. Protrusion of the eyeballs is seldom observed, and it is especially rare when the suspension is brief and the body is cut down early. The pupils are usually dilated. In a few cases of judicial execution by hanging, fracture of the crystalline lens has been found at the autopsy.

Appearances and evidences of genital excitement are sometimes observed upon the bodies of those dead by hanging—in about a quarter of all cases. In the male a turgid state of the penis, and a discharge of seminal fluid, urine, and prostatic fluid. In the female, redness of the labia, vulval hemorrhage, and erect clitoris. All authors agree that these appearances are not peculiar to deaths by hanging; they are found in other forms of violent death. Casper says they have no diagnostic significance. Hofmann attributes them to the action of gravitation after a prolonged suspension. He has not found them about the bodies cut down quickly after suspension, and he explains them as purely hypostatic changes. No author to-day pretends to connect them with any agreeable sexual sensation or erethism.

Lesser makes the observation that extravasations of blood are rarely seen, even with rupture of the muscles of the neck, because of the compression of the parts by the noose. His argument is that the small blood-vessels are divided, but at the same time they are obstructed or compressed, so that blood cannot escape into surrounding parts.

Hofmann concedes the fact observed by Lesser, but gives a different interpretation. He does not think that the small vessels are torn at all, but he believes that the interruption of the circulation is due to the complete compression of the carotids and jugulars. As the cord is ordinarily around the neck at a point below the bifurcation of the carotids, the suspension of the circulation is nearly complete. Moreover, according to Hofmann, the compression of the tissues themselves contributes in a measure to control and prevent sanguineous extravasation.

Such are the appearances which one may find upon the body of a person who has died by hanging. But it must have been evident, in the course of this description, that the diagnosis of this form of death, as a purely anatomical problem, is by no means the easy matter one could wish. Fortunately, cases of doubt very rarely occur, for the circumstantial surroundings of nearly all the cases leave little room for such doubt. The mere finding of a dead body suspended by its neck is, of course, not to be regarded as settling the matter

offhand, any more than the finding of a dead body in the water determines by itself that the person died by drowning. When, however, we recall the variety as well as the *inconstancy* of the signs of death by hanging, their lack of uniformity, the fact that in exceptional but authentic cases of death by hanging they are all lacking, and especially the fact that many of them may be developed by suspending by the neck the recently dead body of one dying in some other way, the purely medicolegal relations of the subject are matters of considerable difficulty. In the great majority of cases, of course, the finding of a suspended body *presumes* at once a death by hanging and by suicide. But one might imagine a homicide by smothering and, immediately after the death, a suspension of the body in such a way as to simulate suicide. Under such conditions, the body being warm when suspended and the tissues relaxed, it would be well-nigh impossible to establish the true facts anatomically, and to demonstrate that it was *not* a suicide. Fortunately, such a case has yet to occur. Fortunately, too, when it does occur, the murderer may himself help the diagnosis by leaving undone or overdoing some of the indications of suicide.

Presuming, now, that the medical examiner by a synthesis of the data, both medical and circumstantial, in his possession is able to reach the conclusion that hanging was the cause of the death, in a given case, the next question that meets him is: Was the hanging accidental, or suicidal, or homicidal?

It is largely a matter of circumstantial proof. The *chances* always favor the conclusion that the case was *suicide*. Accidental hanging is rare, but its possibility is admitted, and a few instances are on record. For instance, sailors falling from aloft; boys experimenting after seeing or hearing of public executions (Bacon); hanging for public exhibition and not cutting the person down quickly enough (Scott and others); children at play (Guy, 286). A case occurred in December, 1884, in which a boy went to sleep with a rope around his neck; the rope tightened and killed him when he leaned forward asleep in his chair. In the summer of 1891, a boy three years old met with a singular accidental death. The little fellow was playing in a swing in the yard, and became twisted up with the rope in such a manner that he choked to death. He was found suspended by the neck, and was dead.

Cases of accidental hanging are so rare, however, and are generally so easily determined that the question is practically narrowed to a decision as to whether homicide or suicide was the motive present. Homicide by hanging is admitted to be

extremely rare. It presumes manifest inequality of vigor, strength, and energy in the two parties, the victim and the assailant, and always in favor of the latter. Otherwise, such a death is hardly conceivable as possible. Take, for instance, two men equally matched in strength, and the hanging of either by the other is not to be thought of as credible; therefore, the victim of homicidal hanging must be either a child, a woman, a youth, or a man much exhausted by previous disease or other causes; or he must be drunk, narcotized, stunned, or asleep, or otherwise rendered incapable of defence; or he is overcome by many at the same time, as in lynching; or he is a victim of deceit, and the aid of an accomplice is invoked, as in the case of Gouffé, in France. In 1875, a tailor in Vienna, hung his five children, aged respectively eight months, two, six, eight, and nine years, and then himself (Hofmann, 375).

In the presence of the admitted rarity of homicidal hanging, a rarity growing out of the difficulty of its performance and the infrequency of favoring circumstances, it would require positive evidence, medical and circumstantial, to establish such a case and to set aside the always present presumption of suicide. Such evidence would consist chiefly of proofs of violence and struggling, for even in the cases cited as examples of the inequality of strength in the parties, it is not to be supposed that the act of murder by hanging could be consummated without some resistance, or at least some degree of rough handling and violence on the part of the murderer. So that all appearances indicating such incidental violence, to be distinguished from those lesions and effects left by the rope, should be observed and noted with great care and with the possibility of their homicidal origin kept in view.

Homicidal Hanging.—The injuries especially suggestive of a homicide or of a struggle preceding it are: Scratches and bruises on various parts of the body; dislocations and fractures, especially of the fingers; ecchymoses about the head and back; excessive violence to the structures embraced by the cord, such as fracture of the *os hyoides* and of the laryngeal cartilages, laceration of the adjacent tissues, fracture and dislocation of the vertebræ, and rupture of the intervertebral ligaments.

It is at once apparent that a great degree of violence would be required for such extensive and serious injuries, and would therefore in nearly every case exclude the idea of suicide. (Judicial executions.) Sometimes the victim is first throttled and then suspended, in which case marks of strangulation

would be left by the fingers or the cord on the throat, marks of which we shall have more to learn in the next chapter.

The situation and character of these indications of homicide must be such that the person suspended could not have readily produced them himself. For it is easily understood that in the preparations for suicide, as well as in the act of hanging, bruises and abrasions and other external injuries may be received in a purely accidental manner. An accusation of homicide is too serious a matter to be settled off hand, without the most rigid exclusion of other probabilities or possibilities by competent evidence. More than this, cases are on record in which suicides have attempted to destroy their lives by razor-wounds of the neck, pistol-shot wounds, and poison, and, finding the method first chosen a disappointing one for any reason, have finished the performance with hanging. Such cases, when they occur, suggest the question in each instance : Are the injuries which are found such as the deceased could have inflicted before he placed the noose about his neck ?

Certain points of evidence may be derived from a study of the surroundings of the dead body and the circumstances of its discovery: Are the doors and windows fastened on the inside ? Does the furniture indicate any struggle ? If not in a room, is the place of the suspension significant ? What is the state of the dress, is it torn or disordered ? Is the hair disarranged ? What kind of rope was used ? What is the character of the knot ? Is there anything in the previous history of the person suspended ? What was his mental state ? Has he made threats or attempts ? Is there any motive for suicide present ?

Strange as it may appear, it is authenticated that a person has hung himself after first tying his hands and his legs. Recorded instances have disproved the view that such deliberate preparation necessarily means homicidal hanging.[1]

In any such case of the discovery of a dead body suspended, it is important to notice whether the suspension is so arranged as clearly to indicate that the body has been *drawn up*, so that the feet are clear from the floor. Is there no chair, table, or box adjacent upon which the suicide stood while making his gruesome preparations, and from which he stepped when all was ready ? What kind of knot was used in the ligature of the limbs, as well as of the neck ?

If homicidal death by hanging is sometimes made to simulate a death by suicide for purposes of concealment, it is not

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[1] Taylor, *Principles and Practice of Medical Jurisprudence*, ii., pp. 56–58. Wharton and Stillé, *Medical Jurisprudence*, section 935.

less noteworthy that *suicides* occasionally entertain the curious fancy that they will feign the methods of the murderer, so as to create a false suspicion. Heinrich, of Berlin, reports such a case: A woman's body was found hanging from the branch of a tree; her feet were off the ground; decayed leaves were in her mouth. A card pinned on her shoulder had these words written on it: "Three of us committed the murder. We found on her 1 thaler and 15 groschen. She only prayed for her two children." Not the slightest mark of violence or anything suggesting a struggle or resistance was found on or about her. After full investigation a decision that the case was one of suicide was reached.

It has been an open question whether corporal infirmity or some abnormality or defect of the hands might not stand in the way of a person's attempts to hang himself. Each case must be judged by itself. A determined purpose will often supply what is otherwise lacking. Blindness has been found to be no bar to this sort of suicide. Extremes of age, too, have been found among the recorded cases. For example, a boy getting weary of life, in one instance, at the age of nine; while in another, a man of ninety-seven found it too tedious to wait longer for the natural end of his life, and both resorted to hanging.

The following abstract of the official report of the post-mortem examination of the body of Charles J. Guiteau, who died by judicial hanging on June 30, 1882, at the United States jail, Washington, D. C., gives a graphic picture of the anatomical appearances after death by hanging:

The body, which was of a faint yellowish tint, was that of a man about five feet seven inches in height, and weighed one hundred and forty-five pounds. The eyes were examined, and the pupils were found to be slightly and equally dilated; the vitreous was cloudy, and the fundus indistinguishable. The conjunctiva of the left eye was congested. Two hours later an appearance as of transverse fracture of the lenses was noticed. There was a yellowish furrow, a few lines in width, extending around the neck in a direction downward and forward, in a line of the rope. On dissection, the sternocleidomastoid muscles were found to be torn in two, about halfway between their points of origin and insertion. The thyrohyoid ligament was also ruptured, and the hyoid bone and thyroid cartilage were widely separated. The large blood-vessels were not injured; neither was there fracture or dislocation of the vertebrae.

The *pia mater* was anemic anteriorly; posteriorly, there was slight hypostasis. The cerebral vessels appeared to be normal

in all respects. There was no roughening of the inner surface of the skull. The *brain* was firm. Its weight, including the cerebrum, cerebellum, pons, and medulla, and a portion of the dura, was forty-nine ounces and a half. The *white substance* was almost absolutely anemic.

The usual median incision was made and the abdomen opened. There was an extravasation of blood into the right pectoralis major muscle near the second rib. The adipose layer of the abdominal section was one inch in thickness. The dome of the diaphragm extended up to the fourth rib on each side. There were old pleuritic adhesions at the apex of the right lung; the upper and middle lobes were congenitally united by connective tissue. The *lung* was normal throughout. There were also old pleuritic adhesions of the left lung to the diaphragm and between the lobes. The heart weighed ten ounces and three quarters; its muscular substance was apparently normal. There was an abundance of fat upon its anterior surface and a villous patch of old pericarditis near the apex of the left ventricle. The *right ventricle* contained a little blood, just forming a clot. The valves were normal. The aorta was slightly atheromatous for a short distance above the valves. All of the abdominal viscera presented large accumulations of fat. They were normally situated. The *liver* was congested; the gall bladder contained a little bile; the spleen was lobulated and enlarged, and weighed eighteen ounces; the capsule was bluish, the substance brown; the Malpighian bodies were hypertrophied; the pancreas was normal; the stomach contained food; the intestines appeared normal and were not opened; the kidneys were congested.

A composite picture of autopsy appearances has been published by Surgeon Major Mackenzie, of Calcutta, of one hundred and thirty suicides by hanging, as follows:

Of 81 cases, the tongue was protruded in 41 ; one-half.
" 40 " the eyes were prominent in 13 ; one-third.
" 20 " frothy mucus was in the nostrils in all.
" 92 " vaginal or urethral discharge was present in 30 ; one-third.
" 8 " the penis was erect in 3 ; three-eighths.
" 93 " the hyoid bone was fractured in 24 ; one-fourth.
" 64 " the thyroid cartilage was fractured in none.
" 11 " the cricoid was fractured in none.
" 77 " the vertebrae were fractured or dislocated in none.
" 90 " the carotid intima was ruptured in 31 ; one-third.
" 71 " the mucosa of the bronchi was congested in 56 ; two-thirds.
" 130 " asphyxia was the cause of death in 119.

In no cases were the muscles of the neck, the larynx, the trachea, or large bronchi injured. In none was there extravasation under the skin of the neck.

CHAPTER XVII.

DEATH BY STRANGULATION.

STRANGULATION is a form of violence so closely allied to the topic discussed in the preceding chapter—death by hanging—that the chief interest will lie in pointing out the important differences which distinguish the one from the other.

The first and fundamental difference is seen in the following definition : Hanging is a constriction of the neck by a ligature, the weight of the body suspended being the effective force whereby the constriction produces fatal results. Strangulation means simple compression of the neck in any form or manner, not necessarily with a rope, and without the weight of the body entering as a factor in any way. The element of the suspension of the body constitutes the one essential distinction between these two forms of death; but this is quite enough to establish specific and interesting differences which will aid in a diagnosis based on the post-mortem appearances.

Death by strangulation presents itself under two principal forms : 1. As manual strangulation, or throttling ; sometimes called *immediate* strangulation ; 2. As strangulation by a rope or other forms of ligature, called *mediate* strangulation. Of these the former is by far the more frequent mode in which the fatal violence is employed. When a ligature of any sort— whether a rope, handkerchief, strap, ribbon, or what not—is used, it may be wound several times about the neck ; or, if a single turn is made, it may be twisted at the back of the neck as with a tourniquet, in order to produce the desired degree of constriction. The manner in which the ligature is applied can often by itself alone serve to indicate at once the essential facts of strangulation, and especially can show whether it has been applied by the hand of some person other than the deceased.

When manual strangulation is the method used the pressure upon the trachea or larynx is at the same time lateral and from the front backward against the spine. The head and the back of the neck are held firmly against some resisting surface, or are supported by the assassin's other hand, making counter-pressure. In this way the obvious result is the closure of the indispensable air-passage. If, as is usually the case, the press-

ure is also from below upward, we have the additional obstruc-
tion to the entrance of the air by the forcing of the *tongue*
upward and backward against the palate and the pharynx.

The somewhat too familiar crime called " garroting " is an
example of the immediate or manual form of strangulation.
The attack is made usually with the intent to rob the victim.
The neck is seized at the front and partial throttling is accom-
plished while the accomplices in the crime rifle the victim's
pockets. It is a crime which, from its own nature, requires
more than one in its performance. This crime of garroting
has only a remote resemblance to the Spanish method of
executing criminals from which its name is derived, and which
is still in vogue. It is described in detail, as follows :

" On February 10, 1892, four leaders of the anarchists, who
led an attack upon the town of Xeres, were executed. Early
in the morning mass was said and shortly afterward the
prisoners, escorted by a number of guards and the priests who,
as they marched before and behind the condemned, read the
prayers for the dying, were taken to the plaza. Here they
ascended the platform and took seats in the chairs. The
executioners fixed the collars about their necks, and in an
exceedingly short time they had paid the penalty of their
crimes with their lives.

" The instrument of death used in Spain is always the gar-
rote, unless shooting is specified. This is a brass collar which
is contracted by means of a screw in the back. As the screw
is turned on the collar shuts upon the neck of the condemned,
and at the same time the sharpened steel point of the screw
enters the spinal marrow where it joins with the brain, causing
instantaneous death.

" The platform on which the men were executed was sur-
rounded by detachments of infantry and cavalry, and the route
from the jail to the platform was lined with soldiers with
loaded rifles. The executions were public, and the plaza and
the streets leading to it were packed with a dense mass of
people from an early hour.

" One of the condemned men struggled desperately to escape
being forced to approach the chair-like stake. So terribly did
he struggle that it required the combined strength of five men
to force him into the death seat, and even then they had much
difficulty in getting his neck into the garrote. This scene
worked the people into a state of rage and indignation terrible
to behold. Men shouted and cursed at the authorities ;
women wept and moaned as they buried their heads in their
aprons and dresses, and several people, male and female,

fainted outright; but there was no attempt made to attack the police or military, for the latter had taught the anarchists of Xeres a lesson which they were not likely to forget for many a long day."

In Turkey judicial executions are accomplished with celerity by strangulation with a bow-string. The thugs of India (bandits or highwaymen) strangle their victims with the soft loin cloth called the cummer band. Chevers, an East India authority, relates cases of strangulation occurring in his country, in which the subjects were strangled with the knee and foot. Flexible twigs and bamboo strips are sometimes used for the purpose. A case of suicide was reported, of a woman, who strangled herself with her long hair.

The Phenomena of Strangulation.—These differ from those of death by hanging. They vary, also, according to the circumstances—the amount of resistance and struggling which are associated with the act. At one extreme we may have to do with strangulation after a prolonged and exciting struggle, the victim being vigorous and the assailant also strong and determined. Or, at the other extreme, the victim is a woman or a child, or a person intoxicated, narcotized, or asleep, and so an easy victim of strangulation speedily accomplished. Between these extremes may be found all varieties to illustrate the *phenomena* of strangulation.

The symptoms or phenomena of strangulation are divisible into four periods or stages.

The **first** stage is a longer or shorter initial or preliminary one in which there is simply a suspension of breathing. It continues less than a minute, and it lasts until the demand for air is imperative and irresistible.

The **second** stage is one of struggle and excitement. It begins with the urgent call for air just mentioned, and lasts until unconsciousness comes. It is characterized by violent efforts to breathe, efforts in which the whole body sympathizes. The countenance shows distress; the hands are clenched; the tongue may be caught between the teeth and bitten; the urine, feces, and seminal fluid may be discharged; there is great struggling.

The **third** stage is one of unconsciousness with irregular, involuntary, spasmodic actions of the limbs. The convulsions may even reach the stage of opisthotonos. The superficial veins are swollen; the surface is livid; the circulation of unrenewed blood in the capillaries is observed in the purple finger-tips and lips; sometimes hemorrhage occurs from the lips, nose, mouth, and ears.

The **fourth** and final stage begins with the cessation of spasms and of active efforts to breathe. The individual is quiet in all parts except the heart; that organ is the last part to die.

These phenomena have been studied experimentally by Faure, a French physiologist, and have been described by him with great precision of detail. Among his observations are the following: 1. He applied a ligature suddenly and forcibly to the neck of a medium-sized dog. For fifty-five seconds the animal seemed not to suffer. Then there was violent agitation; the body stiffened; the dog fell and rolled convulsively; a bloody froth came from the mouth and nostrils; there were violent efforts to breathe; soon death supervened. 2. In another experiment tracheotomy was performed on a dog. An elastic tube was slipped into the trachea through the tracheotomy orifice. Access of air was gradually cut off by closing the lumen of the tube. It was borne up to one-half closure, then great suffering, convulsions, and death followed.

Dr. Graeme Hammond, of New York, tried some experiments on himself to determine whether or not strangulation was painful to its subject. While he sat in a chair an assistant twisted a towel tighter and tighter around the doctor's neck, while another assistant stood near to watch the effects of the operation and to take notes. Dr. Hammond's own words are, perhaps, the best record. He stated his sensations thus: " I first noticed a sensation of warmth and tingling, beginning in the feet and passing quickly over the entire body. Vision partially disappeared, but there was no manifestation of colored lights. My head felt as if about to burst, and there was a confused roaring in the ears. I suffered no loss of consciousness, and was able to tell my friend whether I felt pain from the knife-thrusts which he was inflicting on my hand. In sixty-two seconds from the beginning of the experiment all sensibility was abolished. After a few minutes' rest a *second* trial was made in the same manner as before. This was followed by symptoms like those described above. Sensibility ceased in fifty-five seconds, and a stab with a knife sufficiently deep to draw blood caused no sensation whatever."

According to Claude Bernard, strangulation causes a rise of temperature of 1 or 2 degrees C. He thinks this is due to the changes from arterial to venous blood, especially in the muscles, during the asphyxia.

The time required for strangulation to reach a fatal issue is a matter of some interest. In Faure's experiments on dogs, just mentioned, death occurred in the first observation in three minutes and a half after the ligature was tightened.

Taylor declares, and Tidy agrees, that it is probable that human beings die more readily than animals under such circumtances. A sudden and violent compression of the trachea renders a person powerless to call for help or give an alarm, and it may cause almost immediate insensibility and speedy death. Moreover, the usual attendant circumstances of death by strangulation, of the homicidal variety, would tend to abridge the process. The determined and rapidly progressive action to secure fatal effects upon the neck of the victim by a murderer, animated by reckless and impatient fury, would necessarily shorten the initial stage of the scene and quickly bring on the convulsive movements of the second stage. There would be some difference, too, growing out of the method of strangulation employed. The use of the tourniquet or mechanical garrote would generally be followed (Tardieu) by almost instantaneous death. Manual strangulation is also quickly over. Strangulation with a rope or other form of ligature, not twisted but simply tightened by drawing, would cause a more prolonged struggle and a slower advent of death. The age and vigor of the victim, also, would necessarily modify the element of time. The old, the very young, or those who are incapable through physical weakness or other causes of offering determined resistance, perish by strangulation much more readily than those of mature vigor. From all the considerations and data which are available, therefore, we may conclude that death will follow in from three to five minutes of uninterrupted compression or constriction of the neck under the ordinary conditions of strangulation. That it is sometimes a very brief and easy matter under favoring conditions to kill by strangling is illustrated by a case related by Tardieu: The victim, an old woman with a lean neck and prominent larynx, was strangled to death so quickly and quietly that her husband, just the other side of a thin partition, heard nothing of it.

That homicidal strangulation is easily accomplished under favorable conditions relating to the strength of the parties engaged, and that very little disturbance may attend the struggle, are illustrated in the case of Dr. Clench, cited in Hargrave's *State Trials:* Dr. Clench, a physician of London, was called out of bed by two men late at night in January, 1692. They desired him to visit a sick friend of theirs. He entered a carriage with them, and under their direction the driver drove up one street and down another about the city for about an hour and a quarter. Then they left the carriage. The driver found Dr. Clench sitting on the bottom of the

carriage against the front seat with his head on the cushion. Thinking him in liquor, he shook the passenger, but got no answer. He called a policeman, who found the doctor strangled by a handkerchief in which a piece of coal was placed so as to press directly against the trachea. The coachman had heard no noise whatever in the carriage during his driving about.

In a study of the subject of death by strangulation we are naturally interested in three questions, as in the consideration of the allied subject—death by hanging: 1. What is the proximate cause of death in strangulation? 2. What appearances do we find about the dead body of a person strangled to establish a post-mortem diagnosis, or, in other words, what are the anatomical evidences of a death by strangling? 3. Assuming this diagnosis to be established, what further facts enable us to determine the manner of the death—whether it was accidental, suicidal, or homicidal?

The Cause of Strangulation.—To the first question the comprehensive answer may be made that a death by strangling is in nearly every instance a death by apnea. The essential incident is that air is not permitted to enter the lungs, the air-passages being occluded by external constriction. The necessary consequences of this occlusion quickly follow. The removal of the blood by aëration in the lungs is arrested, and the symptoms and effects of asphyxia quickly supervene.

If other elements than asphyxia enter into the cause of death at all in strangulation, they enter into it in a wholly secondary and incidental way, and can not dispute the claim of asphyxia as the controlling principal factor. Sometimes, no doubt, the intracranial circulation is interfered with by lateral pressure on the neck in the act of strangling. It is easy to see, however, that such pressure is not so inevitable or constant as a feature of this form of violence as it is in a death by hanging. The position of the hand in throttling, or of a rope in strangling, might easily be such as to permit the arteries and veins in the neck to keep their channels open.

Hofmann finds in the traumatic irritation of the pneumogastric nerve, situated as it is so favorably for pressure, an auxiliary cause of death in strangulation, as in death by hanging. This nerve is the regulator of respiration, and Claude Bernard has found that sudden arrest of respiration can be brought about by its compression. Similar inhibition can be brought about by compressing the larynx of dogs after they have been tracheotomized. In these cases the stage of dyspnea in the course of the progressive apnea is materially shortened when compared with that which results from simple constric-

tion of the trachea, *without* any contusion of the pneumogastric. Fisher, among others, has demonstrated that animals can be killed very certainly and quickly by sharp blows upon the larynx, or by quick pressure upon the trunk or branches of the vagus in the neck.

Brouardel gives an example of this interesting effect in his work published in 1897 :[1]

" A priest, whose conduct was not as immaculate as it might be, was obliged to remove his mistress from his vicarage.

" ' The day had passed very sadly,' said Abbe Delacollonge; 'everything was made ready for her departure; the sorrow had broken my heart, and I said to her, We should be happier if we were dead.'

" ' Yes,' she said, ' if we could die together. '

" ' I then said to her jokingly (for I could find no other way of expressing myself at the moment), Could you bear me to cause you much pain ? '

" ' Try,' she replied.

" ' We were both standing up. I took hold of her neck. It was intended as a harmless piece of fun on my part, and she showed by a smile that she regarded it as such. All at once she made a sign of pain and shook her hands, but without uttering any cry. I relaxed the pressure and she fell down. I picked her up, but she was dead.' "

During the hearing of this case in the French Assize an ex-officer of the army made this deposition :

" ' We were in garrison. Among our number were two captains. In a moment of friendly mirth, Captain L. seized Captain S. by the neck, by way of a joke.

" ' Now, old fellow,' said he, ' I am going to put you out of the way.'

" This he said playfully. Captain S. staggered and fell in a state of unconsciousness. Owing to the skilful attention he at once received he was soon restored."

The ease with which asphyxia may be brought on by manual strangulation is well shown by some experiments instituted by Langreuter on the dead body. He found that if the thumb and forefinger were placed externally on the two sides of the thyroid cartilage the slightest pressure sufficed to close the aperture of the glottis. Stronger pressure made the vocal cords overlap. When pressure was made between the larynx and the hyoid bone, the air-passage was effectually obstructed, principally through approximation of the hyothyroid group of ligaments.

[1] *Death and Sudden Death*, p. **22.**

Anatomical Appearances after Death by Strangulation.—The *second* in the series of questions suggested by a case of strangulation is, What are the post-mortem proofs found on the body of a person strangled? They are, in the first place, such as are common to this and to other forms of asphyxia—that is, the *general* indications of the manner of death. Secondly, they have the appearances of a more specific or local character, showing the particular agency or method employed. Both will vary within somewhat wide limits. We may have to base our post-mortem diagnosis on the most trifling, and, perhaps, equivocal anatomical data on the one hand, the body appearing quite normal with the exception of a few tell-tale marks or scarcely perceptible changes; or, on the other hand, we may have presented for our inspection a frightful picture which represents great violence and leaves no doubt as to the cause and manner of death.

First, what does the external inspection discover? The face of a person dead by strangling is generally livid and swollen, sometimes mottled; this livid condition is uniformly more marked than it is in death by hanging. It is most pronounced in the cases of the plethoric, vigorous adult; here the change affects the lips, ears, neck, and face. Exceptionally, the countenance is found placid and pale, but not usually.

Of great consequence and significance in these external signs are the ecchymoses, of small size, observed in the skin, especially about the front of the chest, and giving to that region a spotted, mottled, or dotted appearance. These are not due to direct violence to the part, but are the result of capillary ruptures. Though, perhaps, not to be described as a uniform and constant appearance, it is, however, so frequently observed as to be regarded by some authors, by Tardieu especially, as of great value in diagnosis, particularly as it is present in marked degree when it is present at all. It should be remembered, however, that these subcutaneous ecchymoses are not peculiar to strangulation alone.

Naturally much interest attaches to the local appearances which the neck presents. These will differ according to the method used. If a *rope* or other form of ligature has been employed, we shall find evidence of such use in a groove or depression which has the following characteristics: In direction it is usually horizontal, taking a circular instead of an oblique course, thus distinguishing it from the appearance of the depression left by the cord in a case of hanging. In depth it is shallow, the pressure and constriction being ordinarily of brief duration and the physical results of suspension of the

body being absent. Its outline is more or less broken and interrupted, because of unequal pressure; or because of the inclination of the head to one side; or of the accidental inter-position of foreign bodies between the ligature and the skin; or the intentional placing of hard substances or knots in the ligature, so that greater pressure on the trachea may result. It will be single, double, or even more than double, according to the number of turns which the ligature is made to take. Its base will be *pale*, but not dried or parchment-like, as in death by suspension, the weight of the body having no place as a factor and the duration of the compression being brief. Its edges at either side of the groove will be more or less livid or reddened. Sometimes they are found abraded. Ecchy-moses are an occasional appearance in the groove or at its edges—due to inequalities in the ligature.

Other characteristics pertaining to the mark left by the cord are the following: It corresponds in width with the width of the ligature, as a rule. If a soft and yielding fabric, like a silk handkerchief, tightly twisted, is used, a narrow mark will be left. The situation of the lesion is usually across the front of the neck *below* the larynx; thus offering another contrast with the results left by hanging. The depression is deepest in front. It becomes more apparent as the body cools. So much for the appearances presented by the neck of the victim when a *rope* has been used for his strangulation.

If the strangling has been done with the *hand*, the so-called *manual* or immediate variety, or throttling, we find a different set of appearances. These consist of the marks left by the assailant's hand, especially his fingers. Under ordinary cir-cumstances, the assault is made from the front and with the right hand. In this case the finger-marks will be found on the left side of the victim's neck, with a single mark of the thumb on the right side. The **situation** with reference to the trachea will be well at the side, generally under the angle of the lower jaw; occasionally at the root of the neck close to the clavicle.

The **color** is at first bright red, then violet or bluish like other ecchymoses. The **size** and **shape** will correspond with those of the finger-tips, with the fingers partially flexed and applied with great force. They will appear in two forms, ecchymoses and excoriations. The latter will be particularly important to observe accurately. The direction of the curvi-linear imprint of the nails, their width, depth and color, all have important bearings as data for diagnosis, as well as evidence concerning the manner of the struggle, which hand was used in the assault, and the degree of resistance.

Occasionally the traces of throttling left on the skin by the
fingers are so slight and indistinct as to be readily overlooked;
but it is not so generally, because the violence used is out of
proportion to the need, and the external signs are unmistak-
able.   In the doubtful cases it is all the more imperative to
examine and note with great care and full detail the shape,
size, color, and relative location of all marks about the front
of the neck, since the faintest lesion may assume an aspect of
prime importance when studied in connection with other
appearances in the *deeper parts.*

It is in homicidal throttling that these more serious lesions
of the larynx occur.   Cases are on record of injuries to the
cricoid cartilage (Pyl, Hofmann), to the thyroid cartilage
(Henke), to the hyoid bone and both cartilages (Devergie), of
the hyoid bone broken (Hofmann), and of fracture of the ary-
tenoid cartilage, one case (Schnitzler).   All these mean the
application of great force.   It might be inferred that the elas-
ticity of the larynx would protect it from fracture.   To deter-
mine this point, Keiller, of Edinburgh, instituted a number of
experiments on the dead subject with the following results:[1]

1. Ordinary falls on the larynx are not capable of causing
fracture of the laryngeal cartilages, while even falls from a
height with superadded force are unlikely to do so.

2. Severe pressure applied from before backward, so as
strongly to compress the larynx against the vertebral column,
or violent blows inflicted over the larynx by means of a heavy
body, *may* cause fracture of the larynx.   Fractures so pro-
duced, however, will be most discernible on the *internal* sur-
face, and generally in or near the mesial line.

3. Violent compression applied to the sides of the larynx
(as in throttling) is, of all applied forces, that most likely to
produce fracture of the alæ of the thyroid cartilage, or even of
the cricoid cartilage, and fracture so produced is most per-
ceptible as well as most extensive on the *external* surface of
the larynx.   By this mode of violence, too, the hyoid is most
easily broken.

4. The condition of the larynx (absence or presence of
ossific matter) materially influences its liability to fracture from
external violence.

What are these subcutaneous evidences?   Frequently they
are more marked than are the lesions found after death by
hanging; and they are often out of all proportion to the ex-
ternal traces of injury.   Even when there are no ecchymoses
on the surface, infiltrations and extravasations of blood have

[1] Tidy, *Legal Medicine*, ii., p. 428.

been found not only in the subcutaneous connective tissue of the neck, but in the interior of the muscles, above and below the hyoid bone, and on the outer surface of the thyroid and trachea. In manual strangulation these sanguineous marks have been found circumscribed and isolated, corresponding with the surface marks of the fingers. At other times the extravasations are more diffused, the blood being infiltrated through the loose areolar tissue in all directions. The larynx and trachea usually escape serious injury. Their fracture means extraordinary and very unusual violence.

A marked injection of the mucous membrane of the larynx and trachea is one of the most striking indications of strangulation, whether those parts have been fractured or have escaped uninjured. The inner surface of those organs presents a uniform redness which is characteristic. We almost always find, too, a greater or less amount of froth in the air-passages. It is generally fine in structure and penetrates to even the smallest branches of the bronchi. It is usually white—sometimes pink from blood. Froth, tinged with blood, in the air-passages is regarded by Tardieu as one of the most constant signs of death by strangulation. Occasionally, instead of froth, or with it, free blood is found extravasated in the trachea and bronchi.

The tongue is ordinarily found more or less protruded, and the teeth have left their indentations on the upper and lower surface. Casper, with his usual tendency to incredulity, says: " Repeated observation has convinced me that the condition and position of the tongue are wholly untrustworthy as a sign of strangulation. It is found protruded and bitten in many other forms of death, such as drowning, hemorrhage, poisoning, etc." [1]

In spite of Casper's conservatism, we must admit with the majority of writers that the state of the tongue has a value as confirmatory evidence. It is one of the data; and when we observe in a body just dead that the tongue is swollen, purple, and caught between the teeth, we should be very apt to interpret this appearance as very suggestive of strangling.

Blood (either in a free state or mingled with air in the form of bloody froth) may be found issuing from the mouth and nose. Sometimes, although it is a rare sign, the membrane of the tympanum is ruptured, and this lesion shows itself in a slight dribbling of blood from the auditory meatus. In all these cases in which blood is found externally it indicates

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[1] *A Handbook on the Practice of Forensic Medicine*, Sydenham Edition, ii., p. 162.

extraordinary violence and vicious brutality in the act of strangling. Occasionally the exuding blood is a valuable tell-tale. In Taylor's *Manual*[1] a good illustration of this is recorded: A woman had been murdered by strangulation. The body was packed in a box and delivered to an expressman. He noticed a suspicious red fluid coming from the joints; also a large red stain on the floor where the box stood. He notified the police, who opened the box and found the body. There was a cord tightly encircling the neck. Blood was coming from the nose and mouth, suggesting that the strangling had been done with great violence.

The eyes are generally found wide open with a staring expression. If death is particularly violent, they are prominent or protruding. The pupils are dilated and the conjunctivæ are injected.

The lungs show a condition which represents asphyxia. Generally they are engorged with blood, and so they are of a uniform purple or dark red. Occasionally there is entire absence of the evidences of hyperemia, but an emphysematous condition of the peripheral vesicles is rarely lacking. These patches of emphysema, due to the rupture of air-cells, are multiple, sometimes isolated, sometimes united in groups. They give to the surface of the lung an irregular aspect, as of pseudomembranous layers, very thin, very white, and of varying sizes. They leave the pleural surface uneven, and one characteristic is that they may be punctured and emptied. Punctate subpleural ecchymoses which are so marked in suffocation and drowning are not common in death by strangling, but hemorrhagic nodules in the substance of the lung are much more frequently found, and, in fact, are quite characteristic.

The heart is not uniform. It is sometimes engorged on its right side; sometimes it is quite empty. Ecchymoses or sanguineous extravasations under the pericardium or in the substance of the heart are not common. The blood is not characteristic; generally it is dark and fluid; sometimes it is clotted loosely.

The appearances of the brain, also, are variable and of no great value in the post-mortem diagnosis of strangulation. Usually it is normal; sometimes it is congested. One case on record showed a marked effusion of blood.

Concerning other organs, we do not find anything sufficiently uniform in its presence to assist us; although some authors describe the stomach as showing a marked reddening of the mucous membrane in these cases.

[1] *A Manual of Medical Jurisprudence*, p. 457.

It should be borne in mind that even when a body has remained a considerable time in the ground and putrefaction has advanced to a late stage, the marks of strangulation may still be found in an unequivocal degree.

Wharton and Stillé report the following instructive case:[1] After a lapse of thirty-eight days following the interment, a corpse was disinterred by order of the authorities. It was already greatly decomposed, but evidence of strangulation was obtained chiefly from the fact of the striking contrast of the integuments of the neck with those of the rest of the body. There was a white and shrivelled space over the larynx half an inch broad and extending back on each side, from which, also, to the nape of the neck, over the second vertebra, there ran a groove of a blackish-brown color, dry and difficult to cut.

Taylor[2] reports the following case in which strangulation was verified after a partial destruction of the body: Fire broke out in a cottage in which at the time were a man, his wife, his stepson, ten years old, and a baby. The man got away with the child, and said that his wife and stepson had left the house before the fire. This was false, for the bodies were discovered much charred. They were buried, but later, suspicions of murder and incendiarism arose, and they were exhumed. The wife's body was too much burned to serve any end, but around the neck of the boy there was a horizontal depression a quarter of an inch wide, smooth and quite distinct from the broken, blistered, carbonized skin at either side, and an eighth of an inch deep. The skull was fractured and the tongue protruded, showing strangulation of a living person. The man was found guilty of murder.

The case of the widow Houet, recorded by Beck,[3] is another example: The woman disappeared in 1821. Three persons were suspected of murder, but were set at liberty for lack of evidence. After eleven years a body was found buried in a garden. When uncovered it was hardly more than a skeleton. The grave was four feet deep and the body had been tumbled in, resting on its side, with the spine much bent and the arm raised—a position suggesting that the corpse had been thrown in head foremost. Careful note was made of the proportions and character of the various parts of the skeleton for purposes of identification. The state of the neck was the one thing of most interest. The third, fourth, fifth, and sixth cervical vertebræ and the right clavicle were held together by a blackish

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[1] *Loc. cit.*, section 918.
[2] *Principles and Practice of Medical Jurisprudence*, ii., p. 69.
[3] Beck, *Elements of Medical Jurisprudence*, ii., p. 224.

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mass, in the composition of which it was impossible to recognize any tissue. This mass was surrounded at its lower part by several twists of a cord two lines in diameter and in a very decayed condition. No knot could be found in it. Its direction was exactly horizontal. The commission (Orfila and others) reported: " We feel ourselves justified in concluding: 1. That these bones are those of a human skeleton. 2. That the skeleton is that of a female. 3. That this female had attained the age of from sixty to seventy. 4. That her stature had been about five feet. 5. That the hair, which had been a bright blond color in youth, was mixed with gray at the time of death. 6. That the hands had been small. 7. That, during life, the bones had never suffered any injury. 8. That the woman had died of strangulation, and the act had been, to all appearances, homicidal." The accused were condemned and sentenced to hard labor for life.

The anatomical appearances, therefore, which supply trustworthy data, proving a death by strangulation are these: Externally, a swollen, livid face; protrusion of the tip of the tongue; punctate ecchymoses in the skin of the chest; local lesions about the neck; injection of the conjunctivæ; and bloody froth about the mouth. Internally, vesicular emphysema of the lungs with hemorrhagic nodules in their substance; highly reddened mucosa of the trachea and bronchi; white or bloody froth in the air-passages; dark fluid blood in the heart and solid viscera; and *especially* subcutaneous traumatic lesions about the neck.

The Manner of Death.—The last of the three questions suggested by a death by strangulation is, Was the death accidental, suicidal, or homicidal. The presumption is uniformly in favor of homicide in these cases. This fact gives us another point of contrast between hanging and strangling. In the case of a dead body found hanging, suicide is immediately suggested. In the case of a dead body presenting the appearances of fatal strangulation, the inference is that a second party was the author of the lesions found, and that murder was their end and purpose. At all events, in every case of this kind, the burden of proving that it was something *other* than murder rests on the one who disputes the initial presumption, and he must bring forward strong evidence to establish proof. This is not saying that strangulation is impossible as a matter of accident or suicide, but only that it is extraordinarily rare, and when cases occur they are medicolegal curiosities.

Accidental Strangulation.—The following are some examples of accidental strangulation: A young man who was paralyzed

was in the habit of moving a heavy weight by a cord attached to it and passed around his neck. He was found sitting in a chair, dead, with the cord twisted about his neck. It had probably slipped.[1]

A girl who was carrying fish in a basket on her back, which was fastened with a leather strap around the upper part of her shoulders, was found dead, sitting on a stone wall. The basket had slipped off and the strap had been raised so as to come across the neck and compress the windpipe.[2]

A boy, wearing a silk necktie, was caught in the band of an engine shaft, and his neck was drawn down against the revolving shaft. The circumference of the neck was reduced from twelve to eight inches. No air entered the lungs for one minute. He was black in the face, and blood escaped from the mouth and ears, and he was insensible. He fully recovered.[3]

A porter was caught between an elevator counter-weight and the rail of an iron lattice guard at the side of the wall, just within which the flat counter-weight came down upon his neck; he was strangled at once.[4]

On November 29, 1893, a man was caught by the neck between the top of the door of an elevator car and the floor on which his body fell at the edge of the opening, the car moving down. He was found struggling there, but died before the car could be moved up. There were marks on the side of the neck; his face was livid; his tongue protruded; and his eyes were prominent.[5]

As a general rule, these cases of accidental strangulation present no difficulty to a medical inspector who takes accurate note of the surroundings, provided those surroundings have not been disturbed before his arrival, and he has full opportunity to establish the relations of the body to the objects near it, as well as to examine the nature and degree of the compressing force upon the neck of the person. Moreover, eye-witnesses are generally available.

Suicidal Strangulation.—Suicide by strangulation is undoubtedly rare. Its possibility, indeed, has been denied by some authors on purely physiological grounds. This denial, however, applies chiefly to manual strangulation, the assertion being that a person applying his fingers to his neck cannot use pressure sufficiently long and forcible to cause fatal asphixia. It is fair to say, however, that in any case in which suicide by strangulation is alleged, the evidence, moral and

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[1] Guy, *Forensic Medicine*, p. 289.
[2] *Principles and Practice of Medical Jurisprudence*, ii., p. 67.   [3] *Ibid.*
[4] Author's notes.   [5] *Ibid.*

anatomical, should be of the strongest and most unequivocal character before the far more tenable presumption of homicide is set aside.

Some of the data or indications of suicide are the following : The absence of all signs of resistance and struggling ; the ownership and nature of the ligature ; the articles of dress, such as garters and handkerchiefs, pointing to the victim only ; the kind of knot, its position, whether in front or but little to one side ; the number of knots, whether single—or double, indicating homicide ; the relatively slight force indicated ; whether a tourniquet was used ; the kind of article used, how used, and its ownership ; the previous history of the person dead ; the surroundings of the body ; the inside appearances of the room ; the attitude of the body ; the absence of blood stains.

Wharton and Stillé[1] relate a case in which a sabre was used to tighten the ligature. The ligature was a cotton handkerchief tied in a hard knot at the side of the neck. A sabre had been placed in a loop in front and evidently twisted several times, so that full constriction was accomplished. A broad, deep ecchymosed mark was left on the neck, most pronounced and attended with excoriation where the knot was. The man was a corporal, who killed himself because he had been arrested for neglect of duty.

In another case, reported by Wharton and Stillé,[2] a man, sixty years of age, was found in a wood with a napkin around his neck, which had been tightened by a walking stick thrust through a loop in it. The body was lying on the back, with the legs lying extended in a straight position and the arms extended close along the side of the body, just as if carefully laid out after death. Full evidence of suicide by strangulation was found.

General Pichegru's case is another example :[3] He was confined in prison by Napoleon's orders. At 10 P. M. his cell was locked and the keeper took away the key. He was then alive and well. He was heard coughing in the night. At 7 A. M. he was found dead in his bed. A black silk cravat was around his neck, strongly knotted, and a small stick (eighteen inches long and three and a half in circumference) had been used as a tourniquet to tighten the band. One end of the stick lay against the left cheek, where it had caused an excoriation. There were no evidences of a struggle or resistance. Yet not a few believed that instead of a suicide it was a homicide with Napoleon as its instigator.

[1] *Loc. cit.*, p. 820.　　　　　　　　　　[2] *Loc. cit.*, p. 821.
[3] Taylor, *Principles and Practice of Medical Jurisprudence*, ii., p. 70.

Binner (1888) relates a case (unique, according to Dixon Mann [1]) of suicide by manual strangulation: A woman, forty years of age, who suffered from melancholia, had previously made several attempts to kill herself. She was found dead, crouched in her bed, with both hands compressing the throat. The elbows were supported on the knees, and the back leaned against the wall behind. The marks of her finger-nails were visible on both sides of the neck.

Homicidal Strangulation.—The question of the manner of death in any case of ascertained strangulation might be dismissed by applying the general rules of exclusion, and decide that if accident and suicide are eliminated, the case must be one of *homicide*. There are, however, certain characteristics of homicidal strangulation which serve affirmatively to establish a conclusion. For example, in the case of an adult, the amount of the violence inflicted is generally severe, and its marks are found on the neck and elsewhere. The reason for this is clear; it means a determination on the part of the murderer to accomplish his work with certainty. He overdoes his work; hence the injuries to the neck, superficial and subcutaneous, will be distinct and demonstrative; while bruises and other marks of violence mean struggle and resistance, and are inconsistent with accident and suicide. It is in these cases that we find the more serious lesions about the neck, such as fractures of the thyroid cartilage, the hyoid bone, extensive extravasation of blood, and the like, which are incompatible with any view other than homicide.

In managing a problem of this kind, where the fact of homicidal strangulation is to be determined, certain possibilities ought not to be overlooked. For instance, the finger-marks found on the neck may have resulted from the act of the deceased himself, who, in dying suddenly from some distressing attack in which dyspnea was a marked feature, had applied his hands to his neck. On the other hand, the victim of a homicide may have been asleep, or narcotized, or made insensible by a blow; or the victim may have been a woman or a child; thus rendering the act of throttling so easy that scarcely any tell-tale marks are left. This is not the usual state of things, however, for the assailant who murders by strangling is not nice or studied in his methods; he usually overdoes his work for the sake of certainty, and no matter how feeble and incapable of resistance the victim may be, the post-mortem indications of the cause and manner of the death are usually such as to lead readily to a correct conclusion.

[1] Dixon Mann, *Forensic Medicine*, p. 208.

The author can not better close this chapter than by quoting a case of homicidal strangulation reported in the *Lancet* for February 25, 1893, by Dr. Thomas Stevenson:

"The victim was a medical man, forty-two years old, of good physique, and well nourished. On October the 11th he was alive and well and with his friends at home. That night he spent in carousing, and early the next morning he was seen with a woman with whom he visited various liquor saloons. About noon she left him in the company of three or four men and at that time he was pretty drunk. He left the beer house with the men, two of whom were supporting him by the arms. The party was noisy, and they walked up the street, singing, until they came to a dark and narrow passage leading to a public house. Here one of the men kept a lookout, while the others proceeded to rob and, as it turned out, to strangle the doctor. Within five minutes after entering the passage the three men were seen to emerge by the doors of the public house to which it led, and their victim was found on the pavement of the alley, insensible and doubled up. His collar and sailor-tie were very tight, and he was thought to be in a fit. Froth was issuing from his mouth and nose. His neck clothing was loosened and he was taken to Guy's Hospital, where he was declared to be dead.

"The face was dusky; the pupils were normal; the tongue was not protruded. On the neck the only mark was a small crescentic abrasion, concavity up, situated at about the level of the cricoid or a little to the right of the median line. Rigor mortis developed rapidly and in full degree, and cadaveric lividity was pronounced. The features were calm. There were many minute dusky ecchymoses on the forehead and scalp. On dissection, much dark blood was found effused among the muscles of the neck, reaching from the hyoid bone to the top of the sternum, and chiefly massed around the right side of the larynx and trachea. The cricoid cartilage was fractured and the larynx was broken. The epiglottis was erect and the glottis was free. The tracheal mucous membrane was much injected. The hyoid bone was broken just to the right of the lesser cornu. The thyroid cartilage showed three fractures on its right side. Two hemorrhagic foci were found in the substance of the left lung. The bronchi were reddened. Over the left ventricle of the heart, beneath the pericardium, was a group of pin-point subpericardial ecchymoses. The heart was contracted; the right ventricle contained a small dark clot and fluid blood; the left cavities were empty. The kidneys were hyperemic. The brain and spinal cord were normal."

CHAPTER XVIII.

DEATH BY SUFFOCATION.

WE have studied some of the most important and interesting illustrations of death by asphyxia, namely, death by drowning, hanging, and strangling. We pass now to still another and final group of deaths which may be assigned to this same general class—those which are caused by *suffocation*.

Asphyxia, physiologists tell us, results in one of three ways: 1. When the pulmonary vessels are in a state to obstruct the circulation of the blood through the lungs, and so prevent its renewal by aëration. 2. When the structure of the lung itself is changed and hematosis is thus rendered impossible. 3. When the air does not reach the air-cells of the lungs, the lungs and vessels being normal.

The latter condition is the only one of much interest to the medical jurist; the first two are generally the result of disease. It is in this last group of causes that suffocation is found. A person is suffocated, then, whenever any obstacle or agency intercepts or prevents the entrance of air to the lungs in sufficient quantity for proper renewal of the blood. This is the definition of suffocation in its broadest sense. Taken literally, this definition is indeed broad enough to include the whole group of topics which have been included in the preceding three chapters of legal medicine; and in its strictly etymological sense, suffocation may be said to embrace drowning, hanging, and strangling, as well as some other forms of death. These, however, have distinctive characters of their own, and deserve special consideration along their own lines, and that is why they are considered separately. We shall, however, discover that suffocation has other representative illustrations, equally interesting to investigate and equally important in their relation to criminal jurisprudence, and to this considerable remnant this chapter will be devoted.

Suffocation, however, is sometimes the proximate cause of sudden death in the course of diseases which are not in any way related to unlawful violence in their history, but which in their phenomena closely simulate violence. For example: Cases of tonsillitis sometimes proceed to suppuration and to

the formation of pharyngeal abscesses which are so obstructive to respiration as to cause fatal asphyxia. These cases are examples of inexcusable surgical neglect. Cases of diphtheria, with exudation of tough membrane occluding the rima glottidis and causing sudden death by such occlusion, are other examples. Occasionally, bronchitis in young babies is attended with an accumulation of mucus in the air-passages, and suffocation results.

Other examples of this kind of death are afforded in pulmonary edema of the glottis; in rupture of an aortic aneurism into the trachea or bronchi, with such a rapid outpour of blood as to asphyxiate; and in other forms of hemorrhage obstructing the air-passages, as in pulmonary hemorrhage. All these mishaps have little medicolegal interest.

Accidental Suffocation. — This variety of suffocation offers the largest number of illustrations to the medical inspector. For instance, cases of death resulting from panic in crowds, and great pressure on the walls of the chest causing smothering. Such instances of destruction of life in large numbers have afforded good opportunity to study post-mortem appearances left by suffocation.

Two notable examples were the subject of careful medicolegal investigation in France. In 1837, in an open square, on a fête-day, a great crowd had assembled, and a panic arose from some cause. The crowd lost control of itself, and twenty-three persons were killed. In 1866, on the evening of August, 15th, on the Pont de la Concorde, a woman fainted in the crowd. There were excitement and much pushing to and fro, and a panic resulted in which nine persons were killed. All the victims showed lesions of suffocation.

On the Brooklyn Bridge, in May, 1883, from some cause never fully known, the crowd rushed backward toward the New York end, and fourteen people were killed by crushing.

In Sunderland Hall, in England, in June, 1883, a children's entertainment was held. After the performance was over, and the body of the hall was cleared, twelve hundred children in the gallery began to leave. The door at the foot of the stairs was only twenty inches wide, and only one could pass at a time. One child fell and a great mass came tumbling down the stairs, and two hundred and two dead bodies were taken out. The post-mortem appearances of suffocation were found in nearly every case.

On December 27, 1895, in Baltimore, in the Front Street Theatre, an entertainment attracted a large audience. A leaking gas-pipe in one of the galleries disturbed the pro-

ceedings. A workman, while searching for it, accidentally set the gas on fire, and a cry of " Fire " was raised by an excited individual. Instantly a panic and a rush toward the exits occurred. The alarm was increased by turning out the gas in the house. As soon as possible the jam was relieved and an opportunity occurred to observe the damage that had been done. Twenty-three dead bodies were taken out. Of these the coroner said: " The appearance of most of the bodies shows that death was due to suffocation. In the majority of the bodies I have found no bones broken, showing that they were simply packed so tightly together in the struggle to get out that they were literally smothered to death. The lungs of most were congested, and the hearts were filled with blood."

A still more recent instance of this wholesale form of violence occurred on the Hodynsky Plain near Moscow in May, 1896, when a free feast and entertainment were in progress in connection with the coronation ceremonies. In the struggle for the food, a panic or stampede ensued in which the most horrible results quickly took the place of joyful merry-making. More than fifteen hundred perished. The whole region was strewn with the bodies of those who were killed by the trampling and by suffocation. The force of the surging mob was irresistible and the instant any persons fell the frenzied crowd passed over them, crushing the life out of them. It was a wholesale, ghastly slaughter which took all the spirit out of the coronation festivities at Moscow.

Of the same sort of mishap is the compression of the chest-walls which occurs when a man is buried up to the neck by the caving of a bank of sand at which he is working, or in a well which he is excavating. In these cases there is no inhalation of sand or dust; it is simply compression of all the parts below the neck.

We may, with Casper, include in this group also, such fatal injuries as result from compression of the thorax under the wheels of a wagon; or by a heavy weight, like a bale of cotton, falling on the body; or by burial under the timbers and débris of a falling building.

Dr. Thomas Watson relates the case of a negro model, of fine physical development. In order to fulfil an artist's desire to obtain a cast, the negro's body was inclosed in a plaster-of-Paris mould. The artist neglected to provide for respiration, and the negro was nearly suffocated.

The author has notes of the case of a man who was squeezed to death on top of an elevator car which he was cleaning,

November 9, 1890.   The appearances at the autopsy were
fully characteristic of death by suffocation.

Occasionally, a man subjected to extreme thoracic pressure,
and so put in jeopardy of his life, survives.   In December,
1900, a man was squeezed in a narrow space between the side
of a building and a moving trolley car.   He was taken to
Boston City Hospital, bleeding from the ears.   Several ribs
were broken.   Some hemoptysis occurred.   The color of his
face was a reddish purple, like a Damson plum, and it persisted
many days.   There were many minute subcutaneous ecchy-
moses on the front of the chest.   The conjunctivæ were fully
injected.

Another example of this kind of accidental suffocation is
found in the sand-bank or grain-bin burials in which the whole
body is covered.   Here there is something more than pressure
on the thoracic walls.   In the efforts to breathe there is in-
halation of the medium in which the burial occurred, and this
is quite enough to produce the phenomena of apnea.

Death in a burning building is another illustration of the
same thing.   The inhalation of soot and smoke is quite ample
to bring about fatal suffocation long before the heat, the actual
burning process, has its effect.   With the suffocation is com-
bined, also, the poisonous effect of the carbonic oxid gas
which, evolved in the slow combustion, is inhaled with the
atmosphere.

Intoxicated persons occasionally get into a position of help-
lessness wherein the mouth becomes covered and respiration
is obstructed.   Or, lying on the back, these persons inhale
the vomitus, which they are too drunk to control, and in this
way they perish.   The quite common casualty of *accidental
choking to death* by the lodgment and impaction of meat in the
pharynx is another way in which suffocation claims its victims.

Cases have also been reported[1] in which choking to death
occurred by obstruction of the trachea with foreign bodies
other than meat, such as shells, crusts of bread, fruit stones,
nutshells, coins, screws, living fish (Chevers), and false teeth.
Children are choked by peas, marbles, buttons, beans, and
coins.   Anacreon was suffocated by a grape-seed.   Taylor
relates the instance of a boy, seventeen years of age, who was
choked to death with an oyster.

Infants perish by inhalation of vomitus as they are lying on
the back, which is a very common casualty.   Milk-curds, too,
are inhaled, and sugar teats go wrong.   In order to keep a
child quiet and enable the nurse to sleep, or gossip, or read

[1] Tidy, *Legal Medicine*, ii., p. 449.

her novel undisturbed, a bag made of chamois leather or cotton cloth, holding a lump of sugar, is placed in the child's mouth. The baby is thus completely gagged, and respiration is carried on through the nose. There is easy stoppage of the breath, and suffocation without violence is gradual and without symptoms. The conclusion regarding the case is (the bag being missing) that the death was probably caused by "fits."

In this class of accidents there should be included those cases in which, during anesthesia, the tongue of the patient falls back while he lies supine, and so fills the passage to the larynx in such a way as to place the unconscious subject in danger of fatal asphyxia—a condition requiring care to prevent it and prompt measures to relieve it.

The writer has often thought that among all the specialties there was room for one more in the person of an expert anesthetist who, by skill and experience, would be in a position to prevent disasters of this kind and to relieve a surgical operator of all responsibility touching anesthesia.

Infants and young children are also accidentally smothered in another way: Under bedclothes when put to bed; by their being placed so that the face is in the pillow, and breathing is thus obstructed; by clothes falling over them while asleep; and by too tight or heavy covering when taken out of doors. For example: A young mother carried her baby to church to be baptized, and on her arrival she found the baby dead. She had drawn her shawl over the baby's head to keep out cold.[1]

Suicidal Suffocation.—Suicide by suffocation is an infrequent occurrence. Compared with the more usual methods of self-destruction (drowning, hanging, bullet-wounds, and poison) it is rare indeed. Yet enough cases have gone on record to form an interesting and instructive group of examples. Women are the ordinary victims, and insanity is a common predisposing condition. Suicide by suffocation has as examples cases in which the mouth is stuffed with some efficient foreign body, a handkerchief, or other articles of dress; rags or paper. In one case recorded, a cork was used reinforced with sharp pins. In another case a plug of cotton waste was found forced well back into the pharynx.

Homicidal Suffocation.—Homicide by suffocation is to be distinguished from suffocation by suicide or accident by an intelligent interpretation of the concomitant circumstances, as well as by the situation, surroundings, and conditions of the dead body. Often it is a matter of great difficulty to reach

[1] Holmes, *System of Surgery*, iii., p. 110.

exact conclusions. It is more easy to say in a given case in which the anatomical appearances are those of suffocation that it was not suicide or accident, than to assert affirmatively that it was a murder. In adults suicide by suffocation is such a rare occurrence that the question in these cases is generally narrowed to a decision between accident and crime. In children, suicide being out of the question in any event, the problem is even more simple than it is in the case of adults; but even in these cases there are manifest difficulties.

The antiquity of this form of murder is attested by a scrap of Biblical history. It is related in the Second Book of Kings, in the eighth chapter, that one of the royal line was put out of the way in this fashion. The concise narrative is a good model for the sensational school of modern journalism to follow: "And it came to pass on the morrow that he (Hazael) took a thick cloth and dipped it in water and spread it over Ben-hadad's face so that he died; and Hazael reigned in his (Ben-hadad's) place." Ben-hadad was already very ill, and was not expected to live. Thus, Hazael's homicidal task was the more easy.

Other examples supplied by literature relate to the Princes in the Tower; to Othello's abuse of Desdemona; and to the method of destroying victims intended for anatomical material in the time of Burke and Williams in the eighteenth century.

The victims of homicidal suffocation are the old and infirm, the sick and feeble, and infants—all of these being by far the largest class. They are not male adults, unless previously stupefied or intoxicated, or otherwise rendered incapable of resistance.

The method is readily inferred. Simple obstruction of the respiration by covering the mouth and closing the nostrils with the hand is enough. Sometimes pitch plaster is used to reinforce the hand, but it is a difficult matter to fit the plaster to the inequalities of the face. Again, a wet cloth like a towel is employed, a much more efficient method. Stopping the mouth and nose, with pressure of the knees meanwhile upon the thorax, after the manner of Burke, is another mode of homicide. Plugging the mouth with foreign bodies and substances is another example of the method. The following case of Janet Stuart, reported by Littlejohn, is a good illustration:[1] This girl was found dead in 1855, with a bottle-cork crowded into her larynx, the sealed end of the cork upward. Other evidences of violence were broken ribs, scalp wounds, and the like. It was clearly not an accident occur-

[1] Wharton and Stillé, *Medical Jurisprudence*, section 905.

ring while the girl was drawing the cork with her teeth, for the larger or sealed end of the cork was nearest to the lips. The medical evidence was that the foreign body had been placed in the mouth by violence.

Cases of dust suffocation occasionally occur. A lad of eighteen years of age was forced head downward, by way of a practical joke, into a meal bag containing about a bushel of bran. The mouth of the bag was tied around the boy's legs. He lived twenty minutes after his release. Besides the signs of suffocation in the body, the pathologists found bran in considerable quantity in the bronchi by inhalation.[1]

Caspar[2] relates the case of an illegitimate infant whose body was found in a box containing earth and peat and other refuse. The baby's mouth was crowded full with peat fragments. The post-mortem appearances were those of suffocation. The mother was arrested and tried for infanticide.

A large number of cases of deaths of infants occupy an intermediate place between murder and accident—the latter being principally the result of neglect or heedlessness—all due to suffocation in some form or other, but chiefly by smothering. The instances of overlaying number one a day in London. The circumstances of these deaths are quite uniform. They happen on Saturday night, the parents being in liquor. The usual story of the mother attests the ease of accomplishment. Generally there is really very little to disprove the story. A former German law enacted that babies under two years of age should not be put to sleep in bed with the mother, and some such statute in England and America would be salutary in saving infant life.

It may seem incredible that infants nursing at the breast are ever found as victims of suffocation during that act and as the result of it. Yet Casper is authority for this, and he relates some illustrative cases.[3] The favoring circumstances which attend such a mishap are the weakness of the child, the fulness of the child's stomach, the preoccupation of the mother, and enlarged mammary development. The author has himself seen one such instance in which there was no chance of doubt.

The symptoms produced by suffocation are those of uncomplicated asphyxia. Concisely stated they are as follows: The first stage is marked by dyspnea, or intense air-hunger; respirations are ineffectual, though fully forced. The pulse, at first slow, becomes rapid and irregular. The pupils are

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[1] Wharton and Stillé, *Loc. cit.*, section 904. [2] *Forensic Medicine*, ii., p. 138.
[3] *Ibid.*, ii., p. 143.

dilated; flashes of light come before the eyes. There is tinnitus aurium; there is a feeling of fulness in the head. The senses, however, are alert, the mind is clear, and the memory is acute. Meanwhile, the skin becomes more and more cyanotic, showing the progress of the asphyxia.

Then follows the second stage, in which unconsciousness supervenes as the result of the influence of unaërated blood on the brain-tissues. The dyspnea grows less sharp. Spasmodic movements, though not a uniform symptom, are a feature of this stage, due to the action of the unrenewed blood on the nerve tissues. Involuntary micturition and defecation occur. The color of the skin shows a less pronounced degree of lividity. The heart beats irregularly and feebly. The closing scene has little to attest the continuance of life beyond a certain imperfect *cardiac action*, which is the last function to surrender.

How long a period is required for fatal suffocation? We may derive some aid in answering this question by studying the results of experiments on animals. A committee of the English Medico-Chirurgical Society undertook some observations on this point. From nine experiments on dogs they found that the average duration of respiration after entire deprivation of air was four minutes and five seconds. The average duration of the heart's action was seven minutes and eleven seconds, counting from the beginning of the experiment. The following conclusions were formulated: 1. A dog may be deprived of air for three minutes and fifty seconds, and recover without aid of artificial means. 2. A dog is unlikely to recover if left to itself after deprivation of air for four minutes and ten seconds. Taylor states that these results are applicable to the human subject. It may, therefore, fairly be inferred that the life of a man will be destroyed in from four to five minutes after the power of breathing has been completely arrested; and if full five minutes have elapsed since the lungs received any air, resuscitation is improbable, though quite possible up to the end of the fourth minute.

The treatment of cases discovered in good season is sufficiently simple. *Obviously*, the first and most imperative indication is to remove the obstruction to respiration. For this some surgical procedures may be required. Pharyngeal or esophageal forceps, or tracheotomy, may be necessary; whatever is done must be done in a hurry. After the obstruction is removed, respiration must be stimulated. The Sylvester or Laborde method of artificial respiration will be available. There should be plenty of fresh air and freedom from restraint

in dress. Electricity is not thought to be very useful. General stimulation is proper by means of hypodermic injections of brandy or ether, or by rectal enemata. Ingestion of alcoholic stimulants, hot drinks, etc., when the patient can swallow, is an important indication. Venesection may be useful if the patient is robust and plethoric. It is obvious, other things being equal, that the restoration of a person who has been suffocated, as previously described, is easier than that of a person who has been hanged, strangled, or drowned. In strangling and hanging there is often great violence done to the tissues of the neck : but in suffocation these lesions are absent. So, too, in drowning, respiration is restored with difficulty, because of the water in the lungs, an embarrassment not present in the cases now under consideration.

Anatomical Appearances after Death by Suffocation.—What does the dead body show to demonstrate that death came by suffocation, and in that way only? The medical investigation of such cases is admitted to be a difficult matter when one has to rely solely on what the autopsy shows. When there is no clue, when the environment of the body is negative, when the circumstances of the death are unknown, it would be easy to go astray in the quest for data in the post-mortem examination. The case of Margery Campbell, one of Burke's victims, is an illustration.[1] Of this case, Christison says : " In the body of the woman, no person of skill, whose attention was pointedly excited by being told that from general circumstances murder was probable, but the manner of death was unknown, could have failed to remark signs that would raise a suspicion of suffocation. But if his attention had not been aroused ; if, for example, he had examined the body in the anatomical theatre of a hospital without knowing that suspicions from general circumstances were entertained regarding it, he might have inspected it even minutely, and yet neglected the appearances in question. Nay, a person of skill and experience would have been more likely to do so than another, because everyone who is conversant with pathological anatomy must be familiar with such or similar appearances as arising from various natural causes." This is high authority in illustration of the somewhat equivocal nature of the post-mortem evidence of death by suffocation.

Nevertheless, we are not to assume from this that the signs of death by suffocation are all negative or easily overlooked. In a well-authenticated case of fatal suffocation, with the body fresh and all other conditions favorable, we should look for

[1] Guy, *Forensic Medicine*, p. 294.

and expect to find some or all of the appearances we will now pass in review ; and while, as we shall see, there is no single sign or lesion which alone would be properly regarded as proof, we may have before us a collection of appearances which, taken in connection with surroundings and attendant facts, will enable us to reach definite conclusions.

External Appearances.—Let us study those common to all varieties of suffocation, and after that the modifications peculiar to special methods. What are the external appearances ? The skin of the face and neck shows various degrees of lividity, from mere duskiness to a diffused violet aspect. The lips, ears, and nails show this change especially. Plethoric subjects present it most fully ; and when it is present in its fullest degree, the lividity is very striking.

Besides this general hue of lividity, the skin of the face, neck, and chest shows in many cases numerous minute, even punctate, ecchymoses, small, round, and circumscribed, like purpuric spots. This condition is due to struggling against asphyxia, and it is best seen in those dead from pressure in crowds.

Bloody froth and bloody mucus may be observed in some cases issuing from the the mouth and nostrils ; but it is not a constant sign—indeed, it is rather rare. The conjunctivæ are injected, sharing in the superficial hyperemia.

Internal Appearances.—The heart is overfilled on its right side, and its surface blood-vessels are injected. The blood is dark and fluid in the cardiac cavities and in the large vessels. The lungs are of special interest ; of the external appearances, a condition of peripheral emphysema at once attracts notice. The visceral pleura is not smooth and uniform, but exhibits areas of vesicular rupture of irregular size and shape, slightly raised, and of a lighter color than the rest. These emphysematous areas can be pushed into new locations and, when pricked, are emptied of air.

Punctate Subpleural Ecchymoses.—There is one aspect of the lungs which has aroused considerable controversy as to the cause and as to its value as an anatomical proof of death by suffocation. This is the presence of subpleural ecchymoses. Tardieu was especially the champion of their usefulness in postmortem diagnosis. These ecchymoses appear as minute dots or spots on the surface of the lung, under the pleura, giving the effect of small drops of red fluid. Pressure does not obliterate them. In shape they are round, symmetrical, circumscribed, and well defined. Sometimes they are crescentic. In size they vary from that of a pin's head to that of a small pea. Sometimes several are found coalescing with a scalloped periphery,

but retaining their characters otherwise. In situation they are found on all parts of the pulmonary surface, though they are mostly in the fissures, on the inferior surfaces, or near the root. Pathologically, they are capillary hemorrhages. They are partly the result of venous stasis, the capillary structures being insufficient to withstand the force exerted on them. According to Hofmann, however, they are mainly the evidence of capillary ruptures from vasomotor contraction and pressure laterally at the maximum stage of the asphyxia—the time of tetanic but ineffectual expiration.

The claim which Tardieu put forth in behalf of these sub-pleural ecchymoses, that they were characteristic of death by suffocation, and that they alone were enough to establish the diagnosis, has not escaped challenge and warm criticism. The whole subject has been the theme of controversy, into the merits of which it would not be very profitable to enter largely. Those who deny the full significance which Tardieu has main-tained concerning these minute extravasations declare that cases of undoubted suffocation have happened without them.

Other forms of death by apnea (hanging and drowning) show them. Still other forms of death, wherein apnea plays no part, show them. Ogston has found them after death from scarlatina, heart disease, apoplexy, pneumonia, convulsive poisons, and epilepsy. Stillborn fetuses and fetuses unborn, when the mother died before the beginning of the labor, have manifested them. Falls from a height sometimes develop them. Certain poisons which profoundly affect the blood, such as phosphorus, arsenic, and mercury, bring them to view.

To all this, Tardieu and his disciples reply: That many observers have failed to recognize the appearances described, and are thus not in a position to deny their significance. That in forms of death other than that by suffocation the subpleural ecchymoses, if found at all, are irregular, larger, more diffused, not rounded in outline, and not clearly defined ; while the conditions in which they are found in these cases, their number, their dis-tribution over the organs, and the hemorrhages which accom-pany them leave, in truth, small chance for error. It is con-tended, too, that in death after falls, the condition of things at-tending the injury and the profound effect upon the respiratory apparatus are closely analogous to death by suffocation. Fi-nally, granting the possibility of subpleural ecchymoses in the lungs of stillborn infants, this does not invalidate the practical value of these spots in legal medicine as a sign of suffocation.

It is probable that the views of both parties representing extreme positions are open to question. The more conser-

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vative recent authorities take a rather reserved ground in the matter. Without denying the value of subpleural ecchymoses as collateral and confirmatory aids in making a post-mortem diagnosis of death by suffocation, these writers place less reliance on them as typical data than did Tardieu and his school. They are not infallible guides, but they are useful helps. Ogston says: " Of the frequency and marked character of the punctiform ecchymoses in death by suffocation . . . there is no room for doubt. . . . But I can not follow the dictum—that the presence of these ecchymoses is an undoubted proof of this form of asphyxia exclusively."[1]

Briand and Chaudé, after giving the conditions other than suffocation which are accompanied by punctate subpleural ecchymoses, say:[2] " If we have taken pains to enumerate the various conditions in whieh the formation of subpleural punctate ecchymoses has been observed, it is not with the design of taking away from this sign its true value, but to show that it has not an absolute significance, and that certain ecchymoses found on the surface of a lung do not, by themselves alone, permit one to conclude that the death was by suffocation. But it is still true, as the result of many experiments, that these ecchymoses are more numerous in suffocation than in other forms of asphyxia; that one meets them less frequently in strangulation, and still less in hanging. To appreciate their exact significence, therefore, it is necessary not only to take account of the abundance of these ecchymoses and their dimensions, but of all the signs of violence which coëxist with them in other regions of the body, as, for example, around the mouth and nose and on the walls of the chest."

A committee of the *Société de médecine légale*, in 1878, declared that: 1. Subpleural ecchymoses may arise from spontaneous conditions irrespective of the cause of death. 2. They may be met with in violent asphyxia by hanging, strangling, submersion, by compression of the chest, and by suffocation, but in different degrees. 3. They are of value only when associated with other signs indicating the mode of death.

It is not alone under the pulmonary pleura that the punctiform ecchymoses are developed; under the pericardium these spots are found also, and along the aorta, in the interventricular groove, and between the auricles and ventricles. On the thymus gland of infants they are common. This is im-

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[1] Ogston, *Lectures on Medical Jurisprudence*, pp. 552 and 553.
[2] *Médecine légale*, i., p. 601.

portant in infanticide, because it is rare to find them on the thymus in adults.

On the retina, epiglottis, larynx and trachea, too, they are developed. Rarely, they are found within the abdominal cavity, the peritoneum, the intestine, the stomach; also under the scalp and under the pericranium. They are to be distinguished from effusions caused in difficult childbirth by their smaller size and well-defined outline.

What other appearances do we find about the head after death by suffocation? There is nothing very characteristic. There may be engorgement of the meninges and brain, but not necessarily. If the lungs are hyperemic, the brain will probably be also. Hyperemia of the lungs, however, is by no means a constant incident, although it might be expected on theoretical grounds. Often the lungs have a normal aspect as to blood supply. Much depends on the duration of the asphyxia process. We must not forget, in examining the lungs, to inspect the larynx, trachea, and bronchi. Casper says: "After every kind of violent suffocation, except that proving fatal by neuroparalysis, which happens instantly and leaves the blood in *statu quo*, we find the mucous membrane of the larynx and trachea more or less injected, from isolated, dendritic patches up to uniform reddening of the whole surface." If froth is at the mouth, it will probably be found also in the air-passages; but less if the suffocation is sudden. The importance of examining these parts for foreign bodies, or for scratches, or the *signs* of foreign bodies, is obvious.

In the abdominal group of organs there is little found to reward a search at an autopsy in a death by suffocation, beyond engorgement of the solid glandular viscera, the spleen, liver, and kidneys, with venous blood. The mesenteric and omental vessels are congested in similar fashion.

Such are the general post-mortem indications of death by suffocation. It is manifest that they lack uniformity of character. Various cases of suffocation have sufficient resemblances to warrant their study together in the same group or family. This is, however, far from saying that all examples are identical in phenomena and anatomical appearances. The variety in these respects grows out of the age, sex, and vigor of the victims; the quickness or slowness of the apnea; and especially the methods of its accomplishment.

How are the anatomical appearances modified by the manner of the suffocation? If the suffocation resulted from homicidal efforts to obstruct the breathing by occluding the mouth and nostrils with the hand, or the hand over a towel, or other

such agency, the assault would reasonably leave its evidence in flattening or twisting of the nose and lips ; in excoriations of the face by the finger-nails ; and in ecchymoses from bruises, intentional or accidental, if, as would naturally be expected, much force was used or much resistance shown. The presence of foreign bodies should not be overlooked. Internally, the signs left about the lungs are rather more pronounced than in other cases, so far as the ecchymoses under the pleura and the presence of emphysema are concerned. If, however, the death was a rapid one, the engorgement of the lungs would be missing.

If the case was one of fatal choking by the accidental invasion or obstruction of the air-passages by a foreign body, a piece of meat, or vomitus inhaled, for example, a properly thorough examination of the pharynx and larynx would rapidly reveal what otherwise would be regarded as a mystery. These parts are so generally neglected at an autopsy in the presence of anatomical appearances clearly establishing the cause of death, that we become careless. Every case of doubt, however, should include this examination, and the exploration of the upper air-passages will often be rewarded by finding the offending intruder.

In cases of suffocation by compression of the chest and abdomen, external traumatic lesions on the chest are not expected, because the compressing force is distributed quite widely. In these cases of death by thoracic squeezing, that is, by crowd-pressure, the skin of the back, neck, and upper chest was shown to have a deep, livid discoloration, with many small ecchymoses under the skin. The conjunctivæ are injected generally, but not constantly. Internally, the appearances are more pronounced and affirmative. The subpleural ecchymoses are developed in their most characteristic fashion. Pulmonary emphysema, also, is marked and extensive. Effusions of blood under the scalp are common. Fracture of the ribs is a not uncommon lesion, together with infiltration of blood in the parts receiving the traumatic pressure.

Another series of interesting examples of suffocation comprises cases of death in sand banks, dust heaps, and grain bins; a true living burial. In the majority of cases they are purely matters of accident, although the books record a few instances of infanticide in this manner, and a still smaller number of adult homicides. In this form of suffocation peripheral emphysema is found in its highest degree ; also sanguineous froth in the air-passages, subpleural and subpericranial ecchymoses, and, what is a most important aid in a demonstration

of the cause of death, the pulverulent or other material in the larynx, trachea, and bronchi, into the canal of which it has been inhaled in the efforts to breathe. The finding of this foreign matter in these situations can leave no manner of doubt that it came there during the life of the person.

Devergie relates the case of a man whose head and face were forcibly held in a corn heap until life was extinct. Grain was found in the back of the mouth, and in the pharynx, trachea, esophagus, stomach, and duodenum.

Finally, suffocation may have as one of its examples a death in a box or trunk, or other confined space. Some authors question whether it is correct to call these illustrations of suffocation, and argue that they are like the deaths from deficiency of respirable air in mines, prisons, and the like; in other words, poisoning by carbonic acid gas. Most authorities, however, in legal medicine are ready to include them as cases of suffocation, because their anatomical appearances are so like those of unquestioned suffocation. It happens occasionally that an infanticide is accomplished in this manner; it happens, also, that, as in the case of the German maid-servant, who locked herself in a large trunk, a suicide after this fashion is a medicolegal curiosity.

CHAPTER XIX.

WOUNDS IN THEIR MEDICOLEGAL RELATIONS.

THE importance of this subject is so obvious in the practice and literature of medical jurisprudence that any detailed discussion of its scope is superfluous. Exclude from the books and from common medicolegal experience everything relating to wounds, and it will be found that the remnant is of small proportions. Take the class of homicides, for example. How large a share of the killing in these cases is by wounding! Homicides by drowning, poison, or suffocation take a very inferior rank in point of numbers when compared with murders by weapons. The same is true of suicides. The knife and the pistol figure very freely in the records of these tragedies; while in the class of accidental deaths the lesions due to mechanical violence are very numerous and give ample illustration of the topic before us.

We are met at the outside by the question, "What is a wound?" If we go to the legal, the medicolegal, and the surgical books for counsel or instruction in this matter, we shall find sufficient variety in the definitions to give the widest freedom of choice. But between the surgical and the legal books there will be this marked difference—that all the latter define wounds in a much more comprehensive and inclusive way than the former.

Thus, to cite only a few examples: Bouvier's *Law Dictionary* uses these words: "A wound is *any* lesion of the body; and comprises not only solutions of continuity, but every kind of accident, such as bruises, contusions, fractures, dislocations, and the like."

Taylor says: "A wound includes any personal injury, suddenly arising from any kind of violence applied externally, whether such injury be external or internal."

Casper defines a wound as: "Every alteration of the structure or function of any part of the body by any external cause."

Now compare these very comprehensive definitions with what the *surgical* authorities say, and note the narrower and more limited sense in which the word "wound" is used.

Sir James Paget writes: "Wounds are divisions or solutions of continuity of soft parts, produced by external, direct, and mechanical force."

Gross says: "The term wound . . . is employed to designate all injuries attended with a division of tissues."

Ashhurst declares: "A wound is a division or solution of continuity of the soft tissues, produced by violence."

Dunglison says: "A wound is a solution of continuity in the soft parts by some mechanical agent."

Foster's definition is: "A division of the soft parts of the body by a mechanical force applied externally."

There is no place in these surgical definitions for important injuries which have a distinct standing in medicolegal works. Solution of continuity of the soft parts is the differential mark. It comes, therefore, to this, that, in cases in which there is a clearly defined, unequivocal division of tissues, a real solution of continuity of soft parts, no difficulty can arise, so far as that particular lesion is concerned. From every point of view, it is a "wound."

If, however, a medical witness is asked if he regards a broken bone, a burn, a dislocation, or a contusion as a "wound," he will say that in legal medicine they are so considered, in surgery not, remembering always that for the purposes of forensic medicine the most comprehensive scope of the definition is accepted.

Classification of Wounds.—Wounds have been variously classified by writers on legal medicine. Marc, one of the earlier authors, speaks of wounds as mortal—of necessity mortal and mortal by accident; and non-mortal—entirely curable and partially curable. This division is based on the various degrees of gravity of the injury, looked at from the point of view of the effect on the patient.

Another, having a similar basis, is that in use in France. It is made to fit the French law, which rests on the disability produced by the wounds, and on the incapacity for work for an arbitrary period of twenty days as a result. They are distinguished as follows: Slight (which do not disable for more than twenty days); grave (which cause disability for work extending beyond twenty days), and mortal (which cause death). This is useful retrospectively only; it has no usefulness in prognosis.

The most general and altogether the most satisfactory classification of wounds is based on the character of the wound itself. The effect of the wound on the patient and the medical attendant's relations to it are collateral questions.

Therefore, nearly all medicolegal writers of the present day discuss the subject of wounds from this point of view—the means by which the wound was inflicted and the manner in which the weapon or instrument of harm was used. Thus we classify wounds according as they are made by: 1. Instruments which cut, incised wounds. 2. Instruments which bruise or crush, contused wounds. 3. Instruments which stab or puncture, punctured wounds. 4. Instruments which tear asunder, lacerated wounds. 5. To these are added a fifth class, formerly included under contused wounds, namely, gunshot and pistol-shot wounds. The manner of using the weapon, then, is of five varieties: cutting, bruising, stabbing, tearing, and explosion of powder. The writer will speak chiefly of the post-mortem diagnosis of these wounds from appearances found on the *dead body*.

Incised Wounds.—How shall we know at an autopsy that, in a given instance, we have to deal with a recent incised wound, one made just before the death by the use of a cutting instrument or weapon, drawn across the surface saw-fashion, and not forced into the tissues wedge-fashion?

The writer says, first, of these lesions that their superficial extent, as a rule, is greater than their depth; they are longer than they are deep. Their edges are sharply defined, clean cut, and straight. This is the result if the weapon has a good edge and is held perpendicularly to the surface cut. But sometimes, if the knife is dull, the parts divided show some degree of bruising and laceration like a contusion. Straight edges are lacking, too, when the wound is made on a rounded, convex surface, or when the blade is held obliquely. If the blade is very dull or is nicked along its edge, then the edges of the wound are indented and irregular. The edges are also indented and puckered if the wound is a day or two old when it is studied, or if it has not been interfered with by dressing. This effect is due to the irregular action of the absorbents and the failure of the edges to unite by first intention. Where the skin lies in folds and wrinkles, as in the neck of a very old or very young person, and a cut is made obliquely across the folds, the skin when stretched out after the cut will show a Z-shaped wound, simulating several wounds, although only one cut is made. It is like cutting a folded piece of cloth. Another reason why an incised wound fails at times to show straight, regular edges is the fact that the ordinary circumstances under which homicidal or suicidal cuts are made do not permit the direct movement of the hand, which a simple incision indicates. There is instinctive shrinking or writhing.

The wrist of the hand holding the weapon gets a twist or turn. There is rarely the opportunity to practise surgical precision, as if the victim was under an anesthetic.

Concerning the *deeper* parts of an incised wound: If the direction of the wound is perpendicular to the plane of the part involved, the subcutaneous surfaces will be symmetrical, and a cross-section, like that of a prism or V, will result. If the direction is oblique, there will be a more or less bevelled effect; and the edge of the upper side will be sharp in proportion to the acuteness of the angle made by the blade of the knife with the surface of the skin. Sometimes there is a true flap as the result of an extreme degree of this angle.

The edges of an incised wound remain asunder to a certain extent under ordinary conditions. They naturally tend to separate or gape. Hence, incised wounds show comparatively little relation to the thickness of the blade of the weapon. The degree of the separation depends on three conditions: 1. The relative contraction or relaxation of the underlying muscles. For instance, the same kind of weapon may make widely different wounds on the same part of the body, according to the state of the muscles cut. 2. The *direction* of the wound, whether parallel with the muscular fibers or in a transverse course. 3. The condition of the skin, especially with reference to the looseness of its attachment to the subjacent tissues; its elasticity and contractility.

The *shape* of an incised wound on the skin, from start to finish, is usually fusiform, with a well-defined beginning, middle, and ending. This shape is determined by the degree of gaping and by its depth in the center. But the fusiform shape is the type. The beginning is a single cut, superficial, tailed slightly, and quickly becoming deeper. The ending is single, or (if about the neck) it presents a series of serrations or undulations, and the free angles point toward the origin. The middle is deepest. The depth depends on the force used, the sharpness of the cutting edge, and the resistance of the parts beneath (an ossified cartilage). The gravity of the wound depends on the depth, the vessels divided, and the resulting hemorrhage. Free hemorrhage is one of the diagnostic characteristics of incised wounds. This is determined by the clean division of larger or smaller vessels. The contrast with bruising or tearing is thus marked. Descriptions of incised wounds need not include the detailed mention of the vessels divided; it is neither practicable nor useful. The demonstration of the fact of hemorrhage is enough. The only exception refers to

large vessels, such as the aorta, the carotids, the femorals, and the internal jugulars.

The kind of weapon employed can not be accurately inferred from the appearance of an incised wound. In a general way, we may determine that the weapon had a cutting edge, and we may conclude as to the sharpness of this edge when we have before us a recent, clean-cut, typical incision. The weapon need not necessarily be a knife. Mr. Luke, in his *Lectures*, taught that an incised wound presumed a weapon whose cutting edge represented the junction of two planes at an angle less than 90 degrees. This is now acknowledged to be an

Fig. 20.—Contused wounds made with an iron bar; resembling incised wounds.

error. Recorded cases illustrate incisions with a four-cornered poker, or broken glass, or the edge of a broken pewter or porcelain mug. Of greater interest and importance is the fact that some wounds of the contused class made by a blow with a blunt weapon without any edge at all closely resemble incised wounds made with a knife. The most favorable locations are the scalp, the skin or the eyebrow where the bone is near the surface. Cases are on record of such lesions made by the fist, by a club or stick, and (Ogston) by the blow of a cricket-ball. One means of distinguishing these linear contused wounds resembling cuts from real incisions is the fol-

lowing: A cross-section of a cut is like the letter V, symmetrical and clean down into the apex. Not so a contused wound; its apex is not clean-cut, but is partly filled up with resisting tissues which escaped division—vessels, connective tissues, fascia. Examination of the tissues at either side of the cut will display more or less infiltration with extravasated blood. In order to make accurate observations a lens would be of assistance.

Wounds made with an axe or hatchet or other similar implements, partake of the characters of both incised and punctured wounds. They are classed by Hoffmann under incised wounds, when the edge of the weapon is the part used. It is obvious that such wounds differ from ordinary cuts, because there is no sweep of the edge to and fro, as when a knife is used. The lesion is due to the projection of the edge of the tool in a perpendicular direction against the surface of the body. Much force is used, and to this is added the weight of the entire metal head of the axe. This gives to the resulting lesion a depth out of proportion to the external length, and enables the wound to approach the characters of a penetrating or punctured wound. Bones do not stop the progress of the axe as they stop the progress of the knife. Hence, the increased gravity of this form of violence. When, as is usually the case, we have to study the wounds as they appear about the head, it is not so much the scalp and skull wounds that interest us, as the injuries which the brain receives. Whether made in the brain, the bone, or the soft tissues, a wound made with an axe or a hatchet shows clearly the length and width of the cutting edge if the weapon penetrates deeper than the surface. The cleanness of the cut depends on the sharpness of the edge of the weapon. The depth of the wound shows the force of the blow.

These axe and hatchet wounds are easy of recognition. Their characteristics are so obvious that it would be difficult to miss their true nature. This was well illustrated in the case of the Bordens, in August, 1892, in Fall River. Mr. Borden's head showed ten wounds in the face and the left temple. Mrs. Borden's head presented twenty-one behind the right ear and at the back of the head. Most of them were penetrating lesions. Those which went through the bone showed the force and direction of the blows. One of those on Mr. Borden's skull was studied, and it demonstrated also the length of the cutting edge, and at its lower end, where it penetrated to the depth of an inch and a half and cut through the petrous portion of the left temporal bone, severing the carotid

canal, one had an excellent indication of the thickness of the blade.

Similar lesions with an axe were the cause of death in the Bram homicides on the *Herbert Fuller*, at sea, July, 1896. They were not studied, however, as carefully as they deserved, the decomposed state of the bodies when they were brought ashore deterring the medical inspector from making the accurate observations which the cases demanded.

Contusions.—These lesions are caused by the use of blunt and unyielding instruments or weapons, and they comprise the very comprehensive class of contusion injuries—perhaps the largest class of the injuries requiring judicial investigation in cases of fatal violence. The means used for their production are extremely various. Anything with which a blow can be struck, anything with a blunt, hard surface, whether purposely prepared for a homicidal attack, or caught up under the impulse of the moment as an improvised weapon, or provided by nature in the form of the fist, all these come under the general head of the means employed.

Again, the effects are the same in kind whether the weapon is used upon the body (as when a man strikes another with a club or with a paving stone), or whether the body is forced or thrown violently against a hard and perhaps uneven surface (as when he is knocked down upon a pavement). It is manifest that with this wide variety of the means used, the effects will include an almost endless diversity in form and degree. At one end we have, as an example, the effects of pressure with the finger-tips; at the other the frightful mutilations caused by collision with a locomotive; or the mangling resulting from the passage of an electric car over the body; or the crushing which is effected by the gearing or pulleys of machinery into which the body of the victim is drawn.

It is to be observed at the outset, however, that we rarely find, after a blow, any one of these effects manifested as a solitary lesion. More often, after the same violence, we find a combination and concurrence of various effects on the skin or deeper parts, according to the force used, the direction of the blow, and the region struck. What is of more interest is, that we may observe grave and even fatal effects from a blow which leaves not the slightest trace behind it, externally or internally. Fatal blows over the precordia and epigastrium may arrest the heart's action, causing death by syncope, and no indication of the force or seat of the blow will be discovered at the autopsy.

Another important preliminary observation in the same

direction is that the most extreme violence may be done to the subcutaneous tissues—muscles disorganized, solid organs ruptured, hollow organs opened widely, and bones fractured, while the skin escapes with only the slightest injury, or perhaps does not present any visible traumatism on the most careful examination. The elasticity of the skin gives it this resistent quality. There is an analogy in the ease with which an apple may be crushed when it is inclosed in a wrapper of cotton or silk; the fruit is destroyed, the wrapper is intact.

Dupuytren's case is an illustration: A French soldier in the campaign of 1814 was brought to Dupuytren in an ambulance. No marks of violence were found on the man's body. But, on examining the lumbar region, Dupuytren found it fluctuating and greatly disorganized subcutaneously. The soldier was suffering from extreme collapse, and died in a few hours. At the autopsy the subcutaneous connective tissue, the abdominal walls, and the left kidney were found to be reduced to a pulp; the lumbar muscles were torn, the lower ribs broken, and the abdominal cavity and left pleural cavity were filled with blood.

Taylor[1] speaks of a girl who received a blow on the abdomen from a stone thrown at her. Immediately, great pain and collapse followed, with death in twenty-four hours. No external mark or injury was found. The ileum was ruptured and its contents escaped, setting up general peritonitis.

In June, 1892, the author inspected the dead body of a man who had been struck by the locomotive of an express train, while he was walking on the line. He died two hours after the injury. The only visible external lesions were a small bruise over the right hip and a fracture of the right humerus. On internal examination, five ribs were found broken; the lungs were bruised, the liver and right kidney were crushed and disorganized, and there was a large extravasation of blood in the right lumbar region.

In another case under the author's observation a locomotive engineer, in the act of shifting cars on parallel tracks, was caught by a heavy rope and crushed between the cable and the sides of a car. He was dead when rescued. There was a slight, scarcely visible bruise between the shoulders, with an indistinct bruise on the abdomen; internally, the autopsy revealed eighteen fluidounces of fluid blood in the abdomen; the liver, the left kidney and the pancreas were extensively crushed; the lungs were bruised, the sternum was broken, and five ribs on the right side and nine on the left side were broken.

[1] *Principles and Practice of Medical Jurisprudence*, i., p. 496.

These suggestive illustrations are the more important since it has been repeatedly asserted in courts of law that no severe blow could have been inflicted on the body of a person found dead, if the external examination failed to discover any visible indication of violence. It is worth while to remember, therefore, that while blows with a blunt weapon do usually leave unequivocal effects, there are important exceptions to this rule.

Contusions with Extravasation of Blood in the Subcutaneous Cellular Tissue and Subjacent Soft Parts.—These lesions are designated as ecchymoses. Their cause is the rupture of capillary blood-vessels and escape of the fluid into the surrounding tissues. They are especially marked in their typical external manifestation by swelling and discoloration. The conditions favorable to their characteristic production are : 1. Pressure or a blow of some force sufficient to crush the capillaries. 2. The presence of a solid or resisting tissue (like bone) under that part of the skin which receives the blow or pressure. 3. Looseness of texture in the tissue involved. 4. Vascularity of the part. Perhaps the tissues around the eyes are as good an illustration as any.

It is a mistake, however, to assume that ecchymoses follow a uniform course in the time of their development, or as to their extent after similar degrees of violence upon the same part in different persons, or upon different parts of the same person. A blow on the head, for instance, generally results immediately in the formation of an ecchymosis, with unmistakable characteristics, heat, pain, and swelling ; but there are persons, not a few, who escape even this common result. So, too, a part of the body may be struck and the situation be such that the ecchymosis, instead of appearing forthwith, may be many days in appearing, or, indeed, may not come to the surface at all. Thus, the deep tissues of the thigh may be injured without a trace on the skin ; in such a case all that may be observed is, that at the end of forty, fifty, or sixty days yellowish, greenish, or bluish spots appear as remnants of the primary injury. Therefore, the superficial discoloration is not a conclusive guide to either the extent of the injury to the parts beneath, or to the amount of the violence inflicted. On the other hand, the skin is sometimes discolored out of all proportion to the real injury to the deeper parts ; as, for instance, when a sprained ankle is attended with a deep ecchymosis spreading to the foot and lower part of the leg. As a rule, the infiltrated blood of an ecchymosis extends or distributes itself among the tissues not only according to the severity of the blow, but also according to the ability of the tissues to resist such extension. The

escaping blood, of course, follows the lines of least resistance. For instance: In iliac and hypogastric contusions the ecchymosis shows above; about the great trochanter of the femur, it is below; on the inner side of the head of the tibia, it is above; about the forehead, the discoloration is below, in the eyelids.

It is well to bear in mind that violence inflicted on a living body may not show its effects as an ecchymosis until after death. It is not necessary that the person struck should continue to live in order to bring to view the discolorations which attest the blow. In other words, it is not true that, unless a person assaulted survives for some time after receiving severe blows, ecchymoses will not manifest themselves on his body. Any one who has made many autopsies in cases of death by violence must have repeatedly remarked that bruise discolorations, scarcely visible or not visible at all just after the death, become very pronounced in color and outline twenty-four hours later.

Color-changes in ecchymoses have an obvious interest for our study. The initial color which the skin assumes after a bruise is ordinarily a shade of dull red or purple, seen most characteristically in superficial bruises. Sometimes the purple is so pronounced as to justify the term "black and blue," so frequently used. Sometimes, also, the color of the primary stage is lighter, inclining to crimson or pink; but the normal shade is purple, deep blue, or livid. After a varying period this initial color begins to change. It becomes lighter in its shade; from dark blue or purple it assumes a violet hue. Then, successively, the spots become green and yellow. The change begins at the periphery and ends at the center of the bruise. The discoloration finally disappears, because the blood and its products are absorbed and carried away. The changes in color are due to the decomposition of the blood-globules in the extravasated blood. This decomposition results in a product consisting in part of amorphous matter (brown or green); in part of crystallized bodies (hematin, hematoidin).

Is it possible, by observing the tint which a bruise presents, to declare accurately its age? The answer is that our conclusion can be approximative only. Even the appearance of the initial discoloration is not uniform in the matter of time. It varies with the depth of the effusion. If the tissues involved lie superficially, the ecchymosis will declare itself almost instantly after a blow, or in a very few minutes; while, under other circumstances, the extravasation is deep enough to delay the appearance of the color at the surface, and many

hours or days may intervene. The same considerations apply to the subsequent successive changes in color. Moreover, it is plain that the degree of violence, the extent of effusion, and the age and health of the patient will have a modifying effect. Stated generally, with regard to superficial ecchymoses, the color-changes pursue this programme: At the end of from eighteen to twenty-four hours the margin takes on a lighter hue. For two days (up to the fourth day) it is violet; then green for two days (the fifth and sixth); then yellow on and after the seventh day, until the total fading out about the tenth or twelfth day, or later. The time of the complete disappearance is determined by the extent and depth of the effusion of blood and the health and age of the patient. The influence of age is quite marked. Watson found effused blood in an ecchymosis in an *old* person five weeks after a bruise. Woodman and Tidy say: "We have known a hemorrhage in the conjunctiva to remain unabsorbed six weeks." On the other hand, the rapidity of the disappearance of a bruise on a child's body is a common observation.

The most that one can say after studying an ecchymosis which is green or greenish yellow in color, rather than blue or violet, is, that it represents an interval of more than forty-eight hours since the blow was received, for the change could hardly occur in less time than that. To this extent the color-change enables the medical witness to testify. Even this qualified evidence might easily become of great value under certain circumstances; for instance, in the case of a person found dead eighteen or twenty-four hours after a quarrel, a bruise already turning green in color could be declared as having no connection with that recent affair. Further than this general statement one could hardly go safely; it certainly would be unsafe to try to be dogmatic about the age of bruises, and to set up a limit based on the blue, green, or yellow tint of the ecchymosis.

Hofmann[1] asserts that, although the color of a bruise offers us an insufficient guide to determine its age, the condition of the effused blood in the bruised and infiltrated tissue may help us more. Upon section of an ecchymosis we shall find the *blood altered* according to the time which has elapsed since its escape from the vessels. The older the ecchymosis the thicker will the blood be and the more pronounced the changes in its color from the normal. During the first few days the blood will be found liquid and nearly black if it is studied in thick masses; but if it is thinly spread it will show a normal, dull-red color. Later it becomes brownish, with a more or less

[1] Hofmann, *Nouveaux éléments de médecine légale,* p. 181.

greenish tinge. For several days the red globules preserve their shape ; their destruction begins coincidently with the change in color just mentioned. Their number now diminishes, and they speedily break down. Crystals of hematoidin are found early in the extravasations. They diminish as the thickness of the blood increases and as its color-changes advance. On bodies recently dead these characters (especially the presence of hematoidin crystals) may help us in an approximative determination of the age of the extravasation, but they are of no service in a putrefying body, since the crystals of hematoidin form, sometimes very rapidly, in tissues in process of decomposition.

The most usual form of an ecchymosis as it appears on the surface is nearly circular. There are two reasons for this : 1. The surface which makes the bruise is round usually. 2. The part struck being, as a rule, approximately spherical, only a circumscribed area is involved in the injury. Therefore, weapons and surfaces of manifold description may, by a combination of these conditions, produce ecchymoses closely resembling each other. On the other hand, ecchymoses may reproduce very clearly, under favoring circumstances, the form of the weapon used. For instance, blows in whipping with a rod or cane may leave clear indications of the instrument, in narrow, almost linear streaks. Finger-marks and nail-marks in strangulation are examples of the same observation.

Starkie relates the following observation :[1] "In an attempt at murder, the complainant in his own defence struck the assailant violently in the face with the key of the house door, this being the only weapon he had near at hand, and the ecchymosis which followed this contusion corresponded to the wards of the key ; and it was chiefly through this very singular and unexpected source of evidence that the criminal was afterward identified and brought to trial."

Contusion Wounds.—Contusions are frequently attended by a greater or less degree of division or destruction of the parts involved in the blow. In these cases we have to deal with true solutions of continuity and the lesions may properly be called, medicolegally as well as surgically, *contused wounds.* These lesions are characterized by an endless variety of irregularities in shape and degree of severity. The edges of such wounds are uneven, crushed, bruised, hacked, or indented, with much infiltration of the adjacent tissues. The base of the lesion is ragged and torn, because of the unequal resist-

[1] Starkie, *Law of Evidence.*

ance of the tissues involved. Usually there is very little hemorrhage. The effect on the blood-vessels is analogous to the surgical procedure of torsion for the control of bleeding.

The kind of weapon used in these cases is not easy to determine by means of the wound. If a weapon is produced, the medical witness can only say that the wound in question might have been made with that weapon, or one like it. There can never be such an accurate adaptation of the weapon to the wound as to connect one with the other as a matter of evidence. Therefore, the only way in which the medical man can meet such a problem is to testify to possibilities only. Occasionally one is fortunate enough to have his thorough and minute search for evidence rewarded by finding in or about a wound a splinter or fragment from a weapon. This would be of far greater service in identifying the weapon and in settling the problem of the way in which the lesion was caused than in other practicable comparison. Other substances and materials sometimes get into contused wounds besides bits of wood, and these help to clear up doubts. Gravel, sand, or grass indicate a fall, if they are found in such wounds. In one case, reported by Taylor, hayseed was found in a wound of the scalp, and helped materially to locate a murder in a stable.

Bites, whether human or animal, belong to this class of wounds. In situation these injuries are on easily reached parts of the body. The human assailant bites the nose or fingers of his antagonist; but the bites of animals are always more extensive and serious than those of man. In either case the shape of the wound and its general characters readily identify it.

Ruptures of internal organs by external force form another subdivision under contusion injuries. They result either from violence directly inflicted over the part affected or by transmission—by *contre-coup*. These injuries are produced by falls from a height, by crushing accidents, as between cars or by the passage of wheels over the body, by kicks from men or horses, or by sudden falls from tripping. Much more commonly they are the result of accident than of other forms of violence, like homicide. Casper says: " Healthy organs (lungs, heart, etc.) never rupture spontaneously, and even considerable force is required to rupture them when they are in a healthy condition. Therefore, if at an autopsy an organ otherwise sound is found rent and ruptured, it signifies great external violence."

Most frequently the solid viscera are the parts ruptured,

because of their density, volume, and situation. Hofmann names the organs in the following order as to their vulnerability in this way: Liver, spleen, kidneys, lungs, and heart. More rarely, the stomach, intestine, urinary bladder, and brain are included. It is obvious that the ease with which a fracture or rupture is produced in an organ will depend on the situation of the part and its relative tolerance. Thus, the liver, normally large and accessible, may be very easily broken by force applied to the front of the abdomen. This would be all the more easy if its tissues were changed by disease, making it larger and less resistant.

Finally, there is another class of cases which illustrate an extreme degree of contusion injuries. These are the cases in which large portions and whole regions of the body are disorganized by attrition. Limbs are torn off; soft parts are disintegrated; bones are comminuted. Of course, enormous force is required. One feature of these cases is that, notwithstanding the extensive damage, the amount of hemorrhage is small. Instances of this sort of mutilation are seen in the railway accidents which are so common.

Other examples of this sort of casualty occur among the workers of machinery, who, through carelessness or misadventure, are caught and whirled about pulleys and shafting with great force and rapidity.

The resisting power of the skin is one of the noteworthy features of these cases. The writer has seen what may be properly called subcutaneous decapitation, wherein the man, falling so that his neck was ground under a locomotive or car wheel, was found dead with all the inner tissues in the neck divided, the vertebral column included, yet the skin was not opened, but simply bruised.

Still other extreme illustrations are furnished in the premature explosion of charges of powder, dynamite, and racarock in the course of blasting at ledges and elsewhere. The amount of destruction wrought under these circumstances is always very great, sometimes almost incredible. An extreme example of this occurred at Castle Island, Boston Harbor, on December 6, 1898: Three men in the employ of the United States Engineers were engaged in moving some of the harbor mines which, having been planted for defence in the harbor, were being taken from submarine beds to be unloaded. The charges consisted of 250 pounds of dynamite and gelatin, mixed so as to make a highly explosive compound. The men had three of these on a low dray drawn by one horse. When last seen one of the men was driving, the others were on the

cart. In some mysterious manner, which will never be known, something happened which exploded the mines, and the result was almost outside the bounds of credibility. The three men were absolutely obliterated. The most careful search failed to find more than a few mutilated fragments of the smallest size. An index-finger, the sole of a foot with two toes, a bit of intestine, a lock of black hair, a small section of a spinal column, and a little piece of liver, all the fragments scarcely amounting to a peck in measure, these were all that was left of three men—no other parts, bony or otherwise, were found. Such complete annihilation in a second of time attested the enormous force of the explosion.

CHAPTER XX.

WOUNDS IN THEIR MEDICOLEGAL RELATIONS.
(Continued.)

In the preceding chapter two of the five classes were considered, into which, for medicolegal purposes, all wounds and injuries are divided. We considered the incised and the contused varieties, and will now pass to the third division.

Punctured Wounds.—This class comprises wounds made by pointed weapons or instruments. The weapons used range all the way from needles to cavalry sabres. The typical weapon is the two-edged, flat-bladed dagger or dirk, showing, thus, a sharp point and two cutting edges. Other forms may present themselves as cylindrical or conical weapons, like a needle; or with ridges, angles, and edges, like files, fencing foils, etc. Whatever the weapon may be, the wound which is made by it, as a punctured wound, is determined by the manner in which the instrument is used. It is plunged or thrust into the tissues, point foremost, rather than drawn across or over the surface. Therefore, in contrast with incised wounds, punctured wounds have a depth out of proportion to their superficial extent or orifice of entrance. They are deeper than they are long.

The orifice of the weapon's entrance deserves some notice. It presents appearances with interesting differences. The shape of the weapon modifies it. The typical stab wound, made with a double-edged, rather than a thin-bladed knife, like a dagger, thrust in straight, is a fusiform slit with clean-cut edges, slightly separated at their center, with ends coming together at a sharp angle, like a double convex lens.

It might be expected that a knife with a single cutting edge, like a pocket-knife, would leave a wound like a cross-section of an axe-blade, with one end blunt and the other sharp. This would result only if the blade was very thick. Ordinary knives of this description, however, with only one edge, leave in the skin a wound not to be distinguished from the one first described. Why is this?

The point of these knives is sharp, and once having entered

the skin, the cutting edge does the rest of the work on the soft tissues; while the back or blunt edge simply spreads or distends the wound at its end without extending it. When the weapon is withdrawn, the elasticity of the skin causes the wound to assume the elliptical shape, with two sharp angles. It thus happens that two-edged and single-edged knives make lesions in stabbing which can hardly be distinguished. This

FIG. 21.—Typical forms of punctured wounds.

applies to the soft tissues only. The case is different when a flat bone receives the stab—the thin part of the temporal bone, for example. Here we may find very satisfactory evidence of the kind of weapon used, the width of the blade, and the manner of holding it.

It is a mistake to suppose that weapons, other than those described, leave in the skin a wound that indicates their actual

shape. Dupuytren was the first to point out that cylindrical weapons, used in stabbing, leave in the skin elongated openings with two distinct angles. In this they resemble dagger wounds, though the angles are not so sharp.

Triangular weapons (bayonets) make a stellate wound. It thus appears that weapons with a blunt edge, which do not cut the cutaneous tissues and which act simply like a wedge to force apart the interlacing bundles of white, fibrous tissue in the skin, without dividing them, make a skin wound which is elliptical, irregularly quadrangular, or stellate.

Fig. 22.—Homicidal stab of the neck, wounding the carotid artery and internal jugular vein.

The shape of the wound, however, is further modified according to the state of tension or relaxation of the skin, and the direction of the blow. Thus, when the weapon has penetrated *obliquely* or when the skin is in a condition of uneven tension, the wound gives no suggestion of the shape of the weapon. A triangular or a round instrument may make an oval wound under these conditions, and a flat knife-blade may leave a crescentic opening. If a knife is thrust obliquely into the side of the neck, above the collar-bone,

where the skin is free and loose, it may leave an irregularly triangular opening.

The size of the surface wound, the wound of entrance, will vary according to the kind of weapon used and the manner of using it. If the weapon has a sharp point, but is without any cutting edge, the wound left by it when thrust into the tissues and withdrawn will be less than the diameter of the weapon. The reason is obvious. The skin is elastic, and when the fibers are simply forced apart without clean division they tend to resume their first position as far as may be. But if the weapon has a cutting edge which divides the tissue of the skin, and especially if it is not withdrawn in
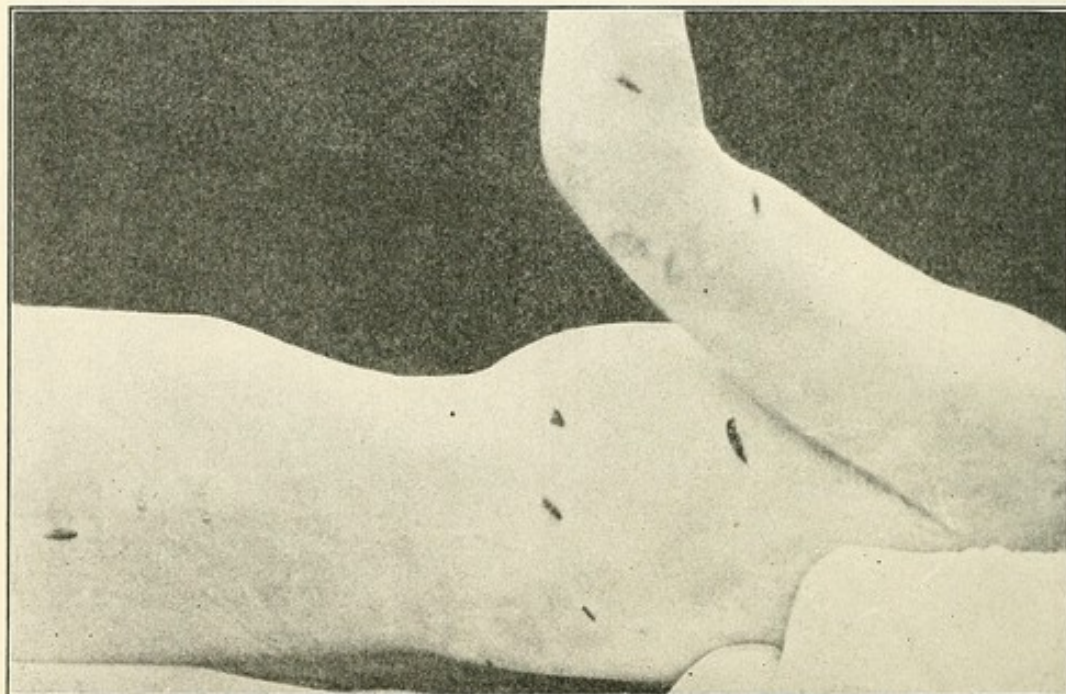
FIG. 23.—Stabs perforating the left arm and penetrating the left side of the body.

the exact axis of its introduction, then the external wound will be longer than the blade is wide. The two elements will bear no relation to each other, and if the part wounded is on the stretch the external cut will be especially out of proportion.

The edges of a punctured wound are regular and symmetrical if the stab is made with a sharp weapon, used with a single thrust or lunge and withdrawn in a straight line. Under other conditions there is more or less irregularity—sometimes an extreme degree of it.

The tendency of all such knife wounds is to show some separation of the edges. However thin the blade may be, the skin wound it makes spreads its sides, so as to form an ellipse.

Here, again, the elasticity of the skin is the factor which is in operation. (See Fig. 21 for the typical characters of a punctured wound.)

When a stab has traversed the body, transfixing it, by penetrating through and through (a bayonet- or sword-thrust), the entrance wound is the larger, of course; its edges are everted, because of traction on the skin in withdrawal; the eversion will be greater if the weapon is rough and rusty.

Punctured wounds made by porcelain or glass are characterized by great irregularity and lack of symmetry in their edges.

In June, 1881, an intoxicated man went to his bedroom, and soon afterward the sound of breaking crockery was heard by the family. He was found on the floor, resting on his elbow. There was very free hemorrhage from his neck. A chamber vessel was in fragments under him. He died in a few minutes. The body was in a great pool of clotted blood, and his head was among the fragments of the chamber vessel. Several of these fragments were pointed and sharp at their edges. In the left side of the neck was a crescentic wound, an inch long at the posterior edge of the sternomastoid muscle. The finger passed into this wound for a distance of two inches under the muscle in the direction of the carotid and internal jugular, both of which vessels lay in the way of the lesion.

The subcutaneous parts of the wound, its deeper elements, will differ according to the character of the weapon, the manner of its use, the region of the body receiving the wound, and the direction of the wound. A clean-cut stab into muscles or solid viscera (the liver or the kidney) leaves a wound corresponding pretty accurately in shape with the weapon. Its sides will be blood-stained; its depth and direction will be determined by the force and manner of using the weapon, the length of the blade, and the resistance and density of the tissues wounded. In muscular tissues some differences will be observed, according to the direction of the wound, whether parallel with the muscular fibers or across them. Besides, there may be an external lesion and several subcutaneous wounds, due to repeated thrusts, without full withdrawal, on account of the struggles of the victim, twisting and trying to escape.

On the other hand, there may be a multiplicity of external wounds, but only one thrust. In the deeper parts of a wound of the abdomen it is generally rare to find the course of the lesion in a direct line from start to finish. That is, the lesions do not overlie one another in such a way, in prolongation

of the external orifice, that a probe can establish the direction or the depth of the stab. These must be demonstrated by dissection, and with changing, movable organs (the stomach and intestine) this is frequently a difficult matter to trace because of the greater or less changes in the position of the viscera under various conditions. This is especially true of stabs involving several folds of the small intestine.

It is, however, generally practicable to find in the depth of such wounds as do not transfix the body, good evidence of the
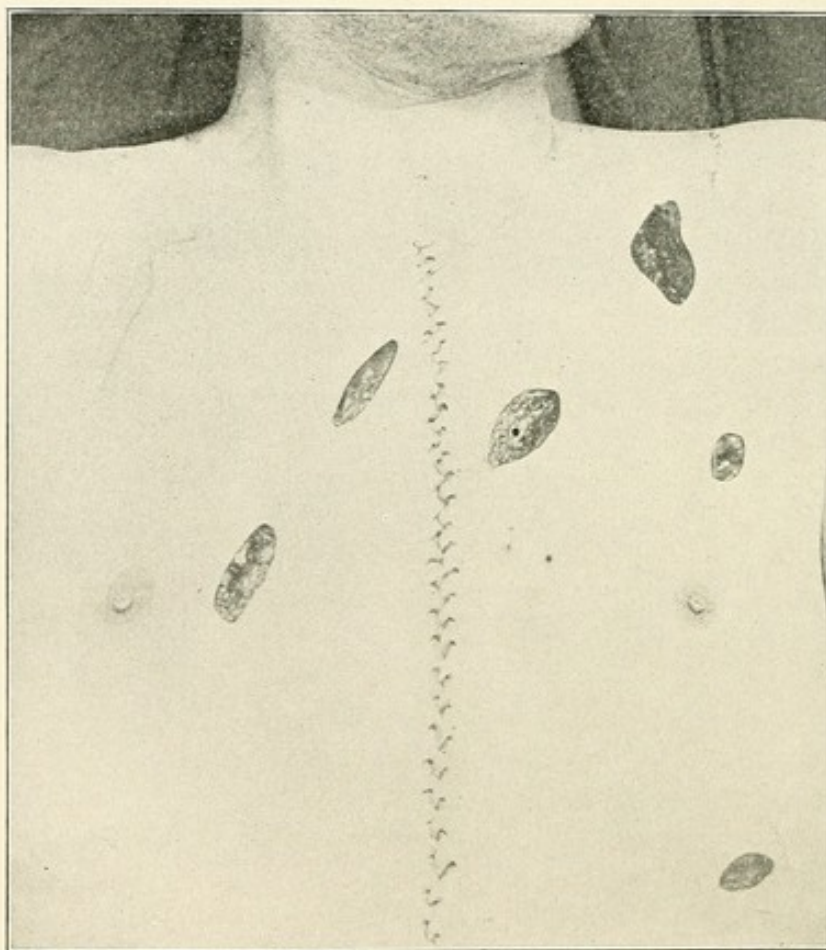
FIG. 24.—Homicidal punctured wounds of the body, showing typical shapes of external wounds.

length of the blade which did the wounding. For reasons already given, we may not be able to state how thick or thin the blade is, but by measuring the distance from the surface lesion to its farthest limit, we may be able to say whether or not the knife introduced in evidence could have done what was found at the autopsy. It is possible that the blade of the weapon may be *longer* than the wound is deep—it could not well be *shorter;* and to be able to say *so much* is a decided advantage.

Punctured wounds rarely bleed much externally. There are two important local exceptions, wherein the vascularity of the part receiving the wound is the obvious cause of the hemorrhage. These exceptions are the neck and the female genitals. Whether there is much internal bleeding will depend on the sharpness and shape of the weapon, and the depth of the wound, as well as on the character of the organs involved. A knife with sharpened point and edges could hardly avoid doing serious injury when thrust deeply into the chest or abdomen, and abundant internal hemorrhage usually results. This result is the more probable and evident because hemorrhage from the viscera is always a much more serious affair than hemorrhage from an open, superficial wound. The conditions in the latter case, favorable to coagulation and hemostasis, are absent in the former. There is, also, besides the absence of exposure to the air, absence also of the support which the blood-vessels of the extremities have from their sheaths and the surrounding muscles—a support which materially helps to stay the bleeding. Hence it is that comparatively small wounds of the liver, spleen, and lungs, which may not have involved any large artery or vein, frequently prove rapidly fatal from hemorrhage out of reach of control. But a blunt weapon, thrust into the tissues, would generally push the tissues aside, without dividing them, so that unless these weapons reach a vital organ—the brain or the heart—to wound it, their lesions are comparatively unimportant.

Lacerated Wounds.—These require only a moment's consideration. They are made by blunt or hooked weapons or instruments which tear the tissues and do not cut them. They are generally lesions due to accident. In many respects they resemble contused wounds and frequently can not be distinguished therefrom. Their edges are irregular, jagged, and swollen, and show marked separation. The skin in the neighborhood is often ecchymosed, and the subcutaneous tissues are bruised and disorganized.

Unless the parts lacerated are very vascular, the wounds of this class, like the wounds of the contused class, do not bleed much. The manner in which the vessels are torn apart is analogous to the crushing effects observed in contusions, and in either case the opportunity for hemorrhage is diminished—very much as it is controlled by the surgical procedure called torsion. Limbs have sometimes been torn out by the lacerations of machinery and other accidents, and yet the patient has escaped with very little loss of blood, although large vessels were sacrificed.

Professor Agnew, in 1891,[1] reported the case of a man whose arm was torn from its socket at the shoulder, and who, leaving his arm at the place of the accident, went about for five days without any surgical attention, exhibiting his shoulder for the price of a drink of liquor.

Gunshot Wounds.—Under this generic title are included all wounds made by the discharge of any kind of missile whatever from any kind of firearm by means of the explosion of gunpowder or its equivalent. We may thus include all classes of firearms, from the latest form of heavy naval ordnance to the tiny toy pistol, and all varieties of missiles from the smallest bullet to a shot or shell from a ten-inch cannon. It is obviously impossible within the present limits to give attention to all examples of gunnery within these extremes. The revolver is the weapon with which legal medicine has usually to deal, and it is this weapon to which constant allusion will be made in this chapter in studying wounds of this class. This study will be limited to recent wounds as they are observed on the dead body, in accordance with the usual conditions of such fatal lesions.

In these wounds we have to study three elements: 1. The entrance orifice made by the missile. 2. The track left in the tissues. 3. The orifice by which the missile left the body, assuming that the shot was a perforated one. For purposes of comparison, the writer will begin with a description of the appearances presented by a wound which has been made with a weapon held at such a relatively remote distance from the body that the bullet alone is the wounding agent. A conical bullet discharged from a revolver held, say, ten feet from the body struck, taking a spiral twist in its onward course from the rifled groove of the pistol barrel, striking the skin point-blank or at right angles with sufficient force to perforate, makes a wound of entrance presenting the following characteristics: 1. It is invariably smaller than the missile, the explanation being found in the elasticity of the skin. It is like firing through a rubber target. The result is that the size of the bullet is not determined or demonstrated by the orifice. Thus, a bullet of 0.32 caliber will take a large probe; one of 0.22 caliber leaves a mere dot, scarcely visible. 2. Its shape is generally irregularly circular. There is an actual loss of tissue. It is a punched-out orifice with frayed edges, a well-defined wound. 3. The edges are thickened and ecchymosed, the ecchymosis extending to the distance of from one to two inches. It is slightly inverted or depressed. It is blackened

[1] *University Medical Magazine.*

but not burned. The smut comes from the bullet's greasy surface discolored by exploded powder. There is little hemorrhage from these wounds under ordinary conditions. They are like contused wounds in that respect. An exception is found if large vessels near the surface, as in the neck, are wounded. Head wounds, also, bleed freely sometimes. It is to be noted that some external wounds are so directed as to form a valve-like orifice, obstructing external bleeding, but permitting hemorrhage into the cavities of the body.

These usual and typical characters of the entrance wound are subject to occasional modifications growing out of the shape of the missile, its momentum, the direction of the line
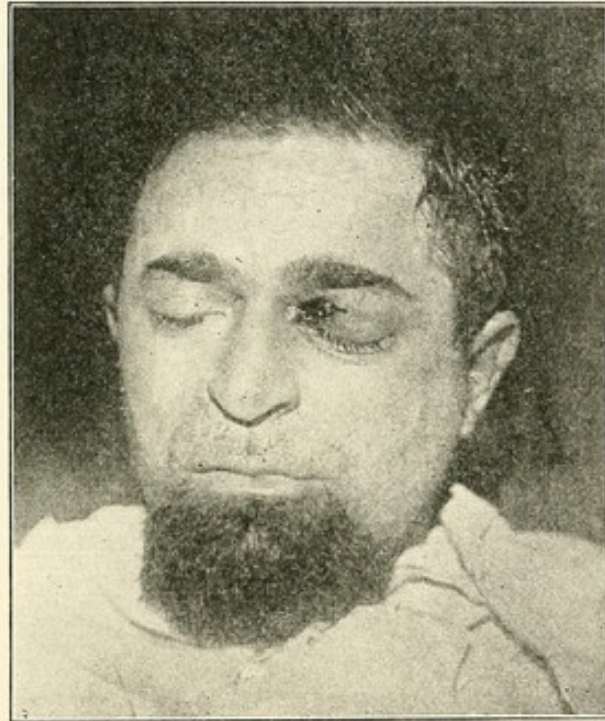
FIG. 25.—Revolver-shot wound into left eye, without marks of powder-grains. Suicidal.

of fire (the angle of incidence), and the characters of the tissues injured. Thus, a bullet fired at an acute angle to the surface struck would make an oval or a linear wound, instead of a round orifice. The writer can imagine, too, that it is possible that a conical bullet, fired in a point-blank direction, should change its axis moderately in its flight, so that it will strike somewhat sidewise, instead of point on, and thus make an oval wound. But he can not conceive that the converse is possible; that a bullet fired at an angle shall so turn as to enter the skin, leaving a round wound as if fired point-blank.

At the trial of one Barrett, in November, 1894, charged with the murder of a man named Farrar, by shooting, it was

shown in evidence that the bullet which killed struck the middle of the sternum, leaving a well-defined round wound; it was then deflected upward and passed through the heart and left lung. The Government experts testified that the wound over the sternum indicated by its shape that the revolver was fired point-blank. They fortified this opinion by numerous experiments.[1] An expert for the defence was found, a medical man of experience, who declared that the shape of a wound in the skin was no criterion of the direction of the line of the fire. In this the writer believes he was wholly wrong, and that a great many observations prove the value of the external wound as an indication of the direction from which the bullet came.

The writer turns now to the external appearances which are incidental to a much nearer shot. We have been considering the surface wound made by a bullet when the muzzle of the weapon is ten feet or more away from the body wounded; let us shorten the distance down to ten inches or less. The new features now to be examined are: Powder smutches around the wound; burns of the skin and hair; lodgement of powder-grains in the skin; the shape and size of the wound itself; and burns of the fabric covering the part wounded.

Blackening of the edges of the entrance wound is due to various causes. As already stated, the effect of the passage of the bullet through the skin is to *bruise* the tissues in the periphery of the wound, and the evidence of this is the discolored and ecchymosed appearance of the skin. This explains part of the change in the color of the skin, and is to be considered in connection with the smut or grime which the bullet leaves in its passage. Besides these, we have to note the marks left in and around the wound by the exploding powder itself, without reference to the bullet. These marks are incidental to a near shot only. The action of the flame of the powder shows itself in the singeing of the hair near the wound; or in burns of the clothing, if the part struck is covered, these clothing burns frequently transmitting a scorch to the underlying skin; or being evidenced in a dried or parchment-like appearance of the skin; or in a superficial black smutching of the skin with powder smoke, a deposit readily washed off. It has been demonstrated that the bullet itself does not burn the tissues, for the process of firing does not heat it to anything approaching a degree capable of burning. The burn which the powder makes has, however, one very interesting and constant feature. If the weapon is held

[1] *Transactions of the Massachusetts Medicolegal Society*, ii., p. 200.

in the hand in the ordinary way, hammer and sight on the barrel directed upward, the wound in the skin will show immediately above its orifice a brand or scorching caused by a slight recoil in the act of firing. The location of this brand will change as the position of the hammer is changed. If the weapon is held in a vise and fired, this relation of the brand to the wound is obliterated. This observation, first made and pub-

Fig. 26.—Homicidal pistol-shot wound of face, with the muzzle at close range.

lished by Dr. D. B. N. Fish,[1] in 1883, supplies an accurate index of the position in which the pistol is held in firing (Fig. 27).

Tattooing of the skin by the lodgement of unexploded powder-grains is an unequivocal evidence of a near shot, and has great medicolegal interest. The minute black dots or specks have a characteristic arrangement with reference to the central wound made by the bullet. They are very numerous and close together directly around the wound, and they become more or less scattered around the periphery (Fig. 26).

[1] *Transactions of the Massachusetts Medicolegal Society*, i., p. 279.

Sometimes they make short lines in the skin, the situation and direction of which indicate the line of fire. Although their typical arrangement is seen best when the naked skin receives the shot, they may also be seen sometimes in cases in which the skin is lightly covered, as with a cotton shirt.

These scattered powder-grains in the skin mean a near shot. Casper says that they require a distance of less than three feet
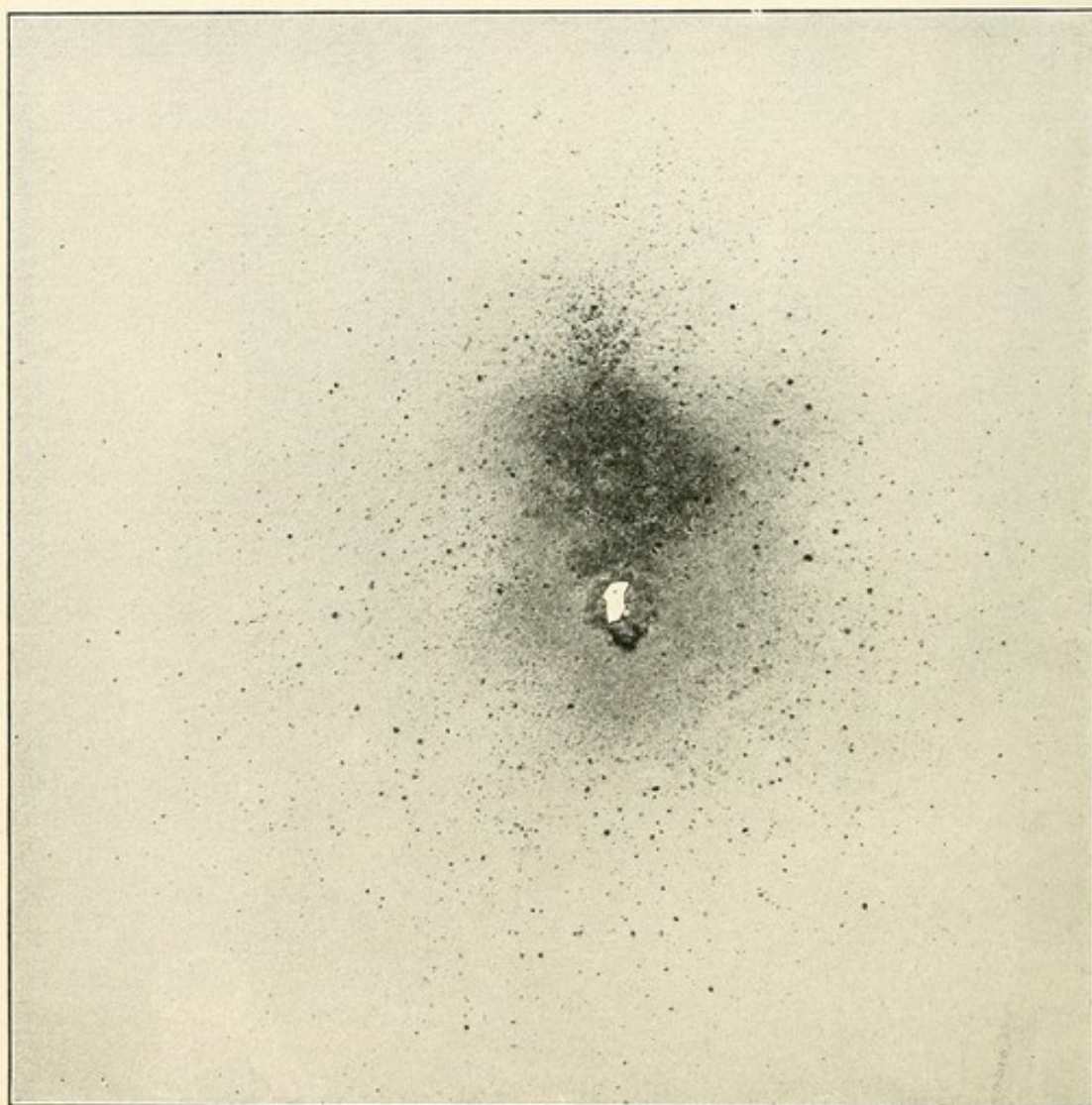
Fig. 27.—Shot from a police revolver, 0.38 caliber, six inches from target.

in the line of fire to bring them out. Briand and Chaudé declare that it is impossible to fix any limit that shall apply to all kinds of weapons and every variety of ammunition; and they show that, in any given case, it is better to make experimental shots with the same weapon, if it is possible to secure it, and with the same kind of cartidges as figured in the homicide. This is unquestionably the best way. In this way we

approximate the real distance of the original shots. It is, however, important to remember this : That while the presence of these powder-dots in the skin around a bullet wound mean a near shot, their absence does not prove the contrary, that the shot was remote. There are many exceptions to demonstrate this. Suicides have shot into the forehead, and the resulting wound was wholly without powder-marks (Fig. 25). This exceptional condition of things is explained by the fact that many of the modern cartridges are charged with powder which, in exploding, leaves no residue. Smokeless powder, fulminate of mercury, and other such explosives are characterized in this way.

What is the effect of the nearest shot possible? We are told that, with the muzzle of the revolver applied firmly to the skin of any part of the body, so that the barrel of the weapon is tightly closed or sealed, the weapon may be fired harmlessly, the bullet falling to the floor or ground without penetrating the skin and leaving only a little bruising. The explanation offered is, that the column of air in the barrel of the weapon is compressed between the bullet and the skin, and the elasticity of this column prevents the escape of the missile and destroys its momentum and its power to wound. Sometimes the barrel of the revolver bursts; or a mishap comes from another quarter in this way: If the muzzle is not applied firmly to the skin and there is no chance of escape for the pent-up gas of the exploding powder, then the external injuries are frightful in extent and severity.

The case of Almy, who was indicted for the murder of Christine Warden, in the summer of 1891, gave rise to questions analogous to the statement just made. A hearing was had on May 4, 1892. There was a wound in the head, the fatal one. A wound of the genitals was also found, small, without a mark of powder, and without external laceration. The bullet had emerged in the loins, leaving a track a little blackened, as seen from the outside. An internal examination was not made. The theory of the Government experts was that Almy purposely placed his revolver in the girl's genitals and fired with horrible, vicious lust. The theory of the defence was that an accidental shot had been fired by Almy while dragging the girl by her ankle, on her back, with the revolver held in the hand that grasped the ankle. Experiments on the cadaver for the purposes of the hearing showed that a revolver fired, as the Government experts claimed, necessarily left much tattooing and made very extensive wounds around the entrance of the missile, in

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marked contrast with what was actually found in connection with the homicide.

It is not essential that a weapon should be loaded with a ball cartridge in order to produce serious or fatal results when fired at a person. A blank cartridge of powder alone can make a round hole in the skin when fired close to the body, the mass of powder-grains not exploded being grouped in a compact mass. Generally, however, these grains scatter, and a near shot makes a severe laceration. Before metallic cartridges were used, and wadding was necessary to keep the powder in place, the discharge of a weapon so loaded has been known to make frightful damage. Paper bullets, used instead of lead, have resulted fatally. Taylor relates a case in which a gun loaded with powder and a kid glove for a cartridge was found adequate to kill.

When a charge of small shot is fired from a fowling-piece, the aim being point-blank and the muzzle near the skin, the wound made in the skin will be round and of such small dimensions as to resemble closely that of a single missile, like a bullet. But if the muzzle is a few inches away from the surface struck, so that the shot begins to deflect and scatter before touching the skin, then the mutilation is very great. In a case observed by the author in November, 1898, a young man was shot by his older brother with a fowling-piece, the muzzle of which was five or six feet away. The whole left side of the face was torn away, and both jaws were smashed and left a crater big enough to take in the fist.

There are some other peculiarities about bullet wounds which have a decided medicolegal interest. A plurality of external wounds does not necessarily imply a plurality of bullets, for the same missile has been known to go in, come out, and enter and perforate again ; or, a bullet may split upon a bone and, with one wound of entrance, make with its two parts two exit wounds, well separated ; or, a bullet may glance upon a bone, and emerge or escape near the wound of entrance.

What are the injuries done to the subcutaneous tissue— that is, the appearances presented by the track of the missile in its passage through the body ? Here, again, as in studying the external wound, we have to deal with effects which are subject to modifications resulting from the force of the missile, its rotary or spiral motion, the direction of the fire, the shape of the missile, and the part struck. In passing through muscle a bullet makes a canal which is ragged at its periphery, bruised, bloody, dark in color, and larger than the bullet. Along the course of the bullet track we often find foreign

substances carried into the wound, such as bits of lead, fragments of woollen or cotton fabric (clothes), and grains of powder.

In a case inspected by the writer a revolver shot carried a gold link from a watch-chain into the thorax, where it was found firmly welded in the nose of the bullet. Occasionally the bullet is so far spent as not to be able to perforate the clothing fabric, but the cloth is carried in with the bullet as an envelope.

If one of the flat bones of the skull is struck, it will be comminuted with fissures going in every direction if the force of the shot is nearly spent; but if the bullet is speeding with much momentum and it strikes the skull, it will leave an orifice with bevelled edges, the bevelling being at the expense of the bony table through which the missile passes last. Observation of this point gives absolute proof of the direction of the line of fire, and is sometimes of great consequence.

When a bullet passes into and through the brain it leaves a track in the cerebral tissue which resembles, but magnifies, the appearances of a bullet wound in muscles. It is straight and direct; is much larger than the bullet; is blood-stained, bruised, and ragged at its edges; and is brownish red in color. Around it the brain-tissue is ecchymosed, softened, and disorganized; it shows a great number of minute hemorrhages, and bits of bone or lead find lodgement, as in the case of muscle. Sometimes the bullet goes through and through the brain, and, without perforating the bone on the side opposite the wound of entrance, it strikes the inner table with force enough to cause a rebound, so that it is found resting in the brain-substance at a distance from the primary track.

In fascia, or in a membranous structure, like the peritoneum or dura mater, the missile does not make a symmetrical, round aperture, but leaves its mark as a slit, as if the fibers of the membrane had been pried apart with a wedge. In this regard these tissues make an exception to the rule, and the appearances described sometimes, as in the abdomen, make the search for the missile a matter of great difficulty.

These observations assume that the shape of the bullet is symmetrical; that no bone is in its course to distort it. But suppose the bullet has lost its conical or spherical shape by impact against a bone? The appearances and gravity of the lesion caused by the missile through the tissues will be changed accordingly.

Attention need hardly be called to the fact that the direction of the track of the bullet through the tissues frequently

fails to correspond with the direction of the line of fire. Bullets are readily diverted from their course; a very slight obstacle suffices to change their direction; bone, fascia, or any other resisting tissues readily give a new course. This is particularly true of round bullets. The deviation may occur immediately on entering the body, or in any part of the course. Wounds of the abdomen are probably the most difficult to follow. This is because, in addition to the ready deflection of the bullet, the organs are constantly shifting position. Through these causes search for the missile at the autopsy after a fatal pistol-shot wound of the abdomen is always a matter of difficulty, frequently a fruitless task. Such was the case at the autopsy of President McKinley. Prolonged search failed to find the missile after it had passed through the stomach and pancreas and had grazed the kidney.

Some very curious examples are cited of the erratic course of bullets in the body. A bullet may be found close to its wound of entrance, nearly completing the circuit of the body. It has struck the forehead and emerged at the occiput, going around the skull under the scalp. At another time it has circumnavigated the thorax outside the ribs, entering in front and emerging behind. It has entered the breast and lodged in the scrotum. It has passed around under the skin of the abdomen without penetrating (Dupuytren). Wharton and Stillé[1] report the following instance: At a duel one of the parties fell, but immediately recovered himself and got up. The bullet had entered in the front of the neck, and glanced from the side of the thyroid cartilage; it went completely around the neck, and lodged under the skin over the larynx, just across the divide.

Exit Wounds.—Let us suppose, now, that the missile has *not* lodged in the body, but has passed through. We have then to study the *third* element of bullet wounds—the wound of *exit*. There has been a great amount of discussion among medicolegal writers, some of it too controversial in tone, touching the differences which the two wounds of entrance and of exit display. The truth is, no two bullet wounds are identical, and it is useless to mark hard and fast lines of description admitting of no variation. As a general rule, it may be accepted that a bullet, passing through the body and still preserving much of its velocity, leaves an exit wound which, under the usual conditions, is larger and more irregular in outline than the entrance wound; has torn or stellate edges, without loss of substance; shows eversion to some extent with protrusion of subcutaneous fat,

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[1] *Medical Jurisprudence*, section 712.

and has margins which are bruised and bloody, but without any sign of burning, smutching, or powder-grains.

Occasionally we come on some extraordinary exception which seems to defy explanation. In a case of the writer's, in 1889, a woman, shot by her husband, received a 0.32 caliber bullet in the tip of her chin. The missile emerged immediately below the lobule of the ear on the same side, leaving a slit in the skin, like an incised wound. In another case, a man was shot, while in his store, by robbers. The bullet entered at the left loin, passed through the body from left to right, and left a wound of exit near the umbilicus, having all the external characters of a punctured wound.

Caspar says:[1] "When a bullet has not lodged, but has passed, along with the air or gas accompanying it, quite through the body, the wound of exit is always smaller than the wound of entrance. All recent observers agree in this opinion." This statement is incomprehensible, with all respect for the distinguished teacher.

In point of fact, the relative size of wounds of entrance and exit varies continually. Unless the velocity of the bullet can be approximately determined from a knowledge of the weapon and its proximity to the wounded person, it would be unsafe to draw a positive conclusion from this circumstance of the size alone of the two wounds, as to the position of the body when wounded, the direction of the line of fire, and the distance of the shot.

More reliance is to be placed on the well-defined outline of one wound (entrance) and the ragged and lacerated aspect of the other (exit) in cases in which the shot was so distant as to leave no stains of powder or smoke, and no burns or periphery of ecchymosis on the skin were present to settle the question.

[1] *Forensic Medicine,* i., p. 266.

CHAPTER XXI.

WOUNDS OF REGIONS, AND THEIR GRAVITY AND PROGNOSIS.

ALTHOUGH in the discussion of the various kinds of wounds and of the data for their post-mortem diagnosis, mention has been made incidentally of lesions as they were related to certain organs and regions, it is interesting and instructive to take a little closer and more special view of this topic—the medico-legal significance of injuries to certain regions, and especially to take into account considerations of their gravity, diagnosis, prognosis, and tendency to destroy life.

Wounds of the Head.—Incised wounds of the scalp, unless they are very extensive, rarely involve danger. Contused wounds and wounds attended with much laceration, are serious in their tendency to septic, erysipelatous inflammation. It is not safe, however, to be positive about the prognosis of any lesion about the head. Small punctured wounds will sometimes give the greatest possible trouble by suppuration, the result of infection; while, on the other hand, the surgical records of hospitals give instances of persons, usually women, whose hair has been caught in machinery and whose scalps have been almost wholly dragged off, yet who have recovered and received new scalps by means of skin-grafting. Therefore, so far as wounds of even the scalp alone are concerned, one needs to exercise some caution and to give a guarded prognosis.

Wounds of the head have special gravity in proportion to their effect on the brain, and it is rare that the brain escapes wholly from injury when the head receives a blow of any severity. The difficulty here is that the internal lesions can not be predicated upon those observed externally in the scalp. The degree of mischief produced in the cerebral tissues can not be measured by the outside appearances. The slightest contusions may lead to the gravest results; while, *per contra*, numerous instances demonstrate that fractures, with depression of the bone and a considerable loss of brain-substance, are not incompatible with recovery. Another difficulty in the way of

accurate prognosis is in the fact that a person may recover apparently from the first effects of a head injury, and then suddenly grow worse and die after an interval, longer or shorter; and, on examination of the brain, a considerable part of its substance will be found disorganized by suppuration, no symptoms of the abscess having appeared until just before the fatal issue. In such cases, it is necessary to be on solid ground in establishing the relation of the cause and effect between antecedent violence, possibly quite remote, and the fatal lesion. It is to be remembered that abscess of the brain is not necessarily dependent on previous violence, and that it may develop as an independent matter; it is also to be borne in mind, on the other hand, that even fatal results may follow a blow on the head insufficient to cause a scalp wound as a primary lesion.

Concussion.—A very common effect of a blow on the head is concussion, with or without extravasation of blood, but without the lesions or effects of compression of the brain. Concussion is usually indicated by fainting and insensibility immediately following the blow—the person is stunned. Sometimes vomiting occurs, and it is a hint of returning consciousness. Occasionally, the concussion is of such gravity as to cause immediate death, and it is important to remember that such a fatal result may supervene and the brain show no visible lesion on post-mortem examination. This is admitted to be extremely rare. In such a case we are compelled to fall back on shock as the cause of death.

It is also important to remember that brain symptoms resembling concussion may, under exceptional conditions, occur without primary symptoms. The head may receive a blow from which there are no immediate effects. The patient goes about his business; then after an interval of a few hours, or perhaps days, head symptoms—confusion of ideas, headache, vertigo, insomnia—possibly paralysis, will supervene, and the patient's life will be in jeopardy from causes at first apparently trivial or without significance. Railway accidents furnish many examples of this experience.

An important medicolegal problem is the differential diagnosis of concussion and intoxication. Station-house cases afford many illustrations. Suppose a case of this kind, to which a physician is called. How will he proceed? The history of the case will help, but this is not always accessible. There is not much reliance to be placed on the odor of the breath, because a man may receive head injuries while sober, although after drinking a little liquor, short of intoxication; because drunkenness and concussion from a blow may coexist,

a frequent coincidence, in fact ; because, in first aid to an injured man, a dose of brandy may have been given as a stimulant. If there is no odor of alcohol in the breath, of course, that element is eliminated from the problem, and the presumption is one of serious head injury.

Pressure on the supra-orbital nerve is said by some to give valuable aid. If compression or concussion exists, there is no reaction ; if alcohol intoxication is the trouble, the patient shows a shrinking or scowl.

When the data are insufficient to enable one to reach a conclusion, the medical attendent should always insist on waiting a reasonable time, so that the delay may help to solve the doubt. Insist also in treating the man in the meanwhile as if he was not insensible from liquor, but from concussion. Let him, in a doubtful case, be treated as a patient, not as a criminal. A few hours will settle the question. This avoidance of error is all the more necessary because : 1. Concussion may be of such a degree as closely to resemble intoxication ; and from the absence of all visible marks of violence on the head and the presence of alcoholic odor in the breath, the attending surgeon might readily go wrong. 2. Intoxication may be so great and the stupor so deep that, taken with a contusion on the head, in itself really of no gravity, as events prove, a wrong conclusion might easily be reached. The police surgeon should, therefore, take time.

As a post-mortem question, it is sometimes difficult to distinguish a death by intoxication from a death by concussion by the anatomical appearances only. Where there has been a blow on the head severe enough, without breaking the skull, to injure the scalp, and where, within the skull, one finds blood extravasated upon the brain, with many minute capillary hemorrhages in the adjacent brain substance, there can hardly be a question of the fact of violence. Short of this, however, the problem is a difficult one. There is nothing to distinguish concussion from intoxication in the appearances which each leaves on the brain, short of the gross lesions mentioned above. The vessels may be injected in both cases, and congestion is the rule. The discovery of alcoholic liquid in the stomach and its odor in the lungs and brain may give rise to the presumption of death by alcoholism only even if one finds an appreciable lesion of the scalp.

The decision must depend on a careful balancing of all the data, and the preponderance of data will settle the problem. Not a few cases, however, occur in which, from the anatomical appearances alone, it is impossible to decide. The answer

must then be based on the special circumstances and symptoms attending the death, so far as they are available.

Another problem which head injuries present to the medical examiner is the differentiation of effusions of blood in the cranial cavity caused by violence, and as a result of spontaneous causes. Suppose we find a moderate ecchymosis of the scalp, no fracture of the skull, and a considerable extravasation of blood compressing the brain—the dead body having been found under circumstances suggesting that an assault may possibly have been committed—how will the autopsy enable one to conclude that the hemorrhage was or was not connected with a blow as its cause?

In the first place, the situation of the ecchymosis, as well as its extent, will have a bearing; a small bruise of the scalp on the back of the head with a large clot within the skull would reasonably lead to a decision that the hemorrhage was idiopathic, and that the bruise came from a fall incidental to the apoplexy—that is, after and not before the hemorrhage, the result and not the cause of it.

Perhaps, however, of most assistance will be the situation and origin of the cerebral clot. Idiopathic hemorrhage (with apoplexy) rarely occurs on the surface of the brain. But traumatic hemorrhage is generally meningeal, or, at all events, peripheral, and it is rare, unless great violence is done to the head with consequent laceration of the brain, that the deeper parts of the organ show lesions due to external force. Moreover, a careful examination of the vessels of the brain will help to determine if the hemorrhage was due to causes other than violence. If they are atheromatous with stiff walls and wide-open lumen, a predisposing condition for rupture is present. In this connection age has an obvious relationship; apoplexy is rare before forty. Intemperance and an excitable, passionate disposition act as predisposing causes; also marked hypertrophy of the left ventricle of the heart.

It is to be remembered that lesions of the brain in head injuries do not correspond invariably in situation with the location of the external lesions. Quite often we find contusion, softening, and disorganization of the gray matter at a point opposite that where the head received the blow. This is called a lesion by *contre-coup*. This is especially the case when the blow, though severe, is not severe enough to cause more than a linear fracture, without any depression. This condition of things will sometimes help to explain the character of the injury. Thus, a blow on the top of the head is very apt to result in contusion, softening, and bleeding at the opposite

base, at a point most likely to lead to fatal compression most speedily, and where only a slight degree of compression will kill quickly. The lesion is found at the base of the frontal lobes after a blow at the occiput, as in falling backward.

Injuries of the Spine.—These, like injuries of the head, are serious in proportion to their effect upon the nervous tissue contained within the bony covering; and when we recall the structure of the vertebral column, how thick and dense the bones are, how strong the ligamentous bands, how reinforced by great masses of muscles, and how the mechanism of the wonderful articular scheme is put together for strength and usefulness, as the central support, we can well understand that great force is necessary to produce harm. This force is generally in the class of injuries called contusions, such as falls, blows, and crushing compression. Rarely, there is a lesion from a revolver shot; more rarely still, punctured wounds are the cause of death. In 1902 the writer investigated the case of a man, an Italian, who received a stab in the side of the neck. The narrow blade of the weapon entered the spinal canal between the third and fourth cervical vertebræ, wounding the spinal cord and causing death in three days after the assault.

A lesion of the cord generally shows itself either as compression or contusion, with disorganization. Both these mean such a degree of violence as to cause a displacement of a vertebra, or of more than one, with consequent pressure. This almost of necessity involves a fracture of some part of the bony structure and a rupture of ligaments. A lesion of the cord is increasingly grave as we approach the upper portion of it. Injuries of the cord above the fourth cervical vertebra cause the most sudden deaths; but sudden death does not invariably follow even a dislocation of the neck. The odontoid process may even be broken from the second vertebra and the cord yet escape fatal harm. But if the cord in this region is compressed, it means inhibition of the function of respiration, and this, of course, means death. In regions below the neck transverse injury of the cord determines paralysis of the parts supplied by nerves given off below the seat of the lesion.

These cases of manifest spinal injury, diagnosticated by displacement, paralysis, and death, are not the difficult ones. They are the cases which most often become the subjects of investigation as criminal cases, and include examples of violence so severe that death is an early primary result; or if the fatal issue is the result of *secondary* processes—myelitis, men-

ingitis, secondary hemorrhage,, or sclerosis—the relation between these and the violence is clearly made.

There are two other classes of spinal injuries which have very small value in criminal jurisprudence, but which play leading parts in civil suits. The first of these consists of strains or sprains of the vertebral column, due to falls or twists of the body. A person tumbles down stairs; steps upon an insecure coal-hole cover; falls into a hole in a sidewalk; or slips on an icy sidewalk; and, in endeavoring to save himself from injury, violently twists the body or suddenly jerks it, the effect is to stretch, possibly to tear, some of the many ligamentous fibers which tie the vertebræ together, and to produce a degree of pain and lameness which persists very long and is often made the basis for claiming great damages. The diagnosis of such cases is largely a matter of inference. The symptoms are almost wholly subjective.

What is to be said of that other class of imputed spinal injuries which have such tremendous pecuniary value and possess such transcendent medicolegal importance—the so-called cases of spinal concussion, otherwise called **railway spine**? Can there be, as the result of a railway collision or other similar violence, in which only the most trifling and insignificant external ecchymoses are found about the back, such a degree of concussion or comminution of the spinal cord as to cause genuine and serious symptoms, with an unfavorable prognosis? Is it reasonable that mere vibration or shaking up of a railway car in a casualty should produce the grave condition so often presented to juries by plaintiffs to substantiate a claim for damages? This question has been a fruitful subject of contention.

In the courts, in medical journals, and in medical societies one side or the other has found numerous and influential advocates. Erichsen may be said to be the ancestor of the spinal concussion theory, and his book, written in 1866, has been the terror of corporation counsel ever since. "*Erichsen's Disease*" is the title with which litigants have sought to designate the symptom-complex. In 1882 Page, an English railway surgeon, wrote a counterblast which has become the standard authority upon the other side. Those who have made special study of diseases of the nervous system, the increasing class of neurologists, are themselves divided into opposing camps. This division of opinion argues that the subject is largely a matter of speculation or guesswork, and that it does not yet rest on a firmly established foundation. The lesions in these cases of so-called railway spine can not be demonstrated;

autopsies are not available. The symptoms are subjective, not objective.

As in the case of sprains of the spine, there is an open door for fraud and exaggeration, and it is not improbable that a vast number of scamps have entered it, and, with the help of skilful lawyers and partisan experts more hungry for plunder than for a good name, have succeeded in convincing juries and in raiding the treasuries of corporations. In good proof of the fraudulent character of some of these cases is their early and too prompt recovery when the end of the litigation proceedings makes no longer useful or valuable the pains in the back, the anesthesias in some parts, the hyperesthesias in other parts, the peculiar gait, the insomnia, the feeble voice, the muscular tremor, the irritability, and the inability to concentrate thought, which comprise the group of purely subjective symptoms not difficult to simulate, but impossible to demonstrate as real. Let the writer not be misunderstood. He does not want to say, and does not mean to say, that every case of alleged spinal injury with obscure, anomalous, equivocal, and purely subjective symptoms is a case of fraud. He does not deny that in some of these cases other symptoms of a purely objective character, such as manifest failure of the general health and sometimes genuine paresis, may follow the shaking up of a railway collision or similar casualty.

The writer is also quite ready to admit that accidental cases have been observed wherein the question of damages or litigation never entered, and in which a blow on the back has been the initiation of a long train of more or less serious spinal symptoms, suggesting some real lesion which could have been demonstrated if death had ensued at once from some other cause, and the spine had been examined before any repair of the primary injury, or before development of secondary troubles could have been possible. The caution the writer insists on is that physicians should never lend themselves to promote unjust litigation, to help fraud, to be the allies of knavery, or the willing accomplices of wicked designs. A wholesome skepticism in cases that are in training for lawsuits is the best mood to nurture, and in such cases care should be taken to separate the symptoms due to spinal injury from those of hysteria, anxiety as to the results of the suit; the whole group of litigation symptoms.

Wounds of the Face.—These, if of any extent, are usually followed by great deformity, but are not generally dangerous. When, however, they penetrate the cavities in which the organs of sense are located they often prove fatal,

either by involving the brain and its membranes or by causing inflammation of that organ. Wounds apparently confined to the external parts of the face thus frequently conceal deep-seated harm. Wounds of this class are ordinarily punctured wounds, and generally are either homicidal or accidental, rarely suicidal. A sharp instrument, for example, penetrating the eyelid, and passing upward, will, without the exercise of much force, perforate the orbital plate of the frontal bone and wound the brain, the bony envelope of the eye at this point being very thin. Sir Astley Cooper reports the case of a girl who fell while playing with a pair of scissors, the point of which passed upward under the upper eyelid. Extraction of the blade was somewhat difficult. For ten days she was under the care of a surgeon, walking some distance to see him. Her eye was inflamed, but it gradually grew better. Then pain suddenly developed, symptoms of meningitis supervened, and she died. An autopsy revealed a wound of the brain.

In 1735, Macklin, an actor, was tried for causing the death of one Hallem by thrusting a stick into his eye. The autopsy revealed the fact that the stick had entered the brain through the orbit, fracturing the bone and injuring the brain. He was convicted of manslaughter. In 1843 one boy killed another in Liverpool by wounding him with a gimlet, thrust into the eye. Death followed in two days. In another case a pipe stem was the weapon. In still another a boy aged ten years had the brush end of a broom thrust into his face by a comrade. He suddenly fell stunned. Symptoms of brain inflammation came on, and he died in sixteen days. The orbital plate was found to be perforated, and purulent inflammation of the meninges and brain was present. A physician in Fall River, in 1892, while in the act of fencing was fatally injured. The foil of his antagonist entered his brain through the orbit and caused death.

Wounds of the nose and mouth are also serious through their proximity to the cranial cavity, and to the injury of the brain. Penetrating punctures by way of the nostrils are reported in criminal records; such a wound may be made without external marks. Wounds of the mouth with firearms used for suicide are not uncommon. They are directed upward and involve the brain; and they usually make frightful ruin in the roof of the mouth. The lips escape damage in these cases. Pistol-shot wounds of the nose must be very uncommon.

Wounds of the neck derive their gravity from the obvious fact that such important blood-vessels lie in their way. Incised wounds are most commonly observed here, generally suicidal,

sometimes homicidal. But the region is not wholly a stranger to punctured wounds, and these take a downward direction usually and are homicidal in character. Lord Castlereagh killed himself by thrusting a penknife into his carotid artery. Pistol-shot wounds of this region are unusual.

Besides the seriousness of wounds of this region, growing out of danger of death by hemorrhage, comes the added danger of death by asphyxia if the larynx or trachea is wounded, and blood finds its way in any quantity into the air-passages. In the same way an incised wound of the larynx exposes the patient to risk of edema of the glottis and suffocation therefrom. In some cases, too, diffuse cellulitis is a secondary result. It spreads rapidly and leads to the burrowing of pus as one of its disasters. Emphysema may occur, also, in any case where an opening has been made into the trachea below the glottis, and the expired air is prevented from having free exit. Especially is this the case when the external wound does not correspond with the wound in the cartilaginous structures. Dysphagia may immediately result or may subsequently arise if the esophagus is involved in the wound. Finally, bronchitis and bronchopneumonia are threatening complications likely to arise as dangerous secondary conditions, affecting the prognosis of wounds of the front of the neck. But we may have serious, even fatal consequences from injuries of the neck without any solution of continuity. A blow upon the larynx may prove suddenly fatal from shock or from the arrest of respiration by spasm of the glottis. Short of an immediate *fatal* effect by a blow, insensibility of longer or shorter duration may ensue. The same result attends sudden compression of the larynx, as in the act of strangling or garroting. As already stated, these effects are due to irritation of the peripheral branches of the pneumogastric nerve.

Wounds of the Chest.—These wounds may involve the thoracic walls only, or they may harm the contained organs. When limited to the chest-walls they are comparatively unimportant; it is only when the violence embraces the deeper parts that harmful results ensue. Contusions of the chest are dangerous according to the degree of violence used. If the force suffices to fracture several ribs, to drive the sharp ends into the lungs, to tear the pleura extensively, or, without fracture of the ribs, to rupture the lungs or diaphragm, the prognosis would naturally be bad. The prognosis is most serious when the *upper* ribs are broken. A simple fracture of the sternum, uncomplicated by deeper injuries, is not a very dangerous matter. As a matter of fact, however, injuries of the

sternum generally are attended by such force as to cause the deeper and more serious lesions.

Wounds of the lungs declare themselves by the expectoration of frothy blood, as well as by symptoms of shock. This external evidence of bleeding may, however, be wholly out of proportion, in its small amount, to the hemorrhage which is going on in the chest out of sight and filling the pleural cavity. Pulmonary wounds, in other words, are primarily dangerous from hemorrhage; and the degree of the hemorrhage depends on the size of the vessels divided and on the extent of pulmonary tissue involved in the lesion. Thus, a division of a large branch of the pulmonary artery or vein, or an extensive lesion of the lung, would mean almost immediate death. Small wounds of the lungs, even perforating wounds, unless some large vessel is involved, are not of necessity very serious. Surgical records tell of numerous cases of recovery after punctured and pistol-shot wounds, which, at first, seemed to have all the elements for unfavorable prognosis. If primary effects are safely borne, there is still the risk of secondary inflammation, like pleurisy or pneumonia; but even these are not by any means inevitable.

Other consequences are emphysema, pneumothorax, hernia of the lung (pneumocele), hydrothorax or effusion from the pleura, empyema, and permanent contraction of the side of the thorax involved. Of all the wounds, the incised wounds of the lungs are reckoned by surgeons as the most dangerous because of the attendant hemorrhage and escape of air. Punctured wounds offer a much more favorable prognosis. It is worth while to remember that in a young person, with yielding ribs, the lungs may be fatally lacerated by external pressure (as in wagon-wheel accidents) and yet the ribs may wholly escape fracture.

Wounds of the Heart.—These are not of necessity or inevitably fatal, as one, at first thought, might be led to assert. They are serious always and fraught with danger, but, as experience teaches, not invariably mortal; and if they are mortal, they are not uniformly so as the immediate consequence of the lesion.

Fischer has collected no less than 452 cases of injury of the heart and pericardium. Of this number, 276 died at intervals of from one hour to nine months. Death was immediate in 104 cases. In 72 cases the patients recovered. Autopsies made long afterward in 36 of these cases of recovery (or one-half of the recoveries) verified the diagnosis. In these 72 cases the wounds were as follows: 10 punctured, 43 incised,

12 gunshot, and 7 lacerated. Other testimony to the same effect might be cited. Many cases are scattered through surgical literature and the journals, demonstrating that wounds of this vital organ are not of necessity instantly fatal or, indeed, mortal at all; and they should serve as a check on the medical witness who is tempted to be dogmatic and decided when serious injuries of the sort are in question.

In December, 1898, Dr. Beer reported in the *Cincinnati Lancet-Clinic* the case of a man who was shot during an engagement in the Civil War in 1861, thirty-seven years before. The bullet had entered the left chest and passed through the left lung and into the left ventricle of the heart. The man had been regarded as being fatally wounded and he received no care on the field. He had finally recovered, however. His repeated assertions that the bullet was in his heart were confirmed by Dr. Beer who made an autopsy, at the man's request, after he died of cancer.

Certain experiments on animals have confirmed the clinical observations on the human subject in the direction of showing that we should be slow in stating that heart wounds are always sure to kill, simply because they are heart wounds. Hare, in 1889, reported 10 experiments on dogs. He wounded the heart with pins, aspirating-needles, scissors, and scalpels. Only 1 of the dogs died from the wound, and the pericardium contained a large clot which compressed the heart and embarrassed its action. One, wounded in the heart with a hat-pin, suffered no inconvenience. The other 8 were killed at various intervals—from forty minutes to four days—by chloroform, and the autopsy established the lesion in the heart, sometimes finding a wound involving both the anterior and posterior wall. In none of these cases, except the one fatal case, did the animal seem to suffer much.

The duration of life after cardiac wounds depends considerably on the part of the heart wounded. Thus, the right ventricle is found to be the cavity, the wounding of whose wall is not only most frequent, but most fatal relatively. Olivier d'Angers collected 61 cases of all varieties of cardiac wounds. In 29 cases the wound was in the right ventricle; in 12 cases, in the left ventricle; in 9 cases, in both ventricles; in 3 cases, in the right auricle; in 1 case, in the left auricle; and in 7 cases, at the base or apex simply.

The direction of the cardiac wound has more effect on its fatality than its situation or extent. If made in the parallel course of the muscular fibers, there may be little or no hemorrhage; but if the wound cuts across the fibers, the edges will

separate and sudden death from the immediate gush of blood will result. It is for this reason that pistol-shot wounds are more serious than other varieties of wounds involving the heart; yet these are not always immediately fatal. Taylor reminds us that the presence of a weapon in a heart wound may retard a fatal result by mechanical obstruction to the effusion of blood, and he instances the case of a lunatic who forced a long stiletto into his chest, wounding the left ventricle, the blade having passed beyond his reach. He lived twenty days in much pain. The autopsy found the stiletto blade firmly imbedded in the substance of the left ventricle. There was pericarditis; and *slow* effusion of blood was demonstrated.

From what has been said it is easily inferred that the cause of death is not so much the amount of blood lost, as it is the filling of the pericardial sac with blood which quickly *compresses* the heart and stops its action. Occasionally, the wound is of such a nature as suddenly to interfere with the innervation of the heart, and so to inhibit its contractile power.

Wounds of the **large vessels of the chest** are, for the most part, mortal; rather more so in fact than are wounds of the cardiac walls. The death is by internal hemorrhage, resulting immediately or in a few hours. But grave as these wounds are of necessity, they have a few cases to their credit in which they have not killed at once. Dr. Heil reports a case in which the patient recovered and lived twelve months after receiving a stab which penetrated the ascending aorta. Other cases might be cited, but they are very few.

Injuries of the **abdomen** offer to the medicolegal student some of the gravest examples of the lesions of violence. Thus, contusion of the abdominal walls, without any rupture of the viscera, may prove to be of the most serious import; and even a slight blow should not be regarded too lightly. Something will depend on the state of the abdominal parietes whether a blow is harmful or not; whether the patient is fat or emaciated; whether the stomach and intestine are full or empty; whether the last meal was recent or remote. Contusions of this region of the body, such as result from falls or blows, cart-wheels passing over the body, or shafts of carts driven against the belly, are followed immediately by intense pain, faintness, and vomiting; the deeper parts escape injury. Indeed, testimony is not lacking to prove that instantaneous death may result from a blow over the epigastrium, acting by shock through the nervous plexuses, without leaving any ecchymosis.

Again, we may have, as the effect of blows, serious lesions

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of the subcutaneous tissues of the abdominal walls, with or without injury of the viscera. For example, rupture of the muscles; contusion of the soft parts, with extravasation of blood, with possible sloughing or suppurative inflammation; or rupture of the peritoneum with resulting hemorrhage, have been observed. In this connection, a word may be said, in passing, of the significance of rupture of the diaphragm. It means great external violence, and is usually associated with other serious lesions affecting adjacent organs. But a rupture may be caused in the diaphragm alone. In such a case the hemorrhage is slight; it is by no means necessarily fatal; or, when fatal, is it immediately so? The chief secondary danger arises from the hernia. The part most commonly ruptured is the left portion.

Rupture of the Stomach and Intestine.—These are of greater medicolegal consequence, for they illustrate the various injuries of the abdominal viscera by external force in the form of contusions causing ruptures of the organs. Take the stomach, for example. Rupture of this organ is, as a rule, a fatal injury. This lesion requires, as a favoring condition, that the stomach should be busy with the digestion of a larger or smaller quantity of food in its cavity. This food, escaping through the rent, into the peritoneal cavity, is a fruitful source of inflammatory mischief which develops rapidly and soon ends fatally. The gastric juice with the food is particularly irritating.

A blow with the knee, a kick with the foot, human or animal, a fall from a height, severe compression, as between two cars or under wagon-wheels, are examples of this kind of violence. The rent usually follows the course of the muscular fibers, and it is sometimes several inches long. At the autopsy the peritoneum is found intensely reddened, and the cavity usually contains a quantity of fluid of a characteristic chocolate color.

Rupture of the intestine is reckoned by surgeons as one of the most formidable of injuries, so far as prognosis is concerned. It is caused by kicks, or the passage of wagon- and carriage-wheels, or by being crushed between railway cars. It presents all varieties, from the merest perforation to entire division of the gut. The chief source of danger is the escape of fecal matter and consecutive shock and peritonitis.

Although the prognosis is so grave, it may be quite within the power of the surgeon of the future to render this injury less formidable by laparotomy done early under antiseptic conditions, and resection of the injured bowel. It is worth

remembering that though a rupture of the intestine is attended with severe symptoms, the patient is not fully disabled by it. Cases are on record in which the injured person has walked a long distance, in which death resulted from secondary causes, and the rupture was found post mortem.

Rupture of the liver, if deeper than a mere superficial tear in the capsule, is almost of necessity fatal, because of shock and hemorrhage. It means a very considerable amount of force, such as compression between cars, violent kicks, and falls under wagon-wheels and under cars, the force being brought to bear either through abdominal or thoracic walls. Superficial cracks are not very serious matters, and they may occur without any specially severe symptoms. Such peripheral lesions are found sometimes in process of repair when the autopsy finds other causes of death. As regards the more serious forms of laceration of the substance of the liver, post-mortem examinations reveal sometimes the most complete smashing of the organ into shreds and fragments. In such cases the fatal issue is quick in following the injury. The size, situation, and friability of the liver favor its rupture by external violence. The violence which suffices to rupture the liver need not be direct. A fall on the feet from an elevation has produced this injury. But even when the force is applied directly over the organ (as by wagon-wheels), we may find the organ thoroughly broken up, yet no external trace of injury is visible. Wounds of the liver by stab or bullet are apt to cause rapidly fatal hemorrhage. They are always reckoned as serious matters, with reference to prognosis.

Rupture of the spleen is a not uncommon result of violence. It closely resembles rupture of the liver in its causation, symptoms, and prognosis. Superficial rents do not of necessity prove serious. They have been found partially healed after injuries causing fatal lesions in other organs. Hemorrhage is the natural result of a large rupture, and this is the usual cause of death. It is, also, the ready cause of death in other lesions than contusion and rupture, such as stabs or bullet wounds. A large and softened spleen is all the more easily ruptured because of that condition. Hence, there are numerous examples of this injury in countries where malaria has done its work on this organ.

Rupture of the kidney has a special danger in the extravasation of urine into surrounding parts. If the rupture is posterior, cellulitis results; if anterior, peritonitis will follow. In either case the lesion is a serious one. Short of this secondary result, however, a blow or a kick in the loins may so

lacerate the kidney as to cause rapidly fatal results from collapse and hemorrhage. On the other hand, the lesion may be so situated and so slight as to end in recovery. It is not of necessity mortal.

Rupture of the bladder may occur as a result of external violence which has left no visible evidence on the skin. A bladder already distended with urine can not well withstand much additional force, and when pressure is applied under such circumstances above the pubes the organ gives way in its posterior wall, near the fundus, leaving a crescentic opening of variable length and direction. Urinary extravasation and death by shock, with peritonitis, is the ordinary result.

A nice medicolegal question might easily present itself in one of these cases: Was the rupture the result of wilful violence, or spontaneous from overdistention? In truth, the only anatomical appearance which would enable one to say that external violence was the cause would be an external ecchymosis, and this evidence is very commonly lacking. In such a case the decision must rest on evidence other than medical, since the appearances left on the bladder are the same in both cases.

Contused wounds of the female genitals have a special gravity because of the vascularity of the parts and their proneness to bleed profusely when wounded. The same is true when the lesion is an incised or lacerated wound. Some very singular instances are recorded of accidental wounding of the vulva by falls or contusions, or wounds with sticks, with fatal consequences. Sometimes a kick may be the cause of the death of a woman. If the blow is at the upper part of the vulva, over the pubes, the lesion may closely resemble an incised wound, and the death is a death from hemorrhage.

In these remarks on injuries of the abdominal and pelvic regions the writer has dwelt mostly on the class of contusions and their effect to cause rupture of the various organs; but, of course, these do not exhaust the subject. The abdominal cavity receives impartially all kinds of wounds—cuts, stabs, and pistol-shots, as well as blows and bruises. Much that has been said, however, with regard to the effect of contusions will apply equally to other forms of violence. For instance, a stab or pistol-shot wound of the stomach or intestine, of the bladder or the kidneys, is a matter of seriousness in cases in which the contents of the viscus escape to set up peritoneal inflammation, and this is the usual course.

A smaller injury of the liver or spleen gives rise to hemorrhage, as the writer has suggested before. Incised or punctured

wounds of the abdominal walls, penetrating the peritoneum, very commonly give exit to a knot of intestine which gives much trouble in its reduction and sometimes requires enlarging of the initial wound. But these wounds, if seen early, and there is no lesion of the intestine, frequently result favorably. Senn's method of demonstration and laparotomy give hope for better results of treatment in the future than have been attained in the past. It need hardly be added that, in considering the prognosis of all these wounds, the general and comprehensive statement may be made that, in addition to the character and gravity of the wound, much depends on the age, health, and habits of the patient, whether he does well or ill after a given injury.

CHAPTER XXII.

WOUNDS INFLICTED BEFORE DEATH. THE MANNER AND PURPOSE OF THE WOUNDING.

BEFORE leaving the subject of wounds, two important medico-legal questions remain to be answered in order that we may have as comprehensive a view as possible of the whole field. The first of these questions is: How shall we determine upon the dead body that the wounds found there were given before death rather than after?

The question is not an infrequent one in trials for homicide, and the attempt is made to obtain help for the defendant from the doubts involved in it. The question may easily arise, too, in other relations. A murderer may kill his victim by a blow on the head and then, to simulate suicide, may make a deep, incised wound of the neck. Or, he may kill by stabbing, and carry the body to a railway track to be mutilated by the next passing train. Or (as in the Parkman case) the homicide may be by striking, and extensive cuts may be made to mutilate or to conceal identity.

With regard to injuries made several days before the death which is their result, there is little difficulty. Here there are signs of vital reaction; the inflammatory changes incidental to repair are manifest; there may be some suppuration, sloughing, or ulceration: or if, by good fortune, healing by first intention closes the wound, that result will be obvious. If the wound is a bruise and not a solution of continuity, then the color-changes peculiar to ecchymoses will be seen. In none of these assumed conditions can there be any doubt that the injuries were received before the patient died.

Suppose, however, an injury has been inflicted a relatively short time, say eight or ten hours, before death, before secondary reparative changes have had time to declare themselves. What appearances are present to enable the examiner to distinguish a wound from a similar lesion made at an equal interval after death?

Incised Wounds.—The post-mortem examination of a

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recent wound made with a cutting instrument on the living body eight or ten hours before death shows the following characters: 1. Evidence of *free* bleeding. 2. Blood in a clotted state about the edges of the wound, and in a condition of infiltration in adjacent tissues. 3. Retraction of the *edges*—gaping—almost enough by itself to distinguish the time. This is due to retraction of the edges of elastic skin. 4. The edges are swollen and injected, or, if short and superficial, agglutinated. 5. Retraction of the *sides* of the wound under the skin—a familiar phenomenon in amputations.

Now, an incised wound on a dead body, made eight or ten hours after the death, shows appearances which are in strong contrast with these. There is little bleeding, and that which is found is of dark, venous, fluid blood which has slowly oozed from the wound. No staining of the adjacent parts is found; there is no injection or infiltration of adjacent tissues; there are no clots in the wounds. The edges of the cut are relatively in close apposition, without any separation or eversion. There is no retraction of the skin and muscles; there is no swelling or other vital change in the edges; they are soft and yielding.

Suppose, however, that, instead of comparing a cut on a living body made several hours before death with a cut on a dead body made several hours after death, we reduce the interval to much briefer limits and undertake to determine the differences which distinguish an incised wound made on the living body an hour or less before death from one made on the dead body an hour or less after death. This, indeed, would be the usual condition of things which such a problem would present. A murderer would not wait for any cadaveric cooling or other changes to occur before he mutilated or wounded the victim of his previous violence. And here he has a very clear and decided advantage over which medical evidence has very small control. The concurrent opinion of all authorities is, that under the conditions assumed, it is extremely difficult, if not impossible, to find anatomical data which would be of service. The nearer we come to the dividing line between one set of appearances and the other (death) the greater the difficulty.

The case of Isaac Sawtell, who was tried in New Hampshire, in 1890, for the alleged murder of his brother, is an example of the problem. Hiram Sawtell was shot on February 5, 1890, at Morrill's barn in Rochester, N. H. Several days later his dead body was found mutilated and buried seven miles and a quarter away in the *Maine* woods. The head was off and the

arms had been cut off with an axe. There was an appreciable degree of contraction of the skin at the neck and on the arms. The question was: Could the body cool and the tissues change in an hour and a half after death to such a degree that there would be no retraction of the edges of the skin, under existing conditions of temperature and clothing; or was the condition of the skin as found at the autopsy consistent with the supposed data? The bearing of the question had a distinct personal relation. If the killing and mutilation had taken place in New Hampshire, capital punishment would have been the penalty; if the homicide had occurred in Maine, the prisoner, if convicted, would have escaped with his life. The Government experts testified that, in their belief, the killing had occurred in New Hampshire.

Punctured Wounds.—With regard to these wounds, very nearly the same remarks apply as in the cases of incised wounds. The same rules are applicable. It is mostly a matter of more or less bleeding, and of more or less vital reaction in the form of swelling at the edges. It is freely admitted that the difficulty in distinguishing a stab made just before death from one made immediately after death is a very great and a very real one.

Contusions and Contused Wounds.—With these wounds, the difficulty of the problem of distinguishing ante-mortem from post-mortem lesions obviously increases as we shorten the period embraced in the arbitrary limits of time, before death and after. With bruises several days old at the time of death, the zones of color, swelling, and appearances on section give sufficient data to establish the fact of their priority with reference to the death. So, too, with a contusion that is recent, but more than two or three hours old when the person died, there is no difficulty in the conclusion that it was a lesion received before death, because we may observe the characteristic discoloration of the part struck; the swelling; the infiltration of the connective tissues; the clotted state of the blood; and the incorporation of the blood with the whole thickness of the true skin; all of which testify to the time of the bruising as ante mortem.

The problem assumes the most interest and difficulty when we are dealing with a bruise produced immediately before death and are required to distinguish it from one of the same severity and in the same situation made a few minutes after death. Experimentally, it has been determined that, as late as three hours after death, a blow on the surface of a cadaver, on the forehead, for instance, will make an ecchymosis. With

this knowledge, then, that there is a pretty close resemblance between contusions made on the body just dead and those made in the last moments of life, it will be well for the medical witness to avoid positive statements and to err on the side of caution.

Lacerated and Gunshot Wounds.—The same considerations apply with equal force to these wounds as to incised, punctured, and contused wounds. The same principles obtain. If, in any case, time enough has elapsed between the injury and the death for reparative changes to be manifest, in even a slight degree, the character of that injury as an ante-mortem one is settled. But if the question rests upon a much briefer interval—if it relates to a comparison of a lacerated or bullet wound received just before death with one inflicted just after death, there are no trustworthy differences which will serve our purpose.

Concerning this question of the discrimination of ante-mortem from post-mortem wounds, two general propositions may be made, applicable to all of these alike: 1. It is a clear advantage to be able to state that a particular wound found on a dead body was unquestionably made either during life or immediately after death, since it can scarcely be supposed that anyone but an assassin would make, upon a body just dead, a wound that would be fatal to the person if he had received it while living. 2. In the absence of any other sufficient cause of death, a wound involving any important part would evidently stand as such cause, and thus must of necessity have been inflicted during life, however equivocal its appearance may be.

The Manner of the Wounding.—Assuming, now, that an examination of a body found dead by wounding has determined the kind of wound inflicted—that is, the manner in which the weapon was used and the sort of weapon employed; and, assuming, furthermore, that, so far as is possible, we have settled the question with regard to the several lesions, whether or not they were inflicted while the person was still living, the next important medicolegal problem which is to be solved with regard to the fatal wounding is, What was the *manner* of the wounding? Was it a case of homicide, suicide, or accident? It is obvious that this question is, perhaps, the most serious of those which confront the medical inspector. It has often happened that the medical witness has to carry the principal burden of proof, and that on his well-considered judgment in such an issue the determination of a case rests. The medicolegal examiner should make a careful analysis and

comparison of all available data, and form his conclusions with judicial firmness. Let us consider some of the aids which he will have in this direction :

The **nature** of the wound will itself help in a general way, although this kind of evidence does not go a great way in the direction of a decision. Thus, stated as a broad proposition, contusions are relatively uncommon as lesions in suicide. The chances are that they are accidental or homicidal. It is obvious that there are exceptions enough to this rule to stand in the way of a more narrow and dogmatic treatment of it. Suicides jump from a height or get in front of railway trains. Insane patients and prisoners beat their heads against solid walls.

The literature of legal medicine contains some remarkable examples of the length to which suicides will go to accomplish their end, even if they violate well-established rules. Dr. Smith, in 1878, related the case of a man who stood before a looking-glass and struck repeated blows on the top of his head with a hammer weighing nearly three pounds. He made a fracture of the skull two inches in diameter and depressed three quarters of an inch, with fissures extending in various directions from this center.[1]

Dr. Allen Staples, in 1889, reported the case of a German stone-cutter, who was intemperate and depressed. He drove into his head two stone chisels, each eight inches and a quarter long and three-eighths of an inch in diameter, with a flat point. One had been driven into the right temporal region and emerged in the left in nearly a direct line, projecting an inch and a quarter, the chisel having been driven close to the head. The other had been driven into the center of the forehead, entering the frontal lobe half an inch. The man had used a mallet weighing two pounds and three-eighths. He was not unconscious when found, but urged that the chisels be driven farther. He walked a distance of forty feet with little aid. The chisels were removed by surgeons, and shortly afterward the patient became comatose and died twenty-six hours after his suicidal act.

Lacerations, as a rule, are the result of accident, though the insane do not scruple to injure themselves in this way. Taylor gives an instance of an insane patient in Guy's Hospital, who tore away the front abdominal wall.

Stabbing is usually homicidal in manner, although the literature of suicide contains some remarkable examples. A case is related in the *Lancet* for 1894, in which an Indian groom

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[1] Luff, *Forensic Medicine*, ii., p. 35.

stabbed himself in the abdomen, making a wound about three inches long; out of this opening the intestines protruded, and the man coolly cut off three of the intestinal loops, each about three inches long, and pushed back the rest.[1]

Maschka records the case of a lunatic, aged fifty-one years, who was found with 285 punctured wounds. He had used a knife entrusted to him, on his partial recovery, for the purpose of cutting an apple. Two hundred of the wounds were in the left side of the chest. He bled profusely, but survived nearly twenty-four hours.

Incised wounds, in contrast with punctured wounds, figure more often in suicides than in homicides. Bullet-wounds have a large representation in both homicides and suicides; but they are in relatively greater excess as suicidal lesions.

RECORD OF TWENTY-SIX YEARS TO MARCH 3, 1903.

Wounds.	Homicide.	Per cent.	Suicide.	Per cent.
Incised	10	6.0	76	20.4
Punctured	32	19.2	4	1.1
Contused	80	48.2	52	13.7
Lacerated	1	.6		
Bullet	43	25.9	259	64.8
	166	99.9	391	100.0

Besides general considerations derived from the nature of the wound, the **situation** is also of importance as a guide in answering our question. Thus, a contused wound on the *top* of the head, or several contusions distributed over the upper and lateral regions of the scalp, afford an inference that a weapon was used, and used by a second party. A suicide chooses for his attacks on himself the accessible regions of his body. For instance: If a knife is the weapon chosen, the wound will probably be found in the throat or about the chest; or in arteries in the bend of the elbow or in the wrist. In one case, that of a priest, fatal hemorrhage was induced by opening the varicose veins of the legs. If pistols are the choice, the temple, mouth, heart, orbit, or ear, is elected as the seat of the wound. The suicide chooses the situation most likely to afford success. Sometimes his knowledge of anatomy is at fault, and he makes a mistake, as when an error is made in locating the heart. But the rule is as stated. The data observed in such a case, however, offer a presumption of suicide, not a demonstration, for a murderer might use the situations generally selected for suicidal wounds, his purpose being to simulate suicide. But, for this design, the murderer

[1] Luff, *Forensic Medicine*, ii., p. 37.

must be uncommonly cool and deliberate, or his victim must be incapable of resistance.

An **incised wound,** or wound of any other description, in a concealed or not readily accessible situation, then presumes homicide. The vulva, for example, would hardly be chosen by a woman suicide to place a fatal wound. Like all general statements, however, this one has exceptions. For example: An insane man hit himself on the head with a cleaver, making more than thirty wounds over the occipital bone. One of these had opened the skull, so that the brain-substance came out of the fissures. Taylor's rule is stated in these words: " There is no wound which a suicide is capable of inflicting on himself which may not be produced by a murderer; but there are many wounds inflicted by a murderer which, from their situation and other circumstances, a suicide would be incapable of producing on his own person." [1]

It is generally agreed that the **course** or **direction** of a wound affords indications of far greater value than situation or general character to determine the question. This, however, applies to incised and punctured wounds much more correctly than to other lesions. Wounds made by a suicide generally follow, in direction, the natural movements of the arm. For instance, an incised wound of the neck which has a direction from left to right and from above downward means a wound for suicide by a right-handed person. Punctured wounds of the suicide class have a direction downward and from right to left, assuming, again, that the person is right-handed. Homicidal wounds of the neck of the incised class are generally deep at both angles as well as at the center, in contrast with suicidal wounds.

A suicide, however, may be left-handed, or may use his left hand because his right hand is not available, being disabled by rheumatism, for example. Or, a murderer may stand *behind* his victim, and so imitate movements which his victim would make. These points are to be proved by coincident facts. Something may be learned in this connection by using the hand of the dead subject experimentally with the weapon, and observing if the lesion is readily made in this fashion.

As to **pistol-shot** wounds, some caution is needed in reaching a conclusion. Some of these bullet wounds seem incredible on the theory of suicide. For example, a shot into the back of the head suggests homicide, yet even this extraordinary situation has been chosen as a target by suicides. A case which occurred in Pittsfield, Massachusetts, on July 4, 1885, illus-

[1] *Principles and Practice of Medical Jurisprudence*, i., p. 511.

trates this :[1] A man was found dead, lying face downward in the street. There was a bullet wound in the occipital region, just to the right of the middle vertical line. Close to the right foot was a 0.32 caliber revolver with three chambers entirely empty, one empty shell, and one cartridge. To the handle of the revolver was tied a piece of strong twine, the free end trailing ninety feet away from the body. The wound was without the external signs of a near shot. The bullet had passed through the cerebellum and through the posterior and middle lobes of the right hemisphere of the cerebrum, and was found much flattened in the anterior lobe. Was the motive murder for robbery? No wallet or pocketbook was found, but the coat was buttoned tightly. Three days later the wallet and pocketbook were found in an ash heap, thirty-six rods from where the body lay. A mark on the sole of the shoe indicated that the twine had been used under the foot as a guy to steady the weapon while it was fired into the back of the head. The inquest found death by suicide.

The **extent** and **number** of the wounds found are guides that should be followed with some caution. It has been stated that a suicide would not have courage and strength to inflict a very extensive wound on himself. Experience is opposed to this view. Suicidal wounds of the neck, for instance, are usually unnecessarily deep for the purpose in view. Sometimes the razor opens widely all the soft tissues on the front of the neck, and is only stopped by the bones of the cervical vertebræ. Hoffman, however, thinks there is some limit in this direction, and counsels that if the wound actually involves the bony tissue of the vertebræ it must presume the exercise of force such as only a murderer would be able to put forth. The same thing applies to the number of the wounds, whether the same weapon or different weapons be used. The multiplicity of lesions is not opposed to the theory of suicide, other things being equal. The examples already given are ample illustrations. Of course, we should examine the individual lesions, their situation and gravity, before we allow ourselves to express an opinion. Naturally, two bullet wounds, through the base of the brain or medulla oblongata, would be absolutely impossible in an affair of suicide, and must mean homicide. The brain, however, may be wounded elsewhere and severely, under a suicidal impulse, and with a multiplicity of lesions sufficient to suggest murder, yet the notion of murder may be wholly eliminated.

MacQueen, in 1890, reported the case of a man, aged thirty-

[1] *Transactions of the Massachusetts Medicolegal Society*, i., p. 352.

five years, whose self-inflicted injuries rivalled the case of the chisel suicide, previously cited. The patient was found with four three-inch nails driven into his head. One was sticking from his forehead and had penetrated an inch and a half into the head. The other three were driven " home," one close to the occiput and two into the top of the head. As it was considered doubtful if he could have driven the nail into the occipital region, the man was questioned, and he answered slowly, but distinctly, " I done it." The nails were removed, and there was copious bleeding from the longitudinal sinus. The patient made a rapid and complete recovery.[1]

Is it possible, however, for an individual with suicidal intent and in quick succession to inflict a perforating bullet wound of the *head* and another of the *heart?* Or is it credible, to reverse the order, that a man could shoot himself first in the *heart* and then at once in the *head?*

The Burton case in Newport, R. I., in October, 1885, raised this question. Burton was found lying dead on his kitchen floor. Just before this discovery a shot, a fall, and a shot were heard. He had been at his breakfast, and unmasticated bread was found protruding from his mouth. At the autopsy a perforating bullet wound of the skull was found; the wound of entrance was in the right parietal region, two inches above and in front of the ear. The ball was found on the opposite side of the brain in the posterior part of the left hemisphere. The second wound was near the left nipple; the left ventricle of the heart was perforated. The revolver was found near the body. The first view was that it was a suicide. Later, rumors and suspicions led to a review of the case, and Burton's daughters and a son-in-law were arrested. At the trial the testimony of the Government medical experts was to the effect that the two shots, taken in connection with other data, indicated that the shots were homicidal and not suicidal. The next morning counsel for the defence came into court and stated that the prisoners desired to retract their plea of " not guilty "—they having made a full confession of their accountability over night. The case attracted much attention. The alleged homicide was a medical student of Philadelphia. He had secured the services of the late Professor Agnew as expert for the defence, but the confession rendered his aid unnecessary. Professor Agnew, however, published a review of the case from the point of view of the defendant's expert witnesses, and promulgated the following conclusions : " 1. It is possible for a ball to enter the brain, without destroying consciousness,

[1] Luff, *Forensic Medicine*, ii., p. 38.

though it may for a few minutes cause some mental confusion. 2. A ball may traverse the brain without causing muscular paralysis. 3. A man may, with his own hand, first shoot himself in the head and within the lapse of a minute inflict a similar wound on the heart. 4. A suicide may first discharge a ball into the chest, wounding the heart, and immediately after send another into the brain."

Professor Agnew cites several cases in support of his position, besides arguing its truth on theoretical grounds : 1. A student shot himself in the head, and, finding that he had not accomplished his purpose, he went to his bedroom, some distance away, and shot himself through the heart. He lived a few moments. 2. A policeman shot himself through the head. The ball entered the right temple and lodged in the cranium on the opposite side. A second shot was fired into his chest, the ball cutting the right side of the heart. Death followed in five minutes. There were witnesses to the whole affair. 3. A boy of nineteen inflicted four shot wounds from a revolver on his own body. The first bullet entered the forehead and lodged in the left temporal lobe; the second ball was fired into the chest and cut through the left ventricle of the heart; the third shot passed into the abdomen ; and the fourth shot into the neck. Death from pericardial hemorrhage resulted. 4. A grocer was found dead in his room, the door of which was found locked. A pistol was clutched in each hand ; one bullet had passed through the brain ; and a second through the heart. 5. A man committed suicide in a park. One ball entered the brain, and the other entered the chest.

Undoubtedly, Professor Agnew was right on hypothetical grounds ; each case must be studied by itself. The Burton case had features about it quite distinct from the wounds that pointed to homicide. The rapid succession of shots with a fall between ; the protrusion of food between the lips ; and the immediate death of the patient gave reasonable grounds for discrediting the possible, though highly improbable, view of suicide.

If there is extensive mutilation of the body for the purpose of destroying identity, or for easier disposal, the interpretation is obvious that a murder either by wounding or in some other manner was the cause of death. There are many well-known illustrations of this. The Parkman case, in 1849, in Boston, is among the classics of legal medicine. The trial of Blondin for murder, in 1903, in Boston, brought out a similar attempt to mutilate his victim by decapitation after strangulation. Also, if after the fatal wounding, the body is buried, no

matter how shallow the grave may be, the presumption of homicide is at once raised. The case of the little girl, Alice Sterling, who was killed by Gilbert on April 10, 1895, and whose body was placed in a hastily prepared hole, is a case in point. The killing had been done by fiendish, crushing blows on the head with an axe, after certain lustful advances had been repelled.

It is well to bear in mind, also, that if suicides sometimes inflict many wounds, thus suggesting a homicide, a murderer may finish his work with a single cut, or thrust, or pistol-shot, after the fashion of a suicide. Ordinarily, however, the murderer's determination outruns his coolness and caution, and he leaves the proof of his homicidal purpose in a multiplicity of wounds, wholly inconsistent with self-infliction. The nature, situation, and direction of these must be studied in connection with their number.

Some examples of these propositions are published in medicolegal records: In 1839, a woman was found dead in New York, with many wounds on her body. Her husband was suspected, but he said that she killed herself. This was proved to be false by inspection of the body. There were eleven stabs, eight being in or near the *left* side of the chest, one penetrating the pericardium and dividing the pulmonary artery. The others were in the back, near the left scapula.

In 1871, a man in York, England, while in delirium tremens, killed his wife by stabbing and cutting her. Fifty-six wounds were found, some of which could not possibly have been the woman's own act.

In the Bram cases, on board the brigantine *Fuller*, a multiplicity of axe wounds was found, the body of Captain Nash showing seven wounds; that of his wife, Mrs. Nash, seven wounds; and that of the mate, nine wounds.

A woman named Mrs. Fleetwood was kicked and pounded to death by her husband on October 15, 1899, in Boston. Her body showed seventy-seven separate contusions, and the theory of suicide or accident was wholly incredible.

The **shape** of a wound does not help us much in solving the question before us. It has been contended that in cases of suicide, wounds are seldom made with steadiness, so as to form a clean cut, unless the person is delirious or insane. This contention is not well based. There are too many exceptions. A determined suicide, using a sharp razor or knife, makes a symmetrical, steady cut, without invoking the aid of delirium. A murderer's performance may lack this symmetry, if his victim struggles, or the weapon is dull. In short, as

Taylor says, "regularity or irregularity in a cut furnishes no presumptive evidence either of homicide or suicide."

The **sex** of a victim of violence has some bearing on the question of crime. A woman with her throat cut is a comparatively rare accident in the records of suicides. Indeed, any form of wounding is uncommon among female suicides, possibly excepting the contused wounds which result from jumping out of a window or off a roof. Women generally seek death by drowning, poisoning, hanging, or jumping from a height. They rarely shoot themselves, or cut their throats, or stab themselves. So, when a woman's body is found dead by wounding, the presumption favors death by homicide, and this presumption must be eliminated by satisfactory evidence, if it is to be disposed of at all.

Exceptions Prove the Rule.—The case of Mrs. Judkins was investigated by the author in January, 1893. She killed her baby by shooting, and she then turned her attempts on herself. Her revolver, aimed at her breast, was snapped, but the cartridge failed; she then stabbed herself in the breast with a Sloyd knife. This failing, she turned on the gas of a bracket burner in the room, and was found inhaling the jet at the tip.

This case suggests the remark that **age** has a positive or obvious significance with reference to the question. It is wholly unlikely that children under ten years of age should ever try to destroy themselves by suicide. The discovery of a youthful victim of violence, therefore, narrows the question to a choice between homicide and accident.

Sometimes we may obtain valuable aid for our judgment in the **position and environment** of a body found dead by wounding. It may be found in an attitude wholly out of consistency with either suicide or accident, and most reasonably explicable by homicidal violence. Sometimes a murderer will try to give to the body of his victim appearances which suggest or simulate suicide, but they generally overdo their endeavors.

On February 21, 1880, a man named Lavoie was found dead on the floor of his bed-room. The body lay on the back, the limbs straight, the clothing smooth; the right hand was in a normal attitude along the side, and the left hand held a revolver and rested on a clean silk handkerchief on the front of the chest. There was a wound from a bullet in the left side of the neck. On a dressing-table in the room was a letter, avowing a suicidal purpose, but it proved not to be in Lavoie's handwriting, but in the handwriting of Lavoie's room-mate. Blood stains were found on the door-frame of a closet at a distance from the body, but

there were no blood spots on the carpet between the body and the closet. It transpired that Lavoie and his room-mate, Hill, had quarrelled over the division of some jewelry and other booty which they had obtained by burglary, and in the course of the quarrel Hill shot his companion and killed him. He then proceeded to " lay out " Lavoie's body and to arrange it as if it were a case of suicide. In this purpose he over-reached himself, and his error was detected and revealed. He was sentenced to prison for life.

In another instance a man was found dead under a small wooden structure behind a wall, with a fatal bullet wound above his left eye. His limbs were strongly flexed as he sat on the ground under the lean-to, and his attitude was such as to forbid any view other than the theory that he had himself assumed it voluntarily in preparation for his self-destruction.

So it is wise to take careful note of all the data of position and surroundings of the body, lest we fall into the trap which a crafty murderer has set. Is the dress of the dead body too much disarranged to imply suicide or accident? Or is it too tidily arranged for these, and so suggesting a hand at work after a murder? How is the furniture arranged, if the body is found in a room? Are the doors and windows secured inside so that the room has to be entered forcibly? Has the person found dead shown a suicidal disposition, or made threats of killing himself, or attempted suicide, or left any written mes-sages? Do the premises show any indications of attempts to clean them, to remove blood-stains, or the like? If so, we have a valuable indication of the homicidal character of the wounds found.

If a weapon is found near the body, its character, condition, and relation to the body will have obvious significance. Sup-pose a dead body presents a fatal wound, and a weapon is found in the right hand, held tightly, and the position of the wound is on the front and accessible part of the body, there is little difficulty in concluding that the case is one of suicide. Or, suppose a dead body is found with the head battered in with hatchet wounds, and no hatchet is found anywhere on the premises (a state of things like that in the Borden cases in Fall River), there is little difficulty in concluding that a mur-der has been committed. Between these two *easy* problems are many, more or less complex, relating to the weapon. For instance, if the weapon is in the same room with the body, but at a distance from it, we look for traces of blood to connect the two. Or, we ask whether a person after receiving a fatal wound, or in the act of receiving it, could throw a weapon to

the position where it is found. Or, whether a person mortally wounded at the spot where the weapon is found could move to the spot where the body is found. In regard to the latter question it is wise to exercise caution.

Many recorded cases teach us the value of possibilities and remarkable exceptions. Guy records the instance of a woman who had her throat cut by a murderer. The trunk and principal branches of the external carotid were divided, and the internal jugular vein was severed. She rose from the ground, ran twenty-three yards, climbed over a gate, fell there, and died. The interval was from fifteen to twenty seconds.[1]

Harriet Bell was stabbed while standing in her doorway, on Kirkland Street, Boston, on March 7, 1882. Her carotid and jugular were both cut. She went the length of her entry and into her kitchen before she sank and died from the hemorrhage. She was able to go twenty feet after the stab. (Fig. 22.)

Ellen E. Stone received a deep stab in the abdomen in December, 1894. The wound went deeply into her liver. She walked down two flights of stairs and almost a quarter of a mile to the Emergency Hospital. She fainted on the threshold, and died a few minutes later in bed.

Even penetrating wounds of the heart are not inevitably fatal at once. Stadelmeyer[2] gives a case in which not only the heart was penetrated by a stab, but the stomach also, and an intercostal artery was wounded. Death did not ensue until the fifth day.

A young negro was stabbed in the chest on a Monday, and he did well until *Saturday* of the same week, when, contrary to orders, he went out. In consequence of this exertion he died. The wound was found at the autopsy to have perforated the fourth costal cartilage, passed through the outer layer of the right ventricular wall without opening the cavity, and then into the left ventricle. The pericardium contained nearly a pint and a half of blood. The cardiac wounds were two-thirds healed.

A woman was murdered by stabbing at Bordentown, Maryland, in 1833. Three of the punctures entered the left ventricle and seven penetrated the lung. She walked some distance down stairs, had some talk with a neighbor, then fell, dying in fifteen minutes.

A young man received a knife wound in the *left ventricle* of the heart, and he walked about for ten minutes. He did not die until six *days* later.

[1] Guy, *Forensic Medicine*, p. 318.
[2] Wharton and Stillé, *Medical Jurisprudence*, section 824.

Sometimes the weapon is found in a place where it would hardly be expected. A case of the writer's will illustrate this: About 3 A.M. on June 14, 1895, he was called to a case which was said to be one of murder. About an hour before much noise had been heard in the basement of a boarding-house; then all became quiet. The men of the house went down stairs, and found a man, a stranger, dead in the basement dining-room. The room was in great confusion; the furniture was upset and blood was on the floor, the walls, and the furniture. It looked like a murder after a struggle. If a murder, where was the murderer? If a suicide, where was the weapon? There was a three-inch gash in the right side of the neck. No knife was visible. The pockets were searched after a while,
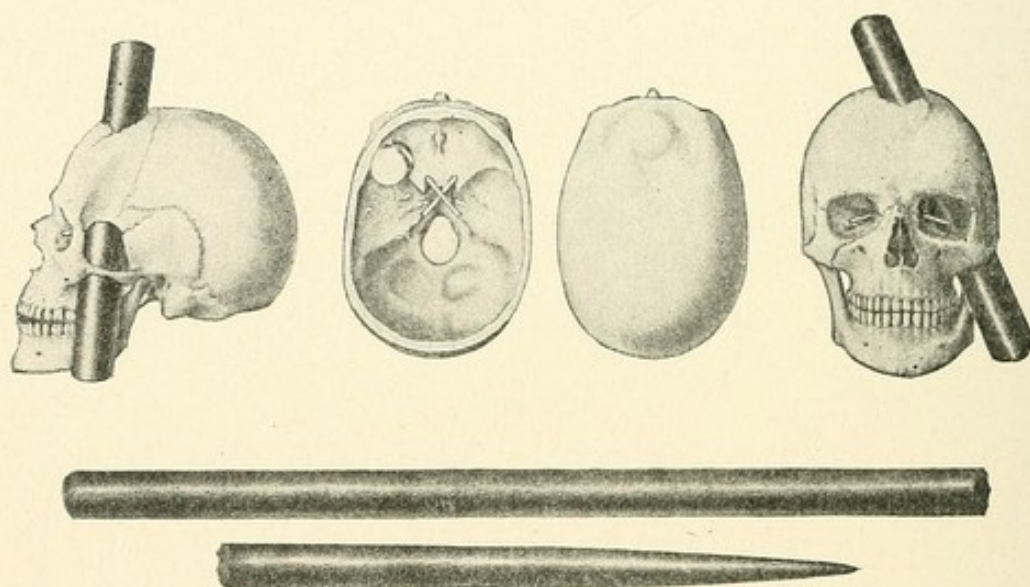
FIG. 27.—Dr. Harlow's case of recovery after the passage of an iron bar through the head.

and a pocket-knife closed and bloody was found in one of the pockets. It transpired that the man was a stable laborer, and that about 1 A.M., delirious with drink, he had rushed out, saying that he was being followed. He ran for a quarter of a mile, then scaled a high fence, and entered the house where he was a stranger. He then stabbed himself, put his knife in his pocket, and after a struggle died from hemorrhage.

With the famous Phineas P. Gage case in mind, and so near home, it is well for physicians (in this vicinity, at least) to be somewhat reserved about opinions, one way or another, as to what a man can do after he is wounded in such a way that, in all reason and by all the precedents, he ought to die instantly. Gage was preparing a blast, and was tamping a charge of

powder in a hole in a rock. The iron which he used was a rod or bar an inch and a quarter in diameter, three feet and seven inches in length, and weighing thirteen pounds and a quarter. In some manner in his use of this tamping iron, he set off the blast as he stood on the rock. The iron was driven high into the air, passing, in its flight, through Gage's head. It entered under the left zygoma and emerged at the top of the head, to the right of the middle line, carrying away the whole central part of the left anterior lobe and a portion of the right parietal region, opening the lateral ventricle and the great longitudinal sinus. Immediately after receiving this injury Gage was " slightly convulsed," but he spoke in a few minutes. He was carried to an ox-cart near the spot, and rode in this cart to his home three-quarters of a mile away, sitting erect. He got out of the cart himself and with a little help walked up a long flight of stairs to his bedroom. He retained his memory perfectly ; his senses did not forsake him, and he gave an intelligible account of what had happened. More than this— he got well, recovering his health fully, except the loss of the left eye. He lived many years afterward, and after his death his skull was obtained by his surgical attendant, and it is now stored and on exhibition, with the tamping-bar, in the Warren Museum of Harvard Medical School.

The kind of weapon found near a dead body may give a hint of the way in which death came about. Sometimes this observation will render incredible a theory of suicide. Suppose a person is found dead with the skull crushed in, and a heavy bat, club, or axe is found close at hand, homicide is the only diagnosis, and it is readily reached.

CHAPTER XXIII.

INFANTICIDE.

THE writer means by infanticide the felonious killing of an infant, usually a newborn infant. In Great Britain and America this is not a specific crime, mentioned as such in the statutes or punishable as such. It comes under the general rules relating to homicide, and, upon conviction by a jury, the accused person is subject to the penalties prescribed for homicide, according to the degree proved, whether first degree, second degree, or manslaughter.

Like other descriptive terms, such as parricide, matricide, fratricide, and filicide, all being under the general term, homicide, so infanticide is a useful word conveying a distinct meaning, without implying any independent penalty. As will be seen presently, however, a special kind of evidence is required by the courts to convict in these cases of infant killing. Hence, as a medicolegal subject, it merits and has always received separate and special treatment in text-book and in lecture-room instruction.

Although infanticide is but one kind of homicide, according to the common law, the Statutes of Massachusetts place it in close relation with another crime for which a specific punishment is provided—concealment of the death of an illegitimate child. Chapter CCXII., which relates to offences against chastity, morality, decency, and good order, has these two sections:

"*Section XVII.*—If a woman conceals the death of issue of her body, which, if born alive, would be a bastard, so that it may not be known whether such issue was born alive or not, or whether it was not murdered, she shall be punished by fine, not exceeding $100, or by imprisonment in the jail, not exceeding one year.

"*Section XVIII.*—A woman indicted for the murder of her infant bastard child may also be charged in the same indictment with the offence described in the preceding section, and, if on trial, the jury acquit her of the charge of murder, they may find her guilty of the concealment."

Under the law as at present interpreted, the manner of the infanticide may be two-fold: It may be an act of commission (wounds, smothering, drowning, strangling, and the like), or it may be infanticide by omission, the withholding of the care which a feeble and helpless newborn baby requires in the first moments of its existence (exposure to cold, neglect to feed, permitting it to lie under the bed-clothing, or in the blood and discharges of its birth). In any event, it is the *intent* which constitutes the crime, and the law requires stronger evidence of wilful violence on the part of the child murderer than it requires in other cases of felonious killing, because under the usual circumstances there are extenuating conditions which must be regarded.

The fact that, in accordance with the principles of English common law, infanticide is not regarded as a specific crime differing from other kinds of felonious killing, relieves us from the study of some perplexing preliminary questions which have troubled medical jurists in other countries whose laws provide a special penalty for child murder, usually less severe in these cases than in homicide of adult victims. Thus, in the literature of Germany, Austria, and France we find these questions seriously engaging the attention of writers on legal medicine: What is a newborn child? How long after the birth does the description "newborn" apply? When is it no longer a newborn child, but an infant subject to the ordinary rules of homicide?

Ogston says: "The inquiry into the age of the infant does not require to extend beyond the fifteenth day of extra-uterine life."

Ollivier d'Angers says: "Newly born applies until the separation of the funis (a wide variation)."

Froriep, reverting to Roman law and adopting a rule which Casper accepts, says: "A newborn infant is *infans sanguinolentus cruentatus.*"

The Bavarian law establishes a fixed definition, and says that a newborn child is one not more than three days old. In Brunswick and Saxony the time limit is twenty-four hours. According to Werner, so long as it has been neither fed nor clad.

Juvenal's definition is: *A matre rubentem.* In Austria and Germany it is immediately after birth.

While we are relieved, however, from considering certain questions which embarrass lawyers and medical jurists on the continent of Europe, we are not free from certain other interesting legal relations which exist in the United States and in

England touching the subject of infanticide. These it will be sufficient to mention without pausing long to comment upon them. As it will be seen, some of these legal requirements are almost paradoxical in character. Some are inconsistent with physiological laws, if not directly opposed to them. Some, literally interpreted, are absolute stumbling blocks in the way of any successful criminal prosecution. All of them are the fruit of threadbare tradition, and might well be modified by statute legislation in order to bring them into harmony with modern medical science. It is for the lawyers and legislators, however, to get rid of the difficulties of their own creation. The student of legal medicine is interested in them chiefly as curiosities.

For example, to support an indictment for infant murder, it must be clearly proved that the child, the victim of the violence, was living at the time of the birth, and that the death occurred after and not before the birth, beyond any shadow of doubt. The law mercifully presumes in such cases that the child was born dead. It throws the burden of proving the contrary upon the prosecution, and no evidence imputing murder will be competent unless it is first made certain by medical or other testimony that the child had survived the birth, and was legally a living child when violence of any form ended the life. Proof for this purpose is of various kinds. The law is satisfied if any unequivocal sign of life is described or proved. The vigor or the duration of the life is not considered as of essential importance to the issue, if only the proof of the life itself is clearly manifested. Hence, any muscular movement whatever, the flexion of a limb, the opening of an eye, the twitching of a lip, has been held to be sufficient. Respiration as shown by thoracic movements, and by other distinct indications, is a true sign of life, no matter how transitory. But, as will be seen in another connection, it does not follow that the child is dead because it is not breathing. Life and respiration are not convertible terms, and a child may be alive physiologically and yet not show a single sign of breathing. Crying is an indisputable proof of life-birth, and in some codes (Scotch) it is required as proof in order to establish civil rights in certain contested cases of inheritance. Crying, of course, implies necessarily the act of respiration.

Pulsation in the navel cord is another clear sign of life, indicating action of the child's heart; and the impulse of the child's heart, as an independent observation, is, before all other physical signs, an incontestable proof. Suppose a child has never cried, never breathed, never moved, the medical witness

would still be justified in declaring the child to have been living, if, at the time in question, the heart was heard or felt to beat. All these evidences would, of course, have to come from witnesses present at the birth or immediately after it. This, however, is not the usual fortune in cases of infanticide. The birth occurs in secret; the mother's mouth is closed; the baby's dead body is the only immediate witness.

The writer has indicated only a part of our difficulty. The law goes further, and requires evidence not only of the general proposition that the child was born alive, but that the birth was a fully completed act; that every part of the child's body was outside the mother's body when the death from violence occurred. If any part of the child's body was within the mother's womb or vagina; if a leg or a foot remained there and the violent death came then, the law says that it was not infanticide. Moreover, the rule is that the child must be proved to have possessed an *independent circulation* at the time of the death. In one English case which is cited in the books, we have an illustration of the difference between physiological and legal life in an infant. The case was one of alleged infanticide, in which the mother of the child was accused. The medical evidence established that the child in the case had breathed. It was found with its head nearly severed from the body. The jury was directed that before they returned a verdict of guilty they must satisfy themselves that the child was completely born; that it had an existence distinct and independent from the mother; and that it was murdered by her. " It was possible," the judge declared, " that the child might have breathed without being completely born into the world, and although this might medically be a live child, it was not one legally," In law the birth of the child must be complete. The prisoner was acquitted.[1]

By an independent circulation we can only understand that condition in which, whether breathing is established or not, the blood no longer passes from the mother to the child. That is, the navel cord no longer furnishes a channel for communication between mother and child, though it is still intact. But while the law declares that the violent death of a child before it is wholly born is not infanticide, it maintains that wilful violence inflicted on a child before or during its birth, from which it dies later, after its full birth, is a crime punishable as homicide. Undoubtedly, there are many kinds of violence which a woman in labor could inflict upon her child during its birth, which could at that time readily destroy its

[1] Taylor, *Principles and Practice of Medical Jurisprudence*, ii., p. 352.

life; but this principle of law offers for her a complete defence. Incidentally, we may, as physicians, derive a bit of passing comfort from this method of the law in its definition of infanticide. When that terrible crisis comes in obstetrics, when, in order to save the life of a parturient mother, the necessity comes to destroy the life of the child, if the destruction is accomplished while the child is still *in utero*, we are spared all scruples growing out of the law.

Finally, besides assuming in any case that the child was born dead, unless the State by its prosecuting officers succeeds in proving the contrary, the law assumes, further, that the cause of the death was a natural cause and not a violent one, until acceptable proof to the contrary is forthcoming. In other words, the burden of proof that the child died by violence, that is to say, by infanticide, rests by law upon the officers of the State who make the complaint. Until that proof is presented, the presumption is wholly favorable to the accused.

The foregoing statement of the legal relations of infanticide gives a clear intimation of the obstacles in the way of conviction and of the infrequency, indeed, of indictments. Let the reader bear in mind the usual circumstances: The accused person is a young woman, pregnant out of wedlock as the fruit of seduction or lust. She strives to conceal her unlawful pregnancy; she has made no preparation for her confinement; she may possibly be ignorant of the true nature of her condition. Finally, there is a secret birth; no assistance or witnesses are present; there is a strong motive to destroy the illegitimate offspring; to hide the proof of her shame and disgrace. The child is secretly killed, by strangulation perhaps, and at the first opportunity its body is either thrown into a privy-vault, or a vacant lot, or it is hidden somewhere about the house. Presently her secret is discovered; she is arrested, and the usual legal proceedings ensue. The medical witness testifies that the child has breathed and was alive when the finger-marks upon its neck were made; but he can not say that the strangling was not *during* the birth; or that the breathing did not occur when only the head was born, and not the body. The Grand Jury reports, "No bill." Or if, disregarding the technical doubts, the Grand Jury indicts, then all the legal presumptions favor the prisoner. If the woman's counsel does his duty by his client, he will have little difficulty, and usually does have little difficulty, in befogging the jury with these doubts which the law itself has established. They sympathize, too, with the unhappy prisoner at the bar in her

peculiar position of distress. They deem it unfair and unjust to doom to the same infamy and the same punishment the hardened and malignant murderer and the young woman who, betrayed by the seducer, to avoid shame and disgrace and the ruin of all her earthly prospects, is driven by a momentary impulse to stifle her newborn illegitimate infant. While recognizing her probable accountability for the destruction of this infant life, they readily give her the full benefit of all the doubts, and, gratefully accepting the alternative offered by the statute, find her guilty of the concealment of the child's death, but not guilty of causing the death itself.

Such is the usual course which a case of infanticide takes. From it may be inferred the fact that the obstacles in the way of conviction are almost insurmountable. Accordingly, prosecuting officers are reluctant to initiate proceedings in cases in which the proof is not conclusive and a conviction not almost sure. Any shrewd lawyer may throw such a shadow of doubt over the testimony of an ordinary case in which a woman has been delivered in secret, and the child has been disposed of immediately upon its birth, that an acquittal follows almost as a matter of course.

Gertrude E., an unmarried woman, roomed alone in a boarding-house. Her neighbors in the house heard unexpected baby-cries in her room. She tried to leave the house, but a suspicious looking bundle under her cloak caused her detention. The bundle contained a dead infant, and the young woman was arrested. The autopsy found well-defined marks of strangulation on the neck and the internal evidences of asphyxia. The baby was fully and normally developed, and there was no other cause of death. The case came before the Grand Jury at its next term. The district attorney asked the medical witness: "May the finger-nail marks on the child's neck have possibly been produced by the accused mother in the course of her labor in her efforts to relieve herself in her travail?" The inevitable answer was: "It is possible, but not credible." The Grand Jury reported, "No bill."

Court cases, however, are no indication of the prevalence of the crime. The instances which reach the bar of justice are only a small minority. The great majority are involved in impenetrable mystery and obscurity. We may decide that, in a case under our investigation, a child has been murdered, but we never know the murderer. These cases, occurring frequently, never get beyond the inquest stage in the judicial programme, and the verdict is: "Came to a violent death at the hands of some person or persons unknown." Bodies of babies

who have been killed are so easily disposed of that it is the merest chance which connects the murderer with the victim beyond a reasonable doubt. These little bodies are found in all sorts of places: in public parks, vacant lots, alley-ways, privy-vaults, sewers, ash barrels, under door-steps, washed ashore by tides, in water-closets of hotels, railway stations, or department stores. There is no clue to their origin or identity, and there is no trace of when, where, or by whom the murder was done.

However, whether or not the murderer is known or undiscovered, the medical questions which are at once suggested upon the finding of an infant's body under circumstances indicating infanticide are interesting and fascinating, as well as important. Many of these questions are inferred from the legal questions already presented. To their study we can profitably devote the rest of this chapter.

Identity.—The chances are against identification, unless the body is found in close proximity to, or in the same house or premises with, the puerperal mother. The medical examiner should, however, take note of everything which will aid. If a woman is arrested for the murder, one point which she will make strenuously for her defence will be that the child is not hers. Hence, in these cases, as well as in cases in which, at the time of the inspection, absolutely nothing is known of the origin of the child, the inspector will be alert to take note of all data that will serve. Wrappings may give a clue. "Mrs. Evelyn Abbott's" name on a newspaper in which a baby's body was wrapped was a clue to a notorious baby farmer, and it led to her conviction. Clothing may put one on the right trail. A child was found with its head battered in, and the clothing was identified as having been made at the State Almshouse, and the mother was traced as a recent inmate of that institution.

Age.—The age and degree of development are not of essential importance; viability is not an element in which the law takes any interest. Yet, at a trial, the question is almost sure to be asked, "What was the age of the child?" Therefore we should note such matters as these as data; they were considered at length in a preceding chapter and need simply a brief summary here: Length, weight, position of umbilicus with reference to center of length; growth of hair and nails, presence of *membrana pupillarum*, and of ossification in the lower femoral epiphysis; mobility of skull bones; and, in male infants, the position of the testicle.

Was the child born alive or was it dead at its birth?

Next, we ask and try to answer this question. For reasons already stated, this may be set down as the imperative, fundamental inquiry in all cases of alleged infanticide, since there is not a more effectual way of meeting and disputing a charge of child murder, or a more frequent defence than by offering medical proof that the child was not born alive. Taylor says :[1] "When it is stated that in most cases of this sort which end in acquittal, in spite of the strongest moral presumption of guilt, the proof fails on this question only, it must be obvious that the subject specially claims attention." These observations give us a hint of the difficulties, as well as of the importance of the question: "Was the child born alive?" We are supposing now that the anatomical appearances are our only guide. There was no witness of the birth, except the accused mother, and her lips are sealed, if she is wise. So the law appeals to the medical inspector to testify upon his examination of the child's dead body, either that he finds evidence of a living birth, or that he is equally sure that the child did not survive, but was still-born. If the latter is established, of course, all proceedings against any person charged with the killing necessarily come to an end. It will best serve our study of this topic, therefore, if, before attacking the more complex features of the problem, we ask at the outset, By what signs shall we distinguish an unequivocal stillbirth, the appearances of a fetus some time dead *in utero?* They are the appearances of intra-uterine maceration.

We notice the marked flaccidity of the soft parts. The head flattens out in its occipital region as the result of gravitation. The ribs are prominent ; the belly is flat in front and bulges at the sides ; the surface is dark red ; there are many bullæ, but no green tinge. The chest is cylindrical, soft, and reddish ; the cuticle is in part detached and comes away from the cutis with great ease ; the true skin is left smooth, slimy, and red. On the hands and feet the skin is thick, blanched, and wrinkled. Under the scalp and in the groins and axillæ there is a quantity of thin, red, gelatinous material. The funis is a large, red, soft, and straight cylinder infiltrated with red fluid. Sometimes there is desiccation or mummification. A putrid odor is absent, provided the membranes have remained intact. The whole body is soapy and slippery. Such appearances render further investigation absolutely superfluous ; no suspicion of infanticide can be entertained ; they mean that the child has died in the womb, and that it has been retained there five days at least—probably more.

[1] *Principles and Practice of Medical Jurisprudence,* ii., p. 317.

These are not the difficult cases; they are readily dismissed. The cases of real difficulty, if not of embarrassment, are those of another class, namely: Those in which the external appearances clearly suggest and indicate a recent living birth, at or near maturity, with or without marks of violence, and entire absence of information as to the attending circumstances of the birth. In contrast with the legal presumption in such a case, there is here a medical presumption that the child was born alive, and that there was a measurable survival of the birth. What proofs have we to establish this presumption? Or, negatively, to refute it and to establish that the child died immediately before or during birth, and so was not a victim of infanticide?

We say at once, and (subject to certain reservations) we say truly, that the condition of the *organs of respiration* is the one controlling test. The first normal act of the infant on emerging from the maternal vulva is to contract the facial muscles, opening the mouth; then to accomplish the first inspiration; then there follows the cry which denotes the full act of respiration, and which is pleasant at once to the mother and to the accoucheur under natural and lawful conditions; but which is unwelcome enough to the unmarried mother who would conceal her unhappy condition and hide her shame. More inspirations follow, and are the result of the cessation of the placental circulation; this is due in part to the contraction of the womb delivered of the fetus and compressing the placenta; in part, also, to the stimulus of the unrenewed blood upon the respiratory centers in the medulla oblongata and creating a strong desire for breath, which if not at once satisfied soon results in the child's asphyxia. There are two results of this operation: 1. Full expansion of the lungs. 2. Full development of the pulmonary circulation. The normal time for these results is very short and is accomplished by two or three vigorous respirations. The objecting critic will say, however: "Yes, admitting all this as the usual normal course, the most ample proof that the child has breathed is not proof, in the legal sense, that it was born alive—that is, that its breathing occurred after it was wholly outside the mother's parts and was in the possession of *extra*-uterine life." This we shall have to admit; for the child may have breathed when the head was delivered, while the body was held in the vagina and womb. It may have breathed while the head was in the vagina, the face presenting—a true case of *vagitus vaginalis*. Indeed, it may have breathed while the head was still within the womb itself—the so-called *vagitus uterinus*.

A sufficient number of cases are on record to take the matter out of the realm of speculation. But, so far as infanticide is concerned, these cases need not give us much trouble. The cases of breathing or crying within the vagina or the womb could not occur without the admission of air; and this presumes the presence of the obstetric attendant and his hand in the vagina. So there is a witness of the birth and of the condition of the child. While the rare cases of respiration and crying on the part of the infant when the head emerges, the body being retained in the maternal passages, can hardly embarrass the medical witness, they are, to be sure, illustrations of the legal fiction that you cannot kill a child in this situation because it is not a child in the legal sense, but a part of the mother—*pars viscerum matris.*

The instance is yet to occur, however, in which the defendant mother is so learned in legal technicalities and so blessed with presence of mind and coolness that she will beat in the head of her bastard offspring and kill it then as it emerges from her vulva after the baby has breathed and cried, and then at her trial defend herself successfully on the ground that, though she meant to destroy her baby and did destroy it wilfully after the act of breathing—as all the evidence demonstrates—yet it was no infanticide, because the baby was dead before it was born. The law may deal with such a defence as it can. Medical men would have no difficulty with it as an anatomical or moral problem.

In all these cases of death following respiration which has been attempted in the womb or vagina, while the head was still undelivered, the anatomical proofs of such respiration are invariably imperfect, if not wholly negative. The breathing at best is necessarily feeble and partial, leaving the lungs atelectatic. It is obvious, too, that on account of the abnormal presentation the labor is necessarily protracted, and aid in the delivery is called for, even if discovery of the clandestine childbirth is the cost. Experience, too, teaches that in nearly every case of the kind the child is born dead, although the assistance was timely and skilful. All these considerations should make one slow to admit the probability of this kind of premature respiration in cases of secret labor—the cases in which infanticide is generally found.

There is another group of cases of exactly the opposite kind, which deserves mention in this connection. They are not cases of premature, but of delayed, respiration. Under the normal conditions there is always a brief delay—momentary perhaps— in which, after the full birth of the child, the establishment of

complete respiration is temporarily delayed under normal conditions. The child is born, fully born, but though alive it does not at once breathe. This intermediate period between birth and breathing is sometimes prolonged to an extraordinary degree. Cases are cited in which, for many hours, the only sign of life in the newborn was pulsation, artificial respiration failing to establish the normal function, the child remaining in a state of passive existence. Maschka records the case of a child born at noon. Artificial respiration was unsuccessful, and the body was laid aside in the dead-room. At 11 A. M. the next day pulsations of the heart were detected with a stethoscope. New attempts at resuscitation were fruitless; there was no respiration; the lungs were fetal.

In some of these cases probably there was the minimum degree of respiration not perceptible to an observer, yet enough to support the life of the infant. But in all these instances, whether of extreme respiratory feebleness or of entire absence of breathing during a longer or shorter time, the post-mortem proofs of breathing would be missing. It is clear that in this intermediate stage between birth and the establishment of respiration, the child being to all intents living, its life might be destroyed feloniously and the act come morally and legally within the limits of infanticide, yet the proofs of its life, so far as breathing is concerned, would be absent. But it is equally clear that such cases of infanticide are incredible. Usually the child is killed to stifle its cries and to prevent discovery. If the baby does not cry or breathe, the mother's aim is fully accomplished by natural death and she has no need to resort to violence. She simply conceals the child, regarding it as dead-born, which, to all intents and purposes, it really is. Notwithstanding these objections, the fact remains that in cases of suspected infanticide immediately after a secret childbirth, the medical inspector looks with the greatest interest into the condition of the thoracic organs of the child, and applies his tests to those organs in the belief that they afford him most important if not conclusive indications touching the question, "Was the child born alive?" He recognizes the truth that proof of respiration is not the only, though it may be the chief, evidence of living birth, so far as the post-mortem appearances are concerned; and he insists that, so far as the dead body of the child can guide him, there being no witnesses of the birth, all the post-mortem proofs of living birth are controlled and dominated by this which the lungs show. Indeed, some go so far as to insist that in the absence of this proof of respiration,

it is impossible from a post-mortem examination to disprove that the child was born dead.[1]

When such evidence fails, we must declare that there is no evidence that the child lived after its birth. Our proofs that the child breathed are derived from two sources: 1. The anatomical and physical alterations wrought in the lungs by the establishment of the function of respiration as demonstrated by gross and by microscopical appearances. 2. Certain special tests designed to show the same result—the penetration of air to the air-cells of the child's lungs.

Let us study these proofs a little more closely. Suppose the fresh, undecomposed body of a newborn child becomes the subject of our inspection. We are not in possession of any facts relating to its birth, but are to rely on what we find in the body as our only guide. The development may be shown, by the weight and length of the body, to be mature. But we note that the thorax externally is not full, but relatively flattened and undeveloped. On section of this cavity, we find that the diaphragm is high up—the fourth or third rib. The lungs are far back, along the spine. The pericardium is exposed fully. The lungs are small as well as retracted; their color is chocolate-maroon—liver-like; they are dense when pinched between the fingers and thumb; there is no feeling of crepitation; their edges are sharp and incurved. The lobular boundaries are seen, but there is no sign of true vesicular structure; if they are cut while held under water in a basin, no bubbles rise to the surface; section shows them to be dry and anemic. And we say, those are the lungs of a child that has not breathed.

In contrast with this series of negative appearances, let us suppose another case. The child's body shows a thorax well arched in front, and expanded. The diaphragm is at a low level. The lungs nearly fill the pleural cavities; nearly cover the pericardium; their edges almost meet in front; crepitation between fingers and thumb is manifest; their general aspect is light and spongy; their color instead of a chocolate-maroon, liver color, is light red or pink, or of a rosy tint, according to the stage of expansion; their surface shows the effects of expanded air-vesicles. Small groups of cells, polygonal and angular in shape, are seen, but they are not raised; sometimes they are seen in groups of four, sometimes arranged irregularly. A lens shows that these thin vesicular walls possess injected blood-vessels. Another characteristic is that they can not be emptied by pressure. If these lungs are cut under water, bub-

[1] Tidy, *Legal Medicine*, ii., p. 266.

bles will exude in a chain to the water surface; there is a feeling of vesicular tissue when the section is made. If a section of the lung-tissue is taken with the microtome, vesicular structure is demonstrated by the microscope. What is our conclusion from these observations? We may reasonably infer that the child has drawn air into the lungs by way of the bronchi, in the act of natural respiration.

Medicolegal science is not satisfied, however, with these contrasts in the gross appearances between the lungs of living and of dead-born children. For years it has required the application of other tests which shall confirm the observations made with the eye and the sense of touch. Enthusiastic devotees of legal medicine have shown their zeal by devising methods which shall fulfil this demand. Some of these pulmonary tests may be simply mentioned for the sake of rejecting them as useless and untrustworthy.

For example: The so-called static test of Schmidt is discredited. It depends on the fact that the absolute weight of the lungs before respiration is less than it is after respiration, in consequence of the afflux of blood resulting from the establishment of the pulmonary circulation. But this is comparative and relative only. It is subject to extreme diversities. It is a matter of more or less weight, according to the degree of the expansion of the lungs, due to respiration.

In one case in which a child was probably killed immediately after birth the lungs were found to weigh 1000 grains; in another case, in which the child had certainly lived eight or nine days, the lungs weighed only 861 grains.[1]

To say, then, that the lungs weigh so much after respiration amounts to nothing, unless we can determine accurately the degree of respiration. Any calculations founded on such sliding premises must inevitably lead to error. In other words, we can have no reliable standard of comparison.

Another test is Ploucquet's, which is equally unsatisfactory. Ploucquet made a small number of observations and laid down a rule. He declared that, before respiration, the weight of the lungs compared with the weight of the whole body was in the ratio of 1 to 70; and that after respiration the ratio changed to 1 to 35—that is, the lungs were twice as heavy. Numerous observations by more recent investigators have, however, shown the error of Ploucquet's conclusions, and have established the fact that, although there is some difference in the two ratios, the average variation, taking a large number of

[1] Taylor, *Principles and Practice of Medical Jurisprudence*, ii., p. 325.

cases together, is far too small to sanction its reliability as a proof of live birth in forensic affairs.

Still another method (Daniel and Bernt) rests on the increase of volume in the lungs after respiration. It is proposed by these observers to measure accurately the increase of volume by noting the amount of water displaced from a full jar when the thoracic organs are submerged fully in the jar. Then to compare this amount of displacement caused by the *fetal* lungs. But these proposals have not met with favor. They are of secondary value when compared with observations of the gross physical appearances.

All these tests and other similar ones readily give place in point of significance, reliability, and importance to one which is the oldest, which has been the subject of most discussion, but which is admitted to-day by all medicolegal authorities as being one of the most useful tests, to be applied always when the question of living birth is presented, and, with certain limitations which are fully understood, to be accepted as trustworthy. This test is the hydrostatic test, or *docimasia pulmonum*. Its principle was recognized by Galen; it was reasserted in 1663 by Bartholin; again elaborated by Rayger in 1670; and fully developed by Schreyer in 1683. It is based on the fact, simple and intelligible, that fetal lungs having no air in them are heavier than water and will sink; while lungs containing air are of a less specific gravity than water, and so, being buoyant, will float.

CHAPTER XXIV.

INFANTICIDE.— (Concluded.)

THE method of applying the hydrostatic test is simple, and may be described as follows: Remove the heart and lungs together, first passing a ligature around the trachea and large vessels under the upper part of the sternum, and again around the vessels just above the diaphragm. Place the organs entire in a jar or basin of fresh water and watch their behavior. Do they float? If so, is it buoyancy above the water? Do they sink? If so, do they sink at once rapidly? Cut each lung into fifteen or twenty pieces and test the buoyancy of these. Wrap the several sections in a towel or coarse cloth; place them upon the floor; stand upon them, making steady and uniform pressure on them. Test the several fragments again as to their ability to float after this process.

Now, stated broadly, one of two inferences follows this hydrostatic test: If the lungs float in their entirety and can buoy up the heart with them; if they also float when separately tested and when cut into small pieces, especially if the buoyancy of the several pieces continues after the application of pressure for the purpose of expelling the air from the air-tissue, there is strong presumptive evidence that the child to whom these lungs belonged has breathed. But if the lungs sink, whether in their entire state or in small sections, the presumption is that the child has not breathed or survived birth, but was stillborn.

Alleged Objections to the Hydrostatic Test.—To the validity of these conclusions, and so to the reliability of the test, two chief objections have been raised: 1. That the lungs of children who have not breathed may float, being rendered buoyant by the gases of putrefaction, by artificial inflation, and by congenital emphysema. 2. That the lungs of children who have breathed may sink, their buoyancy being lost as the results of disease and of imperfect expansion (atelectasis). It is well to consider these objections:

First, the lungs of a stillborn child may be rendered buoyant by the gases of putrefaction. This is true and must be admitted. But it is not an objection which is very embarrass-

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ing or which can overthrow the trustworthiness and usefulness of the hydrostatic test. There are some important points which will serve to distinguish fetal lungs even in a state of buoyancy due to decomposition. Their gross appearances are characteristic; their color is different; and they do not have the firmness of fresh lungs. In their substance and under their surface no true air-vesicles are found; there may be superficial bullæ filled with gas, but these could never be mistaken for air-vesicles. Pressure empties and effaces them, and lung-tissue, so emptied, will sink. It is not so with lung-tissue into which air has been drawn in respiration.

Again, lungs putrefy slowly when inclosed within the thoracic cavity; they are among the last organs to decompose. Hence, if the body generally shows no sign of putrefaction, we may be sure that the appearances about the lungs which look like putrefaction are not that; while if other parts of the body, and the lungs as well, are invaded by putrefaction, the medical inspector must acknowledge that the hydrostatic test, or any other test, is of little use. Ogston says he made observation tests on fifty-two lungs of newborn infants, some of them five months post mortem, and in not a single instance did he find any real difficulty in the application of the test arising from putrefaction.

To the other objections we offer these criticisms: The lungs of stillborn children may be made buoyant by **artificial inflation** with air forced into the organs in attempts to make the child live at the time of the birth. Undoubtedly this is true—fetal lungs may be inflated so that they will float, in this respect simulating lungs into which air has entered in respiration. In considering this objection, however, one or two points may well be remembered. Artificial inflation produces unequal expansion; some parts of the lungs are expanded, others remain solid. This comes in part from the fact that inflation of the lungs outside the body and their expansion by insufflation while they are in the thorax intact, are two widely different matters. The latter is much more difficult of performance than the former. In the course of insufflation practised on the newborn, portions of the lungs are blown up and possibly emphysema may come from forcibly ruptured air-cells. But other parts retain their fetal condition.

Again, those parts which are artificially expanded are pale, without the typical pink tinge, and they are dry, without the afflux of blood. Section of them may, indeed, give exit to some air, which is demonstrated when the cutting is under water, but there is very little blood in the lung tissue. More-

over, as a medicolegal problem, the difficulty is reduced if we remember that artificial inflation necessarily presumes the presence of some active agent in the process; and this active agent must be either the mother of the child attempting to save a life which it is her purpose presently to destroy—an absurd position, or, an obstetrical attendant trying to stimulate natural respiration in the newborn—and therefore available as a witness to clear up the mystery, in case of need.

Emphysema.—This was formerly regarded as a possible condition of either pathological development or of accidental origin arising in the course of the birth. In either case, it was supposed to cause a change in the lungs which made them buoyant and which, therefore, discounted the usefulness of the hydrostatic test. If we accept the supposition that emphysema is possible, the conclusion is undoubtedly correct; but the existence of such a condition in fetal lungs is denied by leading authorities. Casper says: " Not a single well-observed and incontestable case of emphysema, developing itself spontaneously within fetal lungs, is known; it is, therefore, not permissible in forensic medicine to ascribe the buoyancy of the lungs of newborn children to this cause." [1]

Turn, now, to the other class of objections: The lungs may *sink*, although the child has survived birth and has breathed, the natural buoyancy having been lost by (1) processes or effects of disease; by (2) so-called atelectasis; or by (3) very feeble and imperfect expansion.

It is seriously stated by some refined critics that red hepatization, congestion of the lungs, pulmonary apoplexy, congenital tumors, pulmonary edema, condensation of the lungs by serum in the pleuræ, tubercles, and syphilis might cause the lungs to lose their buoyancy after respiration had occurred. Aside from the extraordinary rarity of any of these diseases in newborn children, one must insist that such a criticism has little to commend it. As a practical matter it is purely hypothetical. Besides, disease is unilateral—not general, but partial. Its nature is immediately obvious. If serous or sanguineous in character, pressure will expel it from the lung and enable the tissue to float.

Atelectasis, or imperfect expansion of the lungs, whatever its cause, whether it resides in the lung-tissue itself, or is due to inherent debility of the infant, or to feeble respiration, will unquestionably cause the lungs to sink although the child was born alive. In other words, the fetal condition continues. If survival endures for any length of time, the breathing is bron-

[1] *Forensic Medicine,* iii., p. 73.

chial, or it is confined to a limited part of the lungs. As intimated, these lungs, with such small respiratory changes, show very little to differentiate them from the lungs of still-born children. They are the difficult cases in practice, and they are the cases which offer the most serious objections to the value and usefulness of the hydrostatic test. Even here, however, we are not left wholly helpless. There may be, even in these cases, evidence of living birth which will reward search and may be verified by the test of buoyancy.

Limited sections of lung-tissue may show vesicular structure on inspection (other parts remaining solid and fetal), and these expanded parts will respond affirmatively to the test. As corroborative proof that such lungs have tried to breathe, however feebly, their section under water will give a chain of bubbles, small indeed, but sufficient. Then, too, these lungs show a little coarse froth in the bronchi and trachea—an evidence of vital action impossible to imitate in fetal or dead lungs.

From all that we know, therefore, to the credit of the hydro-static test, and after a fair and unprejudiced review of the objections to it, we are justified in concluding that it is valu-able and in the main trustworthy.

In our search, however, for evidence of the fact that the child was probably born alive, we are not limited to a study of the respiratory organs. The organs of *circulation* may aid us. The establishment of respiration and of the pulmonary circulation modifies the anatomical peculiarities of the fetal circulation very promptly. Under normal conditions it closes the foramen ovale between the two auricles; it contracts the ductus arteriosus to an impervious cord, and it obliterates the ductus venosus which connects the umbilical cord with the vena cava. These changes usually occur at birth, but they may be delayed. The foramen ovale, for example, may persist, and the child's life be in constant jeopardy from cyanosis. Usually, the ductus venosus is the earliest canal to close.

The umbilical vessels, like the other fetal circulatory ele-ments, undergo characteristic alterations at birth. When the child comes into the world under normal conditions pulsation in the arteries is looked for as a sign of life. But as soon as the circulation to and from the placenta is suspended, and the blood takes new channels, these umbilical passages begin to close. It is obvious, however, that from a post-mortem point of view, the state of these vessels is of limited value. If the child whose umbilical cord is under inspection died twenty-four hours or more after its birth, the condition of the

vessels in the cord, impervious and desiccated, would help in establishing the fact of a living birth with some hours' survival. We could not, however, be so certain if survival after a living birth was of *brief* duration; for then the vessels of the funis would not present the characteristic changes which have been mentioned.

Very much the same comment is to be made of the material which surrounds the umbilical vessels—the Wharton's jelly in which they are packed; making the cord as a whole—the vessels and their envelopes. The changes in this gelatinous substance and in the skin of the abdomen where the funis joins the body, afford important help if the child has survived twenty-four hours; but if the survival has been brief, the help is slight.

At birth the cord is of a bluish, pearly-white color; it is about as large as a finger, plump and spiral, and bright and glistening. Let us suppose that it is cut or broken. In from twelve to twenty-four hours it loses its luster, becomes dry, flaccid, and transparent, showing the vessels. The process begins at the outer or free end and it reaches within half an inch of the navel in twenty-four hours; that half inch is the last to yield its moisture. Desiccation proceeds, however, along all the cord, and at the end of the fifth day it is complete, so far as the funis itself is concerned.

Meanwhile, the skin around the point of insertion of the funis at the navel becomes red and swollen and is pushed up along the cord in the shape of a cone. During the second and third days, the cord itself drying more and more, suppuration at the navel begins; a line of demarcation forms; finally the funis separates and drops away between the fourth and ninth day—in the majority of instances on the fifth or sixth day.

We may admit, perhaps, that the funis upon a *stillborn* child may dry, if you give it time enough, and that simply a desiccated cord is, by itself, of little consequence as proof of living birth. This, however, does not apply to the evidences of suppuration, separation, and cicatrization, which are vital processes and cannot be simulated by external forces. These are unequivocal proofs that the child has lived, and they confirm evidences found elsewhere.

Are there any proofs of living birth to be derived from the abdominal group of organs? The presence in the stomach of food, such as milk, farinaceous or saccharine matter is, obviously, a sure evidence. In this research the use of the microscope is of advantage; so are the chemical tests for sugar and starch. The presence of fluids and substances in the stomach which

are *not* food may indicate not only survival after birth, but the manner of death. Dirty water, for instance, or privy fluids may suggest drowning. Tardieu first called attention to the value of air bubbles in the gastric mucus as a proof of live birth. They clearly indicate the vital act of swallowing, and they do not require a long survival of the infant to bring them into sight; an interval of ten or fifteen minutes is ample. They are found intimately mixed and incorporated with the mucus. The objection that they may result from artificial inflation is to be answered in the same way as in artificial inflation of the lungs as an objection to the hydrostatic test.

The intestines may show the presence of air, and when this is manifest it is to be explained, as in the case of air bubbles in the gastric mucus, as an evidence of vital activity. In children born dead there is never any air in any part of the intestinal canal, and the intestines do not float when placed in a vessel of water. But when respiration begins in a living infant, the stomach first, and then the small intestine in consequence of the swallowing of air, takes on the change; and the longer the interval since breathing began and the more vigorous the child is, the more inflated and ready to float will the intestine become.

The entire absence of meconium from the intestines affords a strong indication that the child was born alive and survived its birth several hours. But its presence is no proof that the child was born dead; only, if it is present in a large amount, it may be inferred that the life was of short duration, if the infant survived at all. It must be considered in connection with other conditions; alone, it is not very important.

The kidneys are said to afford evidence of live birth in the shape of uric-acid infarctions in the papillæ. These are usually met with in infants from two to ten days old. The change appears as sharply defined, golden-yellow streaks of crystallized uric acid. Virchow explains their formation by the more rapid oxidation of the tissues in consequence of the establishment of respiration, uric acid, with other products, being formed under such conditions. The water secreted by the child is not sufficient to effect their solution and removal from the kidneys. The value of this proof is lessened, however, because (1) infanticide rarely occurs so late; (2) it is not always found in children from two to ten days old; (3) it has been found in children dead *in utero* or during labor.

Finally, the condition of the middle ear is another proof of living birth. Wreden, in 1877, observed that the tympanum of newborn children was filled with the subepithelial layer of

the mucous membrane, composed of embryonic connective tissue which had undergone metamorphosis during intra-uterine life. Respiration, like all changes serving to bring the ear into functional activity, leads to the *ventilation of the middle ear* and to the partial absorption of the so-called "mucus mass" in the cavity of the tympanum. Therefore, the presence of air in the tympanic cavity and Eustachian tube is held to be a proof that the child survived birth. The gelatinous mass disappears in twenty-four hours after birth, as a rule, but it requires strong respiration. It may be much longer in disappearing, sometimes continuing for two or three weeks. Hence, the equivocal value of the evidence. It is of no value in decomposing bodies, since the gelatinous mass in the middle ear liquefies into a serosanguinolent fluid under the influence of putrefaction. Sometimes instead of air, amniotic fluid and even meconium is found in the tympanic cavity.

The Cause and Manner of Death.—Assuming that, as the result of our inspection and special tests, we conclude that the newborn child which is the subject of our study was born alive and that the survival continued for a brief period before death came, we ask, next, What was the cause of this death? Was this infant killed wilfully or suffered to die negligently? Or have we to deal simply with a death from accidental or natural causes? To answer this question, the method of exclusion will be of assistance.

Actual diseased conditions are now and then acquired in the fetal period and are demonstrated by autopsy. Syphilis inherited from father or mother, or both, is a most common cause of death soon after birth. Infectious diseases, such as variola, measles, scarlatina, and erysipelas, may have developed; more rarely, tuberculosis, septicemia, typhoid fever, and pneumonia are revealed.

Various non-infectious degenerations also occur, such as non-syphilitic inflammations of the serous membranes, intra-uterine diseases of the brain and meninges, and rhachitis. Sometimes we come upon congenital malformations incompatible with life; for example, anomalies of the heart, causing cyanosis; malformations of the alimentary canal, causing atresia of the rectum; the absence of any vital organ; either of these is enough to account for the infant's death. Other conditions constituting *monstrosities* of various types are also occasionally to be found. It must not be forgotten that, however widely these monstrosities vary from the normal, to destroy them is unlawful.

Hemorrhage (not the result of accidental violence) from the

genitals, the rectum, the funis sometimes after birth, or the navel when the funis separates, is an occasional incident. It is common in the children of "bleeders," the subjects of hemophilia. The signs of hemorrhage *post mortem* are the proof.

Difficult and protracted labor sometimes acts to destroy the child's life in spite of the presence of skilful help. The result is brought about in various ways; for example: If the child is lacking in vigor, it may be lost by general exhaustion. In some instances prolonged compression of the child's head produces a fatal congestion or extravasation within the skull, but without any fracture. In other instances unrelieved pressure on the funis is the source of mischief. In rare cases the parietal bone suffers fracture from the pressure on the head. These fractures are usually linear; they are limited to the part receiving pressure; they generally occur in primiparous labors, and they are to be distinguished from intentional violence by their small extent.

Among other incidental evidences of protracted labor which the child's body shows will be the presence of a large caput succedaneum or cephalematoma; the effusion of blood in well-defined extravasations under the scalp and outside the skull; and marked deformity of the head due to prolonged pressure as it passes from the pelvis. It is to be remembered that such tedious labors are not probable as clandestine affairs; discovery is a continuous risk; moreover, most children born under such unfavorable conditions are stillborn, and they have little interest with reference to infanticide.

Accidental mishaps, avoidable or unavoidable, may have occurred to destroy the child's life at the time of birth. This is a favorite theory used in behalf of the defendant mother, accused of child murder, and it requires especially accurate investigation. Concerning the usual casualties affecting the child at its birth: We may come upon cases of accidental rupture of the umbilical cord, and for the occurrence of this mishap we must presume one of two conditions on the part of the woman in labor: 1. She was standing while in travail; the delivery was rapid; the child dropped from her vulva and the funis was insufficiently strong to support the child's weight. 2. If the woman was lying down in the usual attitude, a precipitate labor followed; there were forcible expulsive pains, and the child was expelled like a projectile. Tardieu admits the credibility of such an incident, and recorded instances attest it. When the funis is broken accidentally in the manner described, it usually parts either a few inches from the navel (most commonly about six inches) or close down to the navel. It means

a cord with insufficient toughness to stand the strain. In this regard there is great variety in different specimens.

Hemorrhage might, at first view, be regarded as the natural consequence and immediate cause of death in these cases. As a matter of fact, fatal hemorrhage is a rare occurrence under these conditions. Traction to the point of rupture acts like the torsion produced in a contused wound. An analogy is found in the acts of animals and of squaws who break off the cord, and of some obstetric authorities who do not tie the funis, but divide it with blunt scissors. If fatal hemorrhage ever results (and the authorities consider it a *rare* result), it comes from the breaking of a thick cord, rather than from a thin one, and it is favored by imperfectly established respiration.

There are from time to time cases of bleeding from the umbilical cord by shrinking of its tissues after tying, or by slipping of the ligature. This is an occasional mishap of obstetric practice (without any intentional meddling with it) and leads to the child's death. These accidents, however, are separated from the birth by a considerable lapse of time—by many hours—and are under observation and, therefore, the subject of proof.

A much more common effect of an accident to the navel cord is that the child dies by asphyxia. In this respect the result is like that which follows the premature separation of the placenta. A still closer analogy is offered in the results of an obstruction to the circulation through the cord in consequence of compression during or before birth. Prolapse of the funis between the advancing head and the pelvis, and knots in the cord are illustrations of the accident. If these conditions are not seasonably relieved, the child makes ineffectual, premature efforts to breathe. Sometimes liquor amnii or meconium is drawn into the air-passages.

Accidental Strangulation by the Funis.—The umbilical cord has another important relation affecting itself primarily and indirectly the *child*. Reference is had to the consequences of one or more turns of the cord around the child's neck in the course of the birth. Most cases of this kind end in a stillbirth and are of no significance to us as a matter of medicolegal interest. To be of importance in a case of questionable infanticide, we must assume (1) that the compression of the child's neck by the funis occurred *after* the extrusion of the head and *after* respiration had begun or was attempted; and (2) that these respiratory efforts had left their evidence in the condition of the child's lungs, as seen post mortem.

Under such assumed conditions it is possible to mistake the

effects of an accidental constriction of the neck by a displaced funis for the lesions of intentional criminal strangulation by means of a cord other than the funis. There are, however, four diagnostic data worth remembering: 1. The funis never leaves any mark of excoriation on the skin. 2. The groove around the neck made by the funis is broad, smooth, and uniform, without breaks. 3. There are no ecchymoses; the furrow is reddish-blue. 4. The bottom of the groove is soft, with no indurations or desiccations.

Other mishaps incidental to precipitate labor may occur to create doubt as to the true nature of the affair. They are sometimes used as a defence against a charge of infant murder. They pertain especially to the cases in which the baby's body is found in a privy-vault, a water-closet trap, a slop jar, or a chamber vessel. The women say, in these cases, that the initial pains of labor were mistaken for a desire to defecate, and that while seated in the act of meeting that desire, the child came with a single, prolonged, uncontrollable pain, and was dropped, and accidentally destroyed.

There are many well-authenticated cases in obstetric literature to prove that this is an entirely credible story, and that infants may be lost in this way by deplorable accidents and not through any fault or design on the part of the mother. Many cases of multiparæ caught in this manner are on record; with primiparæ it would be improbable, but not impossible.

When, however, we have to investigate the death of an illegitimate infant whose body is found in a vault or slop jar and the mother undertakes to account for the affair as a precipitate labor over which she had no control, it is well not to believe her too readily. Such women, pregnant out of wedlock, have a strong motive to lie. Hence, it is prudent to ask some questions like the following: Are there any traces of blood in the privy or other premises, such as would be inevitable in a case of labor? Can you track her from one place to another by blood? How does the woman appear when she tells her story? Is she candid or is she acting as if concealing facts? Did she report her trouble? Did she ask for help? Does the child show any caput succedaneum, as of a slow labor? How does the funis appear?

It is well, also, to remember that accidental suffocation may be an innocent incident of the childbirth in consequence of the amniotic membranes becoming lodged over the face, obstructing respiration and preventing the establishment of that function. "To be born with a caul," as this condition is described, is considered by the superstitious as a sign of good luck; but

the good luck depends inevitably upon the seasonable removal of the insignia of good fortune. Naturally, in these cases, as air has not succeeded in reaching the lungs, we find those organs in the fetal state.

Criminal Violence.—We come, now, to consider the proofs that the death of the newborn child in a given case was by criminal violence, and not by natural causes or an innocent accident. Many instances occur which, at the very first view, give ample and convincing evidence of the guilty intent with which the child's life was destroyed. Thus, if the child's body is found concealed, the mouth stuffed full of paper, the post-mortem appearances those of suffocation; with a string or cord wound tightly around the neck, the autopsy again giving asphyxia; with the head beaten in and the skull fractured, and the brain injured to a degree wholly inconsistent with accident; or with the head severed from the body; these examples would leave no room for doubt. These, however, are not the *difficult* cases; nor are they the most common or most numerous among those which are investigated.

In truth, the majority of cases of suspected infanticide are determined rather by the attendant circumstances than by the purely medical or anatomical features brought to view by a medical examination. Where was the body found? Is it the body of an illegitimate child? How does the mother talk and behave? Did she conceal her pregnancy? Especially, did she bring forth the child in secret? Did she make any preparations for her confinement? What did she do or attempt immediately after her confinement? Are any baby-clothes in evidence?

All these questions and others like them enter into the investigation and their answers should be in harmony with the condition of the dead body itself—assuming that the appearances indicate a living birth and that no other hand save the mother's is suspected of the death. Cases of the other sort, in which none of these questions arise, because the origin and identity of the dead baby are involved in impenetrable obscurity, end with the medical examination; and even here very much will be found to reward investigation.

The usual methods by which the infant's life is destroyed in cases of infanticide are as follows: Strangulation, suffocation, drowning, or decapitation. Unusual and extraordinary methods are: Blows on the head, dislocation of the neck by twisting, punctured wounds of various parts, such as the orbits, heart, or fontanelles, poisoning, or starvation.

The appearances found at the autopsy of the body in these

cases do not materially differ from the appearances found in adults under like conditions. The various forms of asphyxia and the various kinds of wounds are alike in all cases, whatever the age of the victim may be. These have been studied in previous chapters and do not need repetition in connection with the present topic. In children, as in adults, the degree of the violence, the *atrocity* and extent of the fatal lesions, help us readily to a conclusion that design and not accident entered into the cause of the death. Sometimes we find on the same body indications of several kinds of violence. For example : blows on the head and drowning ; and wounds and partial destruction by fire are found coexistent. These can leave no doubt of the infanticidal character of the case. Mutilation of the dead body gives similar inferences.

It is interesting to note here, as a matter of personal experience, that although the bodies of newborn babies have been examined by the author during the past twenty-five years to the number of many hundreds, yet the cases which have found their way into the Trial Court have been ridiculously few. Lack of identification and failure to connect the crime with the culprit to the point of conviction have explained the negative results in nearly all the cases, and although scores of instances which were illustrations of death by various forms of violence were seen in newborn children, they were good examples of medicolegal demonstration rather than of judicial discipline.

The first conviction at which the writer assisted as a witness was in 1889. An unmarried woman, twenty-three years old, a recent immigrant, took her illegitimate baby from one place to another, trying in vain to place the child in some institution which would care for it. Unsuccessful and exhausted, and in despair as to her future, she carried the baby at low tide to a place on the tidal flats on the shore, and left it there to be submerged by the returning water at flood tide. The baby's body was found at the next ebb, and the evidences of drowning were manifest. The mother's wanderings were readily traced and her pitiable connection with the baby's death was established. More for shelter than for punishment she was sent to the Reformatory Prison for women for a term of years.

On August 7, 1898, the soil pipe in a house drain was found obstructed. A plumber's aid was secured, and the obstruction proved to be a newborn baby's body, without the head. A little later the head was found in a cellar a mile away ; it was wrapped in a shawl belonging to a Polish girl, who was easily traced and was presently arrested for the murder. She had concealed her pregnancy and childbirth, and on the day of the

latter had cut off her child's head and thrown the body down the water-closet, carrying the head to a house at a distance. The autopsy found that the lungs had received air, and the cause of death, of course, was manifest. Under the advice of the District Attorney at her trial, she pleaded guilty and was sentenced to Prison for two years.

As already stated, there is still another kind of infanticide which comprises instances wherein the child has perished not by violence directly inflicted and readily proved by positive post-mortem indications, but by neglect to care for the child in a proper manner in the first moments of its life after birth. This death by neglect is called infanticide by omission. It occurs almost wholly among women giving birth to children out of wedlock and in secret.

One of the first cases of infanticide the writer ever saw was of this kind. On October 27, 1877, an unmarried woman was found in bed with a dead baby by her side. She said she had been taken with labor-pains in the early morning that day while she was alone. No one attended and no one was called; she had kept her pregnancy a secret. No baby clothes were in evidence. Her baby was born at noon; at 3 P. M. she was discovered by people in the house. The funis was broken. The autopsy showed fully expanded lungs and the appearances of death by suffocation. This was a typical example of its kind. The woman simply did not call for help, and whether she wilfully and maliciously permitted the child to die when she might have saved the life by a single word at the expense of her secret is an open question.

The neglect in these cases occurs in various ways. Sometimes the baby is lost, as this one was, by smothering under the bedclothes, possibly in part by drowning in the blood and liquor amnii under the mother's body. Sometimes prolonged exposure to cold is the cause. Sometimes hemorrhage from the funis is fatal. Various authors object to the term "infanticide by omission or neglect," because it presumes ability to judge of the intent of the woman to destroy her child under circumstances of great distress and misery. But if evidences of death after living birth are present, such cases should be submitted to judicial investigation and the responsibility of the mother determined, if possible. It almost never happens that the mother is brought to trial under these circumstances.

Many allusions have been made in this chapter to the mother of the illegitimate newborn child as being in most cases the guilty agent of its destruction. A medical inspection of that mother may be desirable to verify or to refute the sus-

picion that she is puerperal. Before the medical inspector takes the first step toward the inspection he should be sure to get the woman's unreserved consent to the performance. Although he may come to the bedside armed with some official authority, he has no right to intrude upon the patient without her permission. She is not obliged by any rule of law to give evidence of any sort against herself, and any attempt to proceed against her wishes exposes the physician to a charge of assault upon her. She may not be touched without her acquiescence, obtained without coercion. Assuming, however, that the coast is all clear, then the inspection may reveal upon or about the woman these proofs of her criminality with reference to her child's death : That she has been recently engaged in parturition. That she has concealed the childbirth or attempted to do so. Perhaps, that she has tried to hide the child's body. That her statements are contradictory and inconsistent with well-established physiological obstetric laws. The aptitude which such women show for lying and their excuse for trifling with the truth is obviously one of the obstacles. But if the inquiry is made with tact and the patient's confidence is secured, very much may be learned. The examiner should remember to caution the patient, however, that whatever she states is her willing statement and not a matter of coercion. An enforced or involuntary communication will be apt to hinder the cause rather than to help it.

The examiner will try to inform himself on these points : Whether baby-clothes had been prepared by the mother. In what position she was when the baby came. When did the labor-pains begin ? How long did they last ? When did the liquor amnii escape ? Where ? Was any assistance summoned ? Or did the woman endure her labor alone. Was the child expelled by natural pains alone, or was it helped into the world by the woman's hands pulling at any part ? How much flowing was observed ? What did the woman do first after the baby came ? Did she know all that transpired or was she overcome by faintness or unconsciousness ? Did she feel any movement by the child ? Did she hear any cry at the birth ? What did she do to the baby immediately after the birth ?

In all this inquiry he should avoid leading questions which suggest their answer ; and he should avoid, above all things, the bias either of sympathy or of prejudice.

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CHAPTER XXV.

THE MEDICOLEGAL RELATIONS OF HUMAN BLOOD.

To the practitioner of legal medicine many problems occur in which the properties, characteristics, and behavior of the blood are important elements and assume controlling interest. How are the composition and physical qualities of the blood altered, during life, by various toxic reagents? How does its loss in hemorrhage bring about death, and what are the available evidences of such a result? How is human blood identified in suspected stains on various fabrics and surfaces? What changes does time produce in the appearance of blood effused within the cavities of the body or displayed outside those cavities?

These are some of the questions which meet the medical man in his researches, or on the witness-stand at a trial. The occasions when they arise pertain to violent deaths by wounds. Observations on blood-stains may help to determine the time of death in a case of homicide. They may help in showing its manner and cause; they may aid in fixing guilt upon a suspected person; in establishing the place of murder; in identifying the weapon used. Again, the blood is sometimes very important material in which to search for poisons; and it may also play a part of consequence in affairs of rape, abortion, and infanticide.

The Characters of Normal Blood.—Let us at the outset try to get a clear general idea of the blood in its normal constitution before we apply our study to special questions. We ask physiology and anatomy to enlighten us, giving emphasis to features which have a medicolegal value.

We are told by Foster that "blood, when flowing in a normal condition through the blood-vessels, consists of an almost colorless fluid, the plasma, in which are suspended a large number of more solid bodies, the red and white corpuscles. . . . It is the great medium of exchange between all parts of the body, the lymph acting as middleman. The receptive tissues pour into it the material which they have received from without; the excreting tissues withdraw from it the things

which are no longer of any use; and all the tissues seek in it the substances (including oxygen) which they need for the manifestation of energy, or for the storing up of differentiated material necessary for nutrition; and they return to it the waste products resulting from their activity."

How is this important and essential fluid composed? Allen[1] tells us that in 1000 parts of blood, 790 parts are water, 127 parts are corpuscles, 73 parts are proteid substances, and 10 parts are fatty matters and salts. Its specific gravity is 1055; its reaction is feebly alkaline; its taste is saline; its odor differs in different animals, and is always characteristic, though difficult to describe. But the most interesting and important element of the blood, so far as medical jurisprudence is concerned, is undoubtedly the cell elements, the blood-globules.

We will pass in rapid review their peculiar characteristics—familiar facts though they may be. Of the two kinds (the red and white) the red are of chief interest. These are found to the number of about 5,000,000 to each cubic millimeter, or 325,000,000 to each grain of blood by weight. In shape they are circular, flattened, biconcave discs. In size, 3230 of them placed side by side make an inch; or, in other words, their average diameter is $\frac{1}{3250}$ of an inch. In color they have an orange-yellow tint when examined singly with transmitted light; they assume a reddish tinge when they are aggregated several layers deep. They are without nuclei. They are about one-half of the entire wet volume of the blood.

It is readily recalled that their red color when they are studied in aggregations, and so the general red hue of the blood, is due to the coloring-matter called hemoglobin; that they are elastic and assume marked modifications in form under moderate pressure; that they tend to form rouleaux; that they become swollen and spherical when the blood-plasma is diluted with water and imbibition occurs; and that they are shrunken, crenated, and wrinkled when the opposite condition of concentration of the plasma is present. All these are familiar phenomena.

Blood-platelets.—To the two kinds of blood-corpuscles with which science has long been familiar, recent observers have added a third—the so-called blood-platelets. They are formed in the proportion of about 1 to 30 of the other kinds of elements. They are said to differ in quantity and appearance in different species of animals. By some they are regarded as a probable factor in the process of blood coagulation, especially in the formation of thrombi. Further investigation is

[1] Allen, *Human Anatomy*, section 1, page 29.

needed before they are fully understood or before they can be of much value as data in medicolegal inquiries.

Besides these fluids and solids, certain gases are found in the blood. The chief of these are carbonic acid, oxygen, and nitrogen. The capacity of the blood to absorb oxygen is stated to be more than eight times that of water. This oxygen is held almost exclusively in the red corpuscles, while the carbon dioxid is found altogether in the plasma. This relation of oxygen to the red globules explains the difference between arterial and venous blood, in the matter of color. The red corpuscles owe their color to the presence of *hemoglobin* in their structure. This hemoglobin has a strong affinity for oxygen. As the venous blood passes through the capillaries of the lung, the pulmonary air gives to the globules its complement of oxygen which they forthwith convey to the heart, and so to the systemic circulation, where they part with it as they pass through the peripheral capillaries in all the tissues.

Reduced hemoglobin, deprived of its oxygen as it appears on the way *to* the heart, is purple. Similar changes are wrought when venous blood, just drawn from the veins, is exposed to the air. It quickly takes on the florid arterial tint in consequence of oxygenation. In short, the real physical difference between arterial and venous blood is due to the relative amount of oxygen which each holds.

Is it possible to estimate *accurately* the amount of blood in the human body? The answer to this question is of importance in discussing the subject of hemorrhage. Very many and various estimates have been made, which leave us in some doubt as to what sort of an answer one should give on the witness stand. Weber and Lehmann, using the dead bodies of two criminals, found their blood to be one-eighth of their weight; thus a man weighing 140 pounds contains at least 17½ pounds of blood.

Dunglison's *Dictionary* records the following estimates:

Harvey, Lister, and Moulins	8 pounds.
Blumenback, Lobb, Lower and Lewes . . .	10 "
Sprengel	10 to 15 "
Günther and Bock	15 to 20 "
Blake	16½ to 18¾ "
Müller, Burdach, and Bérard	20 "
Wagner	20 to 25 "
Quesnai	27 "
F. Hoffmann	28 "
Haller	28 to 30 "
Young	40 "
Hamberger	80 "
Keill	100 "

The latest modern authorities, Foster, Dana, Yeo and Bischoff, and Waller agree in fixing the weight of blood at one-thirteenth of the body's weight; in infancy it is one-nineteenth.

The velocity of the circulation of the blood has some obvious bearing upon the question of the absorption of poisons and the rapidity with which toxic substances are taken up and carried to all parts of the body. Physiological experiments lead us to believe that the entire round of the circulation is made in less than half a minute in man; or, more exactly, in from 20 to 25 seconds. An iron salt injected into the jugular vein of one side of the neck of a horse makes its appearance in the blood of the opposite jugular in 27.6 seconds. The velocity is not uniform, however; it is fastest as the blood leaves the left ventricle; it is slower as the capillaries are approached; it is slowest in the capillaries; and it gradually quickens as it reaches the heart in the venæ cavæ. Each impulse of a normal heart throws forward three fluid-ounces of blood.

The Drying of Blood-spatters.—Of much greater significance to the medicolegal student is the time required for the full drying of the blood. This matter may have great importance in affording evidence as to the interval which has elapsed between a homicidal killing and the inspection of the body, and, therefore, as to the actual time of the killing. Of course, those conditions which affect the evaporation of fluids generally exert their influence here—temperature, humidity, and the character of the surface receiving the blood. A drop of blood on a non-absorbent surface, glass, wood, or
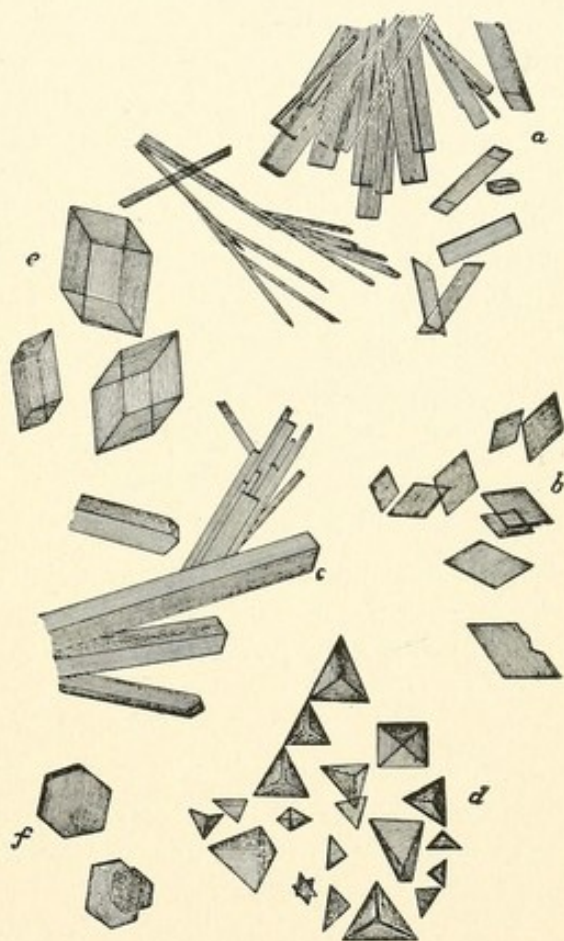
Fig. 27.—Crystallized hemoglobin: *a*, *b*, Crystals from venous blood of man: *c*, from the blood of a cat; *d*, from the blood of a guinea-pig: *e*, from the blood of a hamster; *f*, from the blood of a squirrel (after Frey).

steel, will dry much more slowly than it would on a surface of cotton or linen cloth which would readily take it up. In any event, blood dries more slowly than water because of its viscidity and early coagulation, and if we watch the process, we will be surprised to learn how long it takes.

The writer once made some observations in preparation for a trial. A drop of blood, $\frac{3}{16}$ of an inch in diameter, was deposited on a steel surface in a room at 68° F. It showed no change for 10 minutes; then a drying and contraction began at the edges, which crept toward the center. The drying of the entire drop occupied 50 minutes. Of course, the thicker the mass of blood, the slower the drying. A thin smear on the same surface was dry in 4 minutes; a thicker smear required 9 minutes. On cotton cloth the drying of a thick drop of blood is accomplished in half an hour. On hard wood blood shows but little change during the first half hour, and it requires two hours for the full process of evaporation. These observations have a manifest bearing on the question of the time of a recently discovered homicide; that is, if the exposed blood around the body is found dried and on a hard surface, it has been more than two hours outside the blood-vessels.

Such being the principal directions in which the normal constitution and properties of the blood may interest us as medicolegal students, we inquire next: How does human blood become *altered* under various conditions? What observations does the autopsy-table afford us the opportunity of making relative to the changes wrought in the blood by various toxic, morbid, or traumatic conditions? What alterations are found in its color, consistence, and cellular elements? What modifications in its gross and microscopical appearances?

With reference to disease, we shall not find much to interest us. We may rest content with some general statements. Coagulation, for example, is subject to the greatest variations, blood being found in any condition between extremes of entire fluidity and coagulation into dense and firm masses of coagula, with very red corpuscles. The presence of these decolorized coagula in the cavities of the heart gives us an indication that the death has been a slow affair. Fibrinous coagula also suggest, sometimes, the presence of an unusual amount of fibrin in the blood as a consequence of morbid processes in action during the last days of life. Acute inflammatory affections are especially prone to bring about this result. Pneumonia and erysipelas act similarly.

On the other hand, coagulation may be imperfect or entirely lacking in consequence of either a great diminution in the amount of fibrin (as in dropsy from diseases of the heart, kidneys, or liver), or in consequence of the presence of certain substances which *prevent* coagulation without regard to the relative amount of fibrin—that is, by the presence of carbonic acid, a matter of which the writer will speak more fully presently. The coagulation of the blood in the heart and vessels before death, as in pulmonary embolism and cardiac thrombosis, is of obvious interest in legal medicine in the matter of sudden death.

Again, the consistence of the blood may be changed, not by conditions which affect the process of coagulation, but by a loss of the watery constituent by excessive serous discharges from the intestines, as in cholera, giving a tarry thickness. Or there may be abnormal dilution, as in anemia, through diminution of the solid constituents.

The blood-globules, too, are subject to alterations in their aspect in consequence of various morbid processes. Thus, diphtheria diminishes their size, transforming them into more or less spherical shapes. High fever and septicemia also have the same effect. Pernicious anemia, on the contrary, increases the size of the globules. According to Menassein, alcohol, quinin, morphin, and prussic acid have the same effect also.

Septic processes have some medicolegal interest in their relation to the blood; as, for example, in affairs of abortion or septicemia after wounds. In these cases the gross appearances of the blood have some important characteristics. Blood is quite ready to coagulate in its vessels during life on the least provocation, and then to enter upon other changes. Hence, at an autopsy in a case of pyemia or septicemia we may find the large veins filled with clots which, at first of a deep-red tint, later become brown or rusty. The red globules diffuse their contents and lose their shape. Clots are sometimes found softened and diffluent in the vessels, somewhat resembling pus. It is from these disintegrating and partially adherent clots in the veins that the minute emboli are derived, which migrate to the heart and thence to the lungs and other organs to form purulent foci and to disseminate the septic mischief.

Asphyxia.—It is especially in the numerous conditions which come under the general head of asphyxia that the medicolegal student finds the greatest interest in connection with the aspect of the blood, as in suffocation, drowning, and the like. In a single word, we may declare that the same lethal

cause is found in all these forms of death. Access of air is shut off from the lungs, and the renewal of the blood by aëration and oxygenation is rendered impossible. The phenomena of this condition have engaged our attention in another connection; we are concerned now with its results simply, and with those results as they are found in the blood. After a death by asphyxia we find the blood fluid and of a very dark-purple color. Why is it so?

It is fluid because it is charged with retained carbonic acid, which holds the first place among substances preventing coagulation of the blood. The dark color, also, is easily explained, and must already be familiar to the reader. The hemoglobin of the red globules is (as has been noted) the carrier of oxygen from the lungs, where it is derived from the air, to the tissues where it is used. This hemoglobin gives, when charged with oxygen, the bright-red arterial color which characterizes the blood on its way from the heart to the capillaries. Its freight of oxygen, so carried in the corpuscles, having been delivered, the blood loses its bright arterial hue and assumes the darker venous color, because of the loss of oxygen and the relative gain in carbonic acid. Reaching the lungs in due course, the source of oxygen-supplies is found to be cut off by the asphyxiating agency, and so, no renewal being possible, the blood returns to the *left* ventricle and, as venous blood, is passed on into the arteries again, and so around in a vicious circle.

In death by drowning, in addition to the changes in color and consistence which the blood shows as the effect of asphyxia, another important change has been demonstrated by Brouardel and Vibert. They call it artificial hydremia in consequence of imbibition or absorption of water through the mucosa of the air-passages from the agent in which the submersion occurred. The blood-globules were found by these authors to be diminished in number by from one-fourth to one-third. Globules were altered in shape, becoming more spherical. Fluidity of the blood in drowning is partially explained in this way by these authors.

In death by cold, also, the blood takes on and retains a bright arterial hue unless the amount of blood observed is very considerable, as when it is collected in the heart. In sunstroke the right heart is found engorged with dark fluid blood. Obermeier describes it as acid and as containing an excess of urea. After lightning-stroke and death by electric shock the blood is dark, but it changes readily to a brighter hue on exposure. Coagulation is slow. The old idea that the blood does not coagulate at all under the effects of lightning is now obsolete.

There are certain gaseous agents which, though not classified by all authors as *poisons*, produce under favoring conditions effects as fatal, if not so prompt, as the most deadly poison. The most interesting of these is carbonic oxid.

When we examine a dead body, the circumstances of whose taking off we know nothing about, and we find great, bright-red, florid areas on the skin, taking the place of the ordinary bluish lividities of the dependent parts due to gravitation of the blood to those parts, and upon section of the body there is found a bright, strikingly fresh hue of the muscles and other tissues, and, most important, we notice the blood—that it has a vermilion color and resembles carmine ink—then the inference is that carbonic oxid gas is the one and only cause of death in the case. Of all the sources, the water-gas which is used in dwelling-houses as illuminating-gas is the chief. The writer will have more to say of this in another connection.

Effects of Poisons on the Blood.—To what degree do poisons change the constitution and appearance of human blood? We do not need to penetrate far into the realm of toxicology before we are impressed with an effect which meets us repeatedly and is confirmed by the concurrent evidence of various authorities which we consult as guides, and that is, the nearly uniform manner in which poisons leave the blood in a fluid condition and of a dark color. If we start out with the idea that asphyxia is the only cause of death which may claim a monopoly in thus changing the blood, we are soon dispossessed of this erroneous notion, for we find at the autopsy-table abundant testimony that in poisoning the blood suffers in precisely the same manner, so far as its gross appearances are concerned, as it suffers when its renewal by aëration is prevented in asphyxia. This change is not confined to any one class of poisons; the rule applies to nearly all the principal toxic agents, even those of antagonistic chemical and physiological properties. Acids and alkalies, like oxalic acid and ammonia; irritants and corrosives, such as phosphorus, arsenic, carbolic acid, corrosive sublimate, and tartar emetic; neurotics, like opium, belladonna, hyoscyamus, conium, stramonium, prussic acid, and alcohol; narcotic irritants, such as strychnin, aconitin, gelsemium, nicotin, and santonin—all these poisons when taken in fatal doses leave nearly identical effects on the blood, affecting its color and consistence. Therefore, it will be observed in this respect that the condition of the blood after death by poisoning has but little diagnostic value, nothing indeed which is really helpful or demonstrative.

Why is this so under such dissimilar conditions? The answer is largely a matter of theory and speculation. In the case of *some* poisons, like strychnin, asphyxia is undoubtedly the immediate cause of death, and in such a case we have an obvious legitimate explanation of the state of the blood. In other cases, as in some of the metallic poisons (arsenic, phosphorus), it is reasonable to infer a profound alteration in the constitution of the blood which prevents coagulation post mortem; while in some other instances (prussic acid, alcohol, opium, tartar emetic) we are wholly at a loss to explain the dark and fluid blood which authors mention so uniformly and which pathologists find so often. Whatever may be the explanation which is suggested, the fact remains that the great majority of poisons of all classes leave the blood thus strikingly modified. So much for the changes wrought upon the blood by various toxic agents, simple and compound, gaseous and solid.

Concerning the modifications which putrefaction causes: Decomposition brings about marked changes in the color of the blood. The coloring-matter leaves the solid constituents and is taken up by the serum; the color becomes indistinct and dirty, and, on standing, the supernatant layer of clear serum which is found in healthy, fresh blood does not appear. The microscope shows that the blood-discs have parted with their color and have become converted into pale, globular bodies floating in a yellowish-green fluid. Decomposed blood always contains all sorts of micrococci, bacteria, etc., with the micro-organisms often in active movement. It also often contains bubbles of gas in such number, sometimes, as to give rise to a frothy appearance. Welch has found in this froth examples of the *Bacillus aërogenes capsulatus.*

Hemorrhage.—Passing now to the second topic of our general subject, it may be asked, In what manner does *loss of blood* by *hemorrhage* cause death, and what are the post-mortem proofs of that form of dying? We have been studying the constitution of *impure blood*, of blood whose *quality* has been rendered unfit for the maintenance of life through the alterations which toxic agents and processes have wrought. But, we are told, it is necessary for the continued action of the heart that the blood should be in sufficient quantity, as well as of proper quality—there must be good blood and enough of it. If the blood reaches the heart in insufficient amount, that wondrous force-pump can not and will not act, and we have syncope, either temporary and remediable or fatal, as the result. Before this fatal termination by syncope or anemia is reached, however, a train of symptoms is manifested which demonstrates

the profound effect that loss of blood works upon the general
system. The clinical history of a case of fatal hemorrhage, the
picture which a patient bleeding to death presents, is one never
to be forgotten.

Professor S. D. Gross has left in his classical work on *Surgery*
a graphic description, which can not be improved, of a fatal
hemorrhage :[1] " A person dying from repeated losses of blood,
consequent upon the division of a large vessel, or other causes
of hemorrhage, presents a fearful picture. His countenance is
ghastly pale; his pupils are widely dilated; he pants and sighs
for breath; his ideas are vague and confused; he is sick at the
stomach and vomits; his extremities are icy cold; and the
whole surface is covered with a profuse, clammy perspiration.
The thirst is usually intense and unquenchable; the largest
quantity of water failing to satisfy the urgent needs of the sys-
tem; excessive restlessness and jactitation succeed; the patient
calls loudly for cold air; paroxysm after paroxysm of swoon-
ing recurs; the pulse has, perhaps, already been long absent
from the wrist; the eyes assume a glazed and fixed expression;
the respiration grows more and more feeble; and death often
steals on so imperceptibly as to render it difficult to determine
the precise moment of its occurrence."

The time required for a person to bleed to death will, of
course, vary according to the strength and vigor of the person,
the size and number of vessels wounded, the nature of the
wound, its situation (whether it allows free exit of blood), and
the state of the arteries which are injured. A child or an aged
person would succumb sooner than a strong man in full vigor,
all things being equal as regards the wound. And an artery
of large size cut half-way or more across (incompletely divided)
would be a more serious affair than the same vessel cut wholly
across and left free to contract upon itself and so partially to
control the stream of blood. Stiff, atheromatous arteries if cut
are more intractable than normal vessels, as has been already
noted, and cuts and contusions differ in their liability to hem-
orrhage.

Perhaps, when the question is asked in court, " How long
will a man be in bleeding to death?" our best course, remem-
bering these various modifying conditions, is to state the short-
est time in which death may follow the *division* of the largest
arteries. We are told[2] that an open wound of the carotid
or femoral artery may destroy life in a few seconds. " Very
large losses of blood, whether external or internal, sometimes

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[1] Gross, *System of Surgery*, i., p. 666.
[2] Holmes : *System of Surgery*, i., p. 461.

prove as suddenly fatal as any shot from a pistol could be."[1] "In wounds of the large arterial and venous trunks around the heart death is generally instantaneous from the sudden and profuse hemorrhage."[2]

From these statements as a starting-point, we may formulate our guesses in any given case, according to the data in the case; but it must be understood that they are *only guesses*. Too many extraordinary exceptions have been recorded to allow us to be dogmatic. For instance, Holmes[3] relates the case of a sailor who lived nearly three days with a large aperture in his ascending aorta. Cases of penetrating wounds of the heart in which the patient survived hours, days, and even weeks are on record.

In considering this matter of fatal hemorrhage and the time required for its consummation, it may be well to remember certain well-known surgical facts: 1. That a rapid flow of blood from a single large vessel will kill more quickly than the loss of the same or a much larger amount oozing from many points. 2. That a wounded vein is of less consequence than a wounded artery. 3. That certain persons subject to hemorrhagic diathesis, or hemophilia, and called "bleeders," are placed in jeopardy of their lives by the most trifling wounds. 4. That a number of small wounds may kill by hemorrhage as surely, if not so quickly, as a single large one.

If the question of the time required in fatal hemorrhage is a difficult one to answer, the related question, How much blood must be lost in order that death shall result? is not less puzzling. It is impossible to be exact. Watson states that the loss of from five to eight pounds is sufficient to prove fatal to adults.

In the case of a man named Millsop, who was stabbed during the month of November, 1893, there was a loss of two quarts and two fluidounces (sixty-six fluidounces—a little more than four pounds). He lived fifteen minutes.

In the case of a woman, in November, 1893, dying from ruptured aneurism of the arch of the aorta, there was a loss of two quarts.

In a case of the author's a man died by hemorrhage from an aneurism of the aorta, which emptied into the pleural cavity. At the autopsy thirty-six fluidounces of bloody serum, and six pounds and a half, by weight, of a dark-colored firm coagulum were removed. There is a real advantage in observing such a

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[1] Woodman and Tidy : *Handy Book of Forensic Medicine*, p. 634.
[2] Taylor : *Principles and Practice of Medical Jurisprudence*, i., p. 661.
[3] Holmes : *System of Surgery*, i., p. 461.

case in relation to such an inquiry as the present, for all the blood then is saved.

A moment's reflection, however, will show that such a question is at once unprofitable and unimportant. It is unprofitable because any attempted answer is subject to numerous fallacies and errors. For instance, a difference is found in individuals in their tolerance of the loss of blood (equal in amount and from the same kind of wounds), their state of health being the same. Again, it is often impossible to measure accurately or to estimate with exactness the amount of blood whose loss actually caused the death, as distinguished from the blood which flowed *after* the death from the same open vessels and possessing the same physical appearances as that which escaped before death. It is well known that so long as the body remains warm and the blood liquid, the latter continues to drain away from the injured or ruptured vessels in gradually diminishing degree. The amount of this post-mortem bleeding may be large or small according to the vascularity of the part affected or the size of the vessels opened; it depends upon the modifications growing out of conditions of age, sex, the physical health and vigor (whether of plethora or of anemia); the position of the body when wounded; subsequently, the suddenness of the loss ("a person may fall into a fatal syncope from the loss of a quantity of blood in a few seconds, which he would have been able to bear without sinking had it escaped slowly") and the *vessel* divided (arteries being more serious than veins because the hemorrhage is more rapid).

The question, however, is unimportant, as well as unprofitable, because in a given case it is wholly secondary to the main problem—whether the death was actually caused by hemorrhage. Proofs of a death by hemorrhage are to be sought in a post-mortem examination of the body, and in the anatomical appearances which that examination reveals, rather than in a guess, however accurate it may be, of the number of pounds of blood which have flowed, before and after death, upon the floor or ground around the body or, if the bleeding was internal, into the cavities of the body. Of course, it is correct to measure or to *estimate* (if measuring can not be done) the quantity of blood shed, and to reckon this observation for what it is worth as one of the data of the case. It often impresses a jury as a fact of consequence, but that is different from regarding such a measurement as controlling proof, positive or negative, of the cause of death—as if one should say, "I find only three pounds of blood here; that is not sufficient

loss to have caused death." He should look rather to the state of the tissues.

What are the post-mortem appearances characteristic of a death by syncope due to hemorrhage? They are easy of comprehension, and may readily be summarized in a single expression—general anemia. Externally we notice a waxy pallor of the skin; the absence of livid patches on the dependent parts; and the absence of red color from the lips, the tongue, and the conjunctivæ. Internally we observe anemia of all the organs; that the heart is empty and contracted; that the lungs are pale; that the large vessels are depleted; that the liver, spleen, and kidneys are deficient in blood; and that there is a general aspect of exsanguinity. We note, also, the presence of a wound dividing the vessels, and, negatively, the absence of disease as a cause of death.

Fatal consequences, however, may and frequently do ensue from hemorrhage, not as the result of the amount of the blood lost, but by the effects of the presence of the blood within closed cavities of the body, acting to compress vital organs and to interfere with their functions to such an extent as to cause death. Examples of this will readily be recalled in the hemorrhages which occur, either idiopathically or traumatically, within the skull, the pleura, the pericardium, and the spinal canal. The action in these cases of compression is physical or mechanical. In knife-wounds, also, about the neck in suicide, the blood may be inhaled into the trachea and occasion death by asphyxia.

Identification of Suspected Blood-stains.—We come now to the final and, from a medicolegal point of view, the chief question of our topic—the identification of human blood in certain suspected stains.

For the determination of this question legal medicine has four methods or instrumentalities at its disposal: 1. Chemistry. 2. The spectroscope. 3. The microscope. 4. Bacteriology. The first and the second answer the question, Is the stain a blood-stain? The third and fourth profess their ability to declare that the stain is not only a blood-stain, but that it is probably a stain left by human blood. Before proceeding to discuss these methods in detail and to describe their practical application, it will be well to mention two or three matters of a preliminary and more general character relating to blood-stains.

It is to be remarked, in the first place, that the medical expert's difficulties about blood-stains do not relate to freshly effused blood in larger or smaller quantities, or to the victim

of a homicide lying in a puddle of blood, about which there can not be the possibility of a mistake. These are not the occasions demanding the skilful use of scientific methods. The color, outline, clots, attendant circumstances, and exsanguine aspect of the body suffice to settle the nature of the stain under ordinary conditions. The cases, on the contrary, which *do* call for the exercise of the greatest care and skill, which are involved in doubt, and sometimes give rise to deplorable conflicts of testimony in murder trials, are quite different from these. For example, a homicide has been committed; its method was by wounding with a weapon; its perpetrator is suspected and arrested. There is no direct evidence; all is circumstantial. In search of proof the detectives overhaul all the clothing which by any possibility was associated with the suspect. Perhaps the search is made days or weeks after the act. They find on his coat, vest, trousers, or shirt a dry, reddish stain which, perhaps, has been partially washed out—a small affair, but of large import if its true nature is revealed. The prisoner says it is not blood; or if he admits at all that it is blood, he declares that it is innocent—chicken's, pig's, or horse's-blood. He throws the burden of proving that it is human blood and connected with the murder upon the State which is accusing him.

Or, suppose that in this same case there is found about the man's clothing a pocket-knife; its blades are clean and bright, except that in the little notch in the steel by which the blade is lifted, or at the junction of the blade and handle, some dry, brownish-red deposit has attracted the attention of the officers. Is this scanty material a part of the proof of the prisoner's guilt? Is it the dried remnant of human blood left there and overlooked until the detectives find it? Or is it, as the prisoner insists, nothing but rust or a bit of tobacco lodged there after a smoker's harmless use of the knife?

A hatchet is found a week or more after the dead body of a man has been discovered in an adjacent house with his head crushed and battered by blows. The hatchet shows some suggestive patches of dull red about its blade, with some dark blotches on the handle. Are they blood-stains? If they *are* blood, is the blood human and thus, presumably, connected with the homicide?

These are the conditions which call for the highest exercise of accurate observation and technical skill. They illustrate the ordinary conditions under which experts are called upon to assist the prosecuting officers in unravelling cases of crime and in fixing guilt. They offer temptations to an over-

emphatic manner of testifying on the part of the medical witness; and, equally, the opportunity for denial and contradiction by the medical experts for the defense.

A question of this kind frequently arises in murder trials, upon which a medical opinion is sought. Is it possible that a murder could be committed by wounding—by blows with the sharp edge of an axe, for example—and the murderer escape extensive spattering and staining with blood? At first thought, we would naturally answer in the negative. Experience in hospital amphitheatres at ordinary surgical operations would suggest the impossibility of dealing repeated blows on a person's head with an axe and escaping all or nearly all bloody evidence of it. In this matter, however, the writer thinks we may readily err, and cases on record confirm this view.

At the Borden trial, in 1893, at the Bram trial, in 1895, and in the Manchester (Fall River) case, in 1893, the conditions of the homicides were favorable for much blood-spattering, but, on diligent search, none was found. These negative instances teach us to be conservative; and the answer to the above question should be: "Blood-stains in such cases would be probable, but not necessary, as incidents of the homicide."

The prudent medical inspector, who cares for his comfort on the witness-stand, will always make an accurate record of the situation in which he finds the suspected blood-stains which are submitted to him. And of the stain itself, he will note the size and shape of its outline in each instance. By these data he may throw light on the question of the manner of the killing, whether it was homicide or suicide, and he will clearly demonstrate his own accuracy and credibility.

For example, What does this peculiar shape of a blood-stain mean? (Fig. 30.) This indicates a spurting or sprinkling from a small artery, throwing a jet from a distance. It means something more than a mere drop. It may have been thrown from a weapon, as well as spurted from an artery. It clearly demonstrates the direction from which it came—the broader and thinner portion being the part nearest the source, and the pointed, narrow, and thicker part being that which is most remote from the source of the blood. Observations of this sort are sometimes of great help in determining how the assailant stood, and how the victim was struck when assaulted.

Sometimes stains are best detected and brought to view by artificial light. On dark surfaces, and especially on woollen stuffs, candle-light shows the dull-red stain which may be quite readily overlooked by daylight. Ollivier is to be credited with the first demonstration of this fact. It was illus-

trated quite fully in an important murder trial in New Hampshire (Sawtell), in which stains were detected on the dark-green cloth of a carriage cushion by means of artificial light.

Sometimes search in *obscure* situations is rewarded by finding traces of blood. For instance, in the seams of clothes, along the welts of shoes, and in cracks and crevices of weapons. Suppose a homicide has been committed and, in the search for evidence, the detectives find a garment belonging to a man who is suspected of the crime; the garment displays some red stains upon it, and it is submitted to the medical
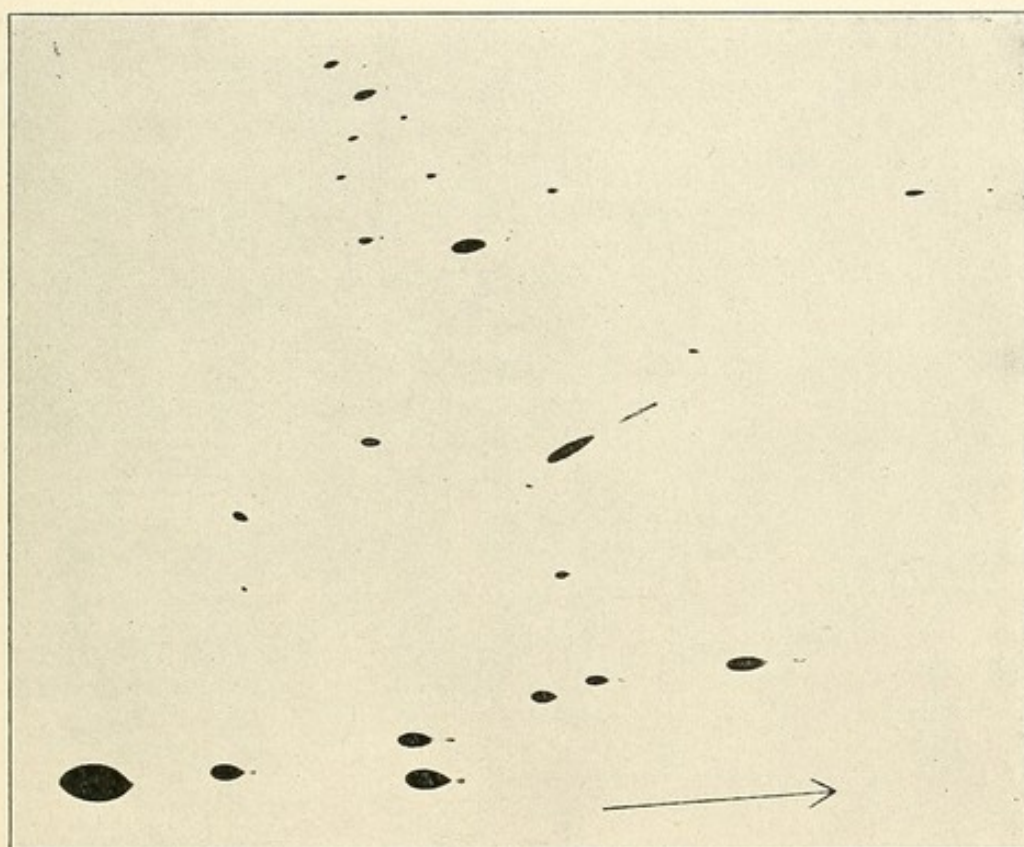
FIG 30.—Blood spatters (Wood).

inspector to determine the question, "Are those stains the stains of human blood?" What will he do in the technical process of his collection of data to enable him to answer the question?

First, he will carefully note the situation, shape, color, and consistence of the several stains, and make an accurate memorandum. He will place his private mark on the various garments for purposes of identification, because he will recognize the great importance of these articles as evidence, and the need of extreme care to prevent any doubt regarding them developing while in his care.

Next, with a strong lens or a microscope of a low amplifying power, he will make a preliminary examination of the gross appearances of the spots. If *blood* is their cause, and not a mere staining or coloring of the fibers of the fabric with some other agent, he will find that each fiber has a shining, glossy appearance due to the dried coagulum which incloses it.

The *color* of blood-stains is not a matter of such importance as to be of much real assistance in determining their *age*. Stated in a general way, we say that recent stains are red and old stains are brown. But this general observation is subject to many modifications and exceptions. The change from red to brown is speediest in warm weather. It is greatest in thick layers of blood. It differs somewhat as to the surface of material on which it lies—on a light surface or fabric it is paler and duller than on others.

Taylor [1] says: "After a period of five or six days it is scarcely possible to determine from the appearance the date of a stain, even conjecturally." And Woodman and Tidy [2] make this rule: "If the color of a blood-stain is bright red, it is proof that the stain is recent; if it is *brown*, it is no proof that it is *old*." It should be added that once the change to brown has occurred, it is permanent and is not subject to further alteration.

Sometimes minute, dry coagula are found in the meshes of the fabric which has received the blood-stain. These coagula have an appearance suggesting dried jelly; they stiffen the fabric. On felt the coagulum lies on the surface and does not go deeper. In certain lights a blood-stain on dark woolen cloth has a dark-red hue; if the angle of the light is changed, the hue becomes of a bright crimson. This is a characteristic of blood-stains. By reflected light a stain appears *glossy*, whether the fabric is white or colored.

If we wet a blood-stain with distilled water, and press on it a piece of white blotting-paper or filtering-paper, the blood yields a distinctly red imprint which may be useful in applying some of the chemical tests to be described.

Assuming that there is a stain of sufficient size, or a number of stains ample for the purpose, the examiner goes through a series of tests as follows: He will cut a slip from one of the stained areas and suspend it in cold distilled water in a test-tube or watch-glass to determine the solubility of the stain. In dealing with old stains a cold saturated solution of borax may be used instead of distilled water. If the borax solution

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[1] *Principles and Practice of Medical Jurisprudence*, i., p. 556.
[2] *Handy Book of Forensic Medicine*, p. 587.

is used, the use of heat, raising the solution to a temperature of 100° F., is advised. If the suspected stain contains blood, a red or reddish-brown deposit will accumulate at the bottom of the solution. Wormley states that so small a proportion of blood as 1 to 5000 is enough to give a visible red stain to the water in the test-tube. *Old* stains and those which have been exposed to heat above 170° F., are comparatively insoluble and require special chemical treatment and prolonged immersion.

In the medicolegal determination of blood-stains the aid of chemistry is invoked to find: (1) hemoglobin or the product of its decomposition; (2) serum-albumin of blood-serum.

These constituents are present in the blood of all animals, so that their detection in any specimens does not tell us from what animal the specimen comes. Moreover, there is a difference in the value and importance of the constituents themselves as evidence. The presence of albumin is comparatively insignificant as proof, and any tests applied are simply *confirmatory* if they are used later; they are only *suggestive* if used early. Inasmuch as the material available is sometimes small, it might be better, as a rule, to economize what is provided, and use the more important and trustworthy tests first.

Thus far, it has been assumed that the blood-stain is on a white or nearly white fabric. On other surfaces, wood or metal, such as weapons, and on carpets, the conditions, appearances, and methods of testing are somewhat different. Blood-stains on clean surfaces of steel or iron, if seen before time has elapsed for the formation of oxid of iron (rust), are quite easy to identify. They are of a clear red or reddish brown, according to thickness. They are easily detached, and if they are thicker than a smear, they scale off on the application of heat. If they are simply superficial stains, of no depth, they must be moistened with distilled water, scraped off carefully, and examined by means of the tests described. If a metal weapon has been exposed some time to air and moisture, spots of rust will have formed, mingled with the blood-stains, and in gross appearances not unlike them. In such cases it will be necessary to scrape off the two, blood and rust, together; place them in distilled water, and separate the insoluble particles of oxid of iron by filtration; then to submit the blood solution to the usual tests.

A blood-stain on wood may be shaved off and immersed in water, or water and salt, making a solution which can be tested as in the case of fabrics as already described. Or, if

on a surface that can not be cut, scraped, or immersed, moistened filtering-paper may be placed on it, and the paper, stained in that way, be tested.

Blood-stains on carpets or dark stuffs are best brought to view, as the writer has already suggested, by candle-light. With the light held at a proper angle the shiny surface characteristic of a blood-clot will be made manifest. If scratched with the finger-nail, this surface will show a vermilion mark.

From these preliminary observations, which may be described as a *reconnaissance* rather than a demonstration, we may pass to a brief consideration of more technical tests, requiring special skill.

The Hemin Test.—Modern chemists place at the head of the tests, in point of utility, the hemin test. This seeks to obtain crystals of a halogen salt of hematin from the specimen; and the crystals themselves are called hemin or Teichmann's crystals. It is an exceedingly delicate test, and serves to discover affirmative results in so small a quantity of blood as $\frac{1}{100}$ of a grain (Wormley). Guy[1] says of its reliability: "If the test succeeds, it is absolutely conclusive of the presence of blood." In this emphatic statement he is confirmed by other equally good authorities.

It is applied in the following manner: A small fragment of blood from the dry stain or spot is placed on a glass microscope slide. To it is added a small drop of water containing in solution a minute crystal of chlorid of sodium or iodid of potassium. It is then evaporated to dryness over a gentle heat. The dried spot is covered with a cover-glass, and a drop of *glacial acetic acid* is allowed to make its way under the cover-glass from the edge. The slide is heated slowly and gently until bubbles are seen to form under the cover-glass. This shows that the acetic acid is at its boiling-point, and care should be taken not to carry the heat beyond this point. The specimen is then allowed to cool, and the hemin crystals, which are soluble in boiling glacial acetic acid, will form and may be observed by means of the microscope. The normal form of these crystals is rhombic. Sometimes they aggregate in groups. Their color is dark brown or yellowish, if examined separately without detritus. They are permanent, and may be mounted and preserved indefinitely for further examination or for demonstration in court.

Schoenbein's Guaiacum Test.—This test is another demonstration of blood. To a few drops of the dissolved blood or the red blood-solution add a few drops of alcoholic solution of

[1] *Forensic Medicine*, p. 323.

PLATE III.
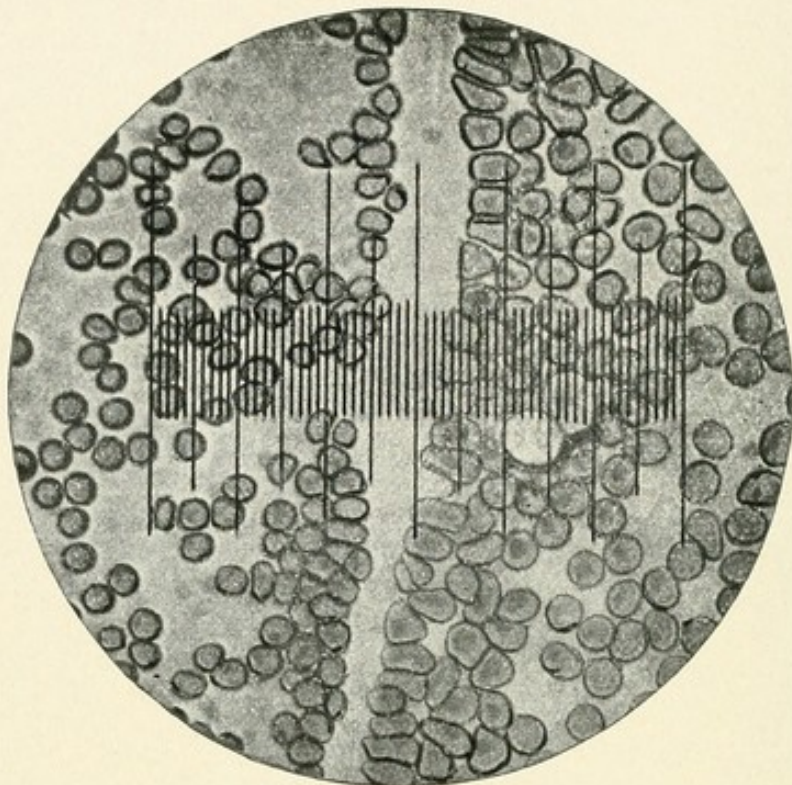
Ox.   Human.

Blood-corpuscles (ox and human), side by side, magnified 450 diameters.
Micrometry illustrated (Formad).
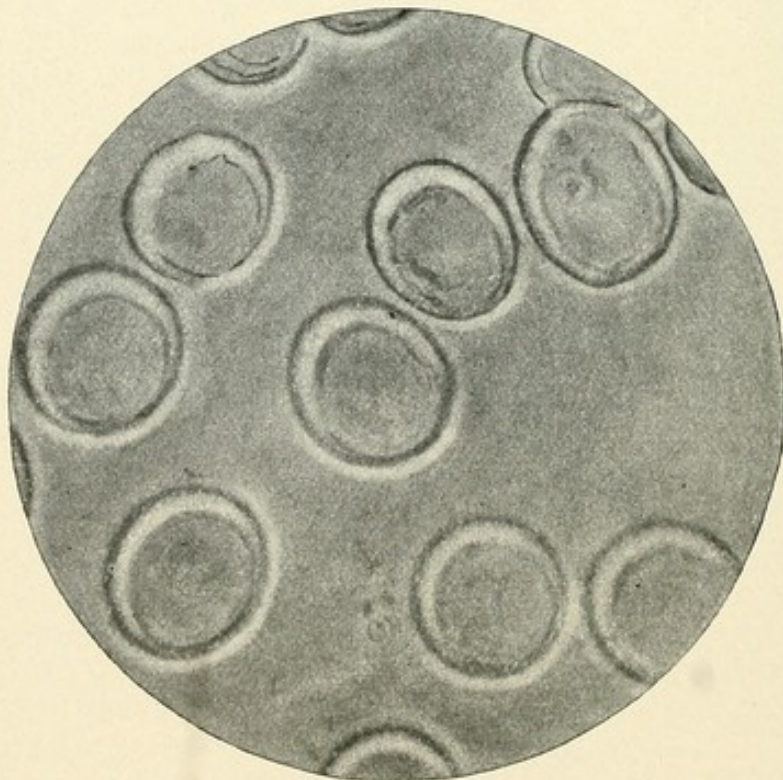
Fresh human blood.   Red blood-corpuscles, magnified 2000 diameters.   Photo-
micrograph, $\frac{1}{18}$ Zeiss Hom. oil-immersion and projection eye-piece (Formad).

guaiacum freshly made, and the result will be a reddish-white precipitate of resin of guaiacum. To the mixture add a few drops of ethereal solution of peroxid of hydrogen (ozonic ether), and the result is a change of color to a beautiful blue. Add, finally, some alcohol or ether, and the effect will be that the resin precipitate will be dissolved, giving a deep sapphire blue. Now, whether the blood is old or new, concentrated or diluted, entire, as first fixed, or partly removed by washing, this reaction with guaiacum and peroxid of hydrogen is constant. Rather better results follow if the solution of the blood coloring-matter is diluted. The red-colored stain left on blotting-paper which has been applied to a blood-stained fabric will give the color-changes above described, just like a solution of blood. Wormley[1] asserts that a 1 : 1000 solution of blood gives excellent results, and that a 1 : 5000 gives unequivocal reactions. The test may be applied directly to a stain if it is on a white fabric surface, first moistening it with a drop of water.

The guaiacum test is a valuable negative test. That is, when *no* color-change results from its application, it is sure that no blood is present. Its value as a positive proof of the presence of blood should always be corroborated by other tests, because other substances, like glue, casein, compounds of iron, and indigo, may produce a blue color.

It has been stated, however, as an additional objection to this test, that other substances, animal and mineral, especially iron, will oxidize the guaiacum resin and give the blue color which is depended on as a reaction with blood. All these other substances, however, effect the change without the peroxid of hydrogen; blood does not do so. Taylor[2] says: "There is no other red coloring-matter known, other than that of blood, that will yield these results under the combined action of the two reagents."

The colorless stains of mucus, sweat, and saliva, and the yellow stain of bile, are said to give the reaction. But these could never be mistaken for blood, their physical characters being quite sufficient to distinguish them. Moreover, there are other substances which bring the reaction—but they do so very slowly. Taylor[3] says: "It is the very essence of this test with blood that the reaction is immediate, or that it takes place within a few seconds. No reliance ought to be placed upon any change of color which requires hours for its production, since guaiac resin, either alone or in mixture with

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[1] *Micro-Chemistry of Poisons*, p. 710.
[2] *Principles and Practice of Medical Jurisprudence*, i., p. 567.   [3] *Ibid.*

the peroxid, becomes slowly blue under long exposure to air."

The Spectroscopic Test.— In addition to these chemical tests, we have at our disposal the *optical* proof furnished by the spectroscope. Any very elaborate description of the instrument or of the technic of its use is unnecessary. Suffice it to say that the optical test depends on the principle that when light which has passed through a solution of blood is received upon a prism, the spectrum which is produced presents characteristic black bands, the portions of light corresponding with these bands having been absorbed by the coloring-matter of the blood. Since Hoppe-Seyler first noted this fact in 1862, and proposed to make medicolegal use of it, it has been found by other observers that different spectra of typical and constant character may be obtained from blood under differing conditions relating to the oxidation of its coloring-matter and the effect of certain chemical reagents on the hemoglobin.

The instrument now recommended as best fitted to secure the most satisfactory results is the microspectroscope of Abbe or of Sorby-Browning, which permits two spectra to be examined coincidently, the suspected spectrum being placed alongside that of a known sample of blood as a standard for comparison. The microspectroscope may be fitted to any microscope, but the binocular instrument is the most convenient. Low amplifying powers are used. Artificial light is preferred. The solution to be examined is placed in tubes of glass, giving a thickness of fluid half an inch deep. The instrument having been adjusted and the standard and suspected solutions placed, the spectral effects observed will be found to vary with the age of the blood, the amount of blood in the solution, the depth of the column of solution through which the light passes, and the nature of the reagents, if any, which have been used.

Thus far, if our tests have been successful, they have succeeded only in the establishing that a suspected stain is a *blood*-stain ; but they have not informed us concerning the origin of the blood. It is simply *red blood*. And, now, another witness comes into court, claiming ability to declare definitely that the blood in a stain, in a given case, is probably human blood, and none other ; or, if not human, that it is from a bird or animal which can be named. This witness is the microscope. Its claim is based on the assumed practicability of differentiating blood-disks of mankind and of various animals by means of diametric measurements ; and, furthermore, of determining the blood of oviparous animals from the blood of mammals, by differences in the shape of the blood-corpuscle, as well as

PLATE IV.
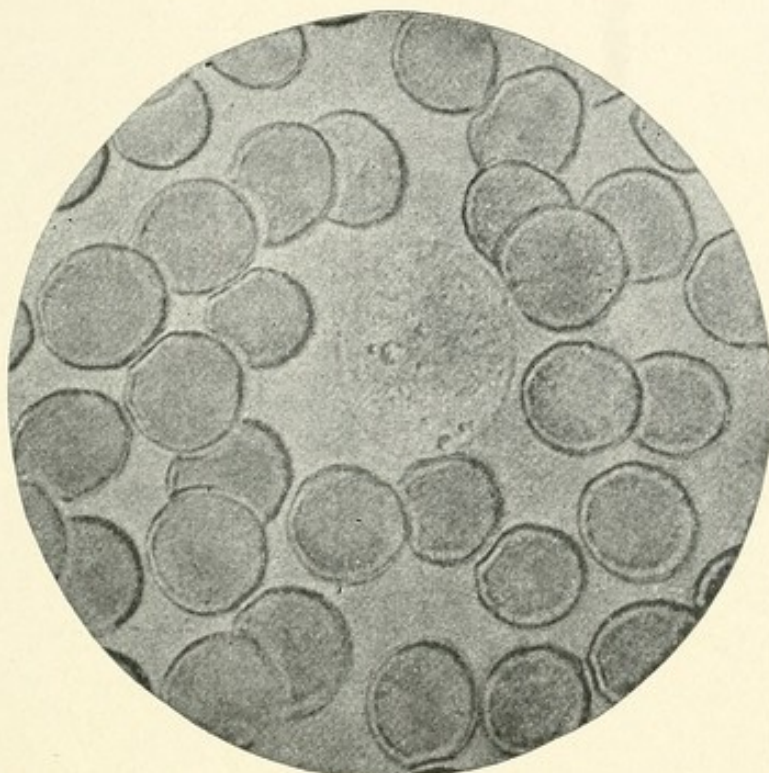
Blood-corpuscles of man, magnified 1250 diameters (Formad).
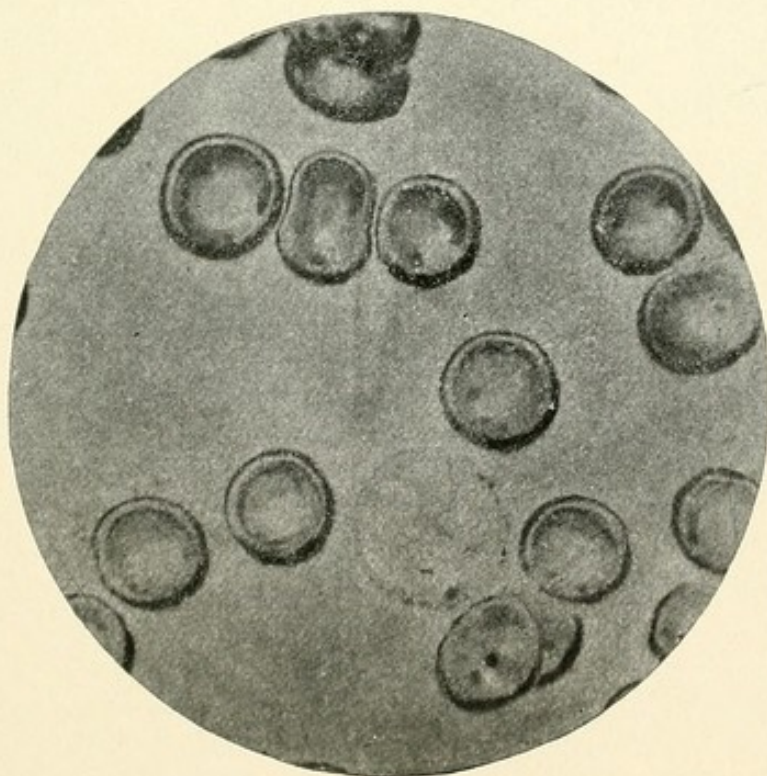
Blood-corpuscles of guinea-pig, magnified 1250 diameters, $\frac{1}{18}$ Zeiss Hom. immersion (Formad).

in their size, and by the presence of a nucleus in the blood-disks of the former, and not in those of the latter.

It is admitted that with fresh blood as our material, the blood-globules of mammals (the camel excepted) are easily to be distinguished from those of oviparous animals (birds, fishes, reptiles). The former are circular, flattened, bi-concave, non-nucleated, and of comparatively small diameter. The latter are oval or elliptical; they show a distinct nucleus, and have a relatively large diameter. The camel family of mammals has blood-corpuscles which are oval, but non-nucleated, thus forming a notable exception in both directions. It is admitted, too, that between the red blood-globules of man and those of some mammals there are appreciable differences in the diameters.

It is important to remember that these observations are with fresh blood. In none of these tabulated cases are we dealing with the conditions usually imposed by medicolegal emergencies. The results are interesting and fascinating scientifically, but when a man's life is in the scale, sound, judicial fairness is better than scientific conceit or assertion.

We must remember the ordinary medicolegal conditions under which the expert works: 1. He has an old and dried stain of disputed origin. 2. The animals whose blood is usually invoked by the defence in disputing the contention of the prosecution are dogs, rabbits, pigs, oxen or cows, horses, and sheep or goats, and they are uncomfortably close to the human class in any scale of measurements of their blood-disks. 3. The animals whose blood is most in contrast with human blood in the matter of blood-disk measurements, such as the elephant, the leopard, the ibex, and the deer, are not likely to be cited at capital trials. 4. The action of fluids and solvents used to restore dried blood to something like its fresh state is attended with uncertainty in the matter of the uniformity of the results. There is no fixed standard. The great number and variety of these reagents prove this uncertainty. 5. Even under normal conditions, in adult life, the blood-globules of the same species, whether human or of the lower animals, do not have a uniform diameter, but show a considerable range between minimum and maximum. 6. Finally, the possible alterations in the size of the corpuscles, due not only to time and exposure, but to diseased conditions.

Wormley says: "Corpuscles may *shrink*, but they do not *increase* in size beyond their normal diameters, in consequence of exposure." Gamgee states that in anemia they may diminish in size to $\frac{1}{3900}$ of an inch. In pernicious anemia (Eichhorst), on the other hand, they may be found enlarged to a

diameter of $\frac{1}{3000}$ of an inch, and may also be found oval and nucleated in the human subject. Menassein found them smaller than normal in septicemia, in conditions of high fever, and in poisoning by carbon dioxid.

All these modifying conditions would be and should be seized upon by defendant counsel to throw doubt on testimony that, in a given case, the blood-stain was human.

These authoritative statements should not, however, be misinterpreted or misapplied. Because they teach caution, they do not teach incredulity or indifference. With new and improved methods in microscopy and technics it may yet be possible to solve the question of identification of human blood-disks, so as to satisfy medicolegal as well as academic, scientific requirements. Indeed, some enthusiastic microscopists even now declare that it is possible to determine the question with satisfactory accuracy.

As the writer has indicated, however, it is clearly practicable to determine negatively with the microscope some extremely important matters relating to blood-stains. Suppose, for example (as in a murder which occurred several years ago in Groton in this State), the accused attempts to explain certain suspicious stains on his clothing as having been caused by the blood of a fowl, the microscope may at once determine that he lies. Or, turning the case about, suppose the detectives insist that the stain is a stain of human blood, the microscope is able to determine that the globules in its field are oval and have distinct nuclei—evidently the accused should have the benefit of that fact. Or, the microscope finds globules *so large* that we can say conscientiously they are surely not human globules ; but we will not undertake to say from what animal they were derived—here, again, we are clearly aiding justice.

Bearing in mind these limitations to the usefulness of the microscope as they are regarded by expert authorities, we proceed in a given case as follows : With a needle we pick off a minute fragment of the dried clot from the surface presenting it, and place it on a glass slide. It is obviously better to avoid any admixture with the material on which the clot has formed, so that we may have blood alone for our observation. With a cover-glass we press upon the bit of clot and reduce it to a powder. It is now ready for some solvent reagent, and we place the specimen on the microscopic stage and with a pipette introduce a minute quantity of the solvent at the edge of the cover-glass. In composition and nature, these liquids are of two kinds : First, such as have the property of dissolving the fibrin which glues the corpuscles together ; and, secondly, such

PLATE V.
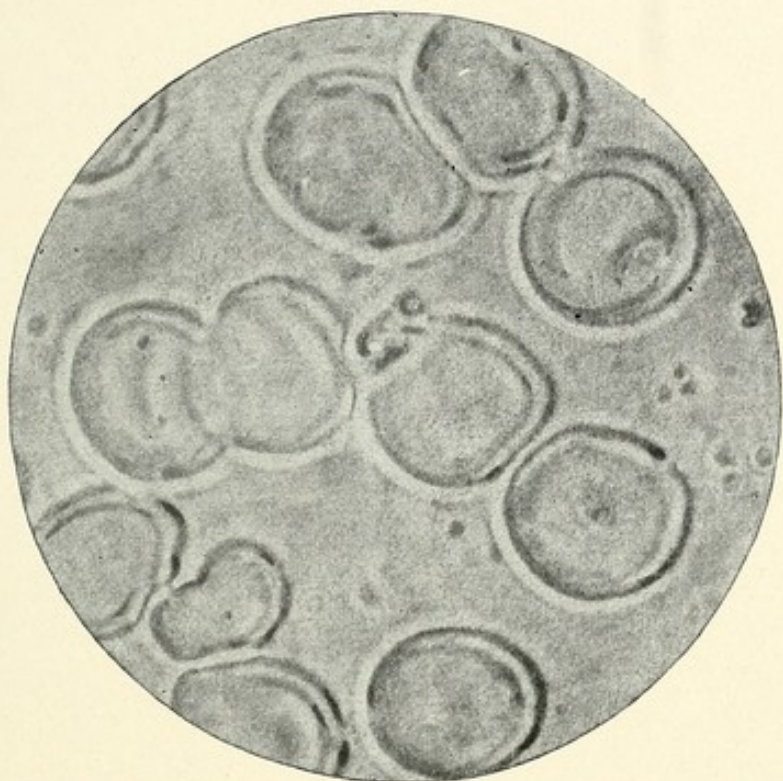
Human blood-corpuscles, recovered from dried clot two days old, magnified
2000 diameters (Formad).
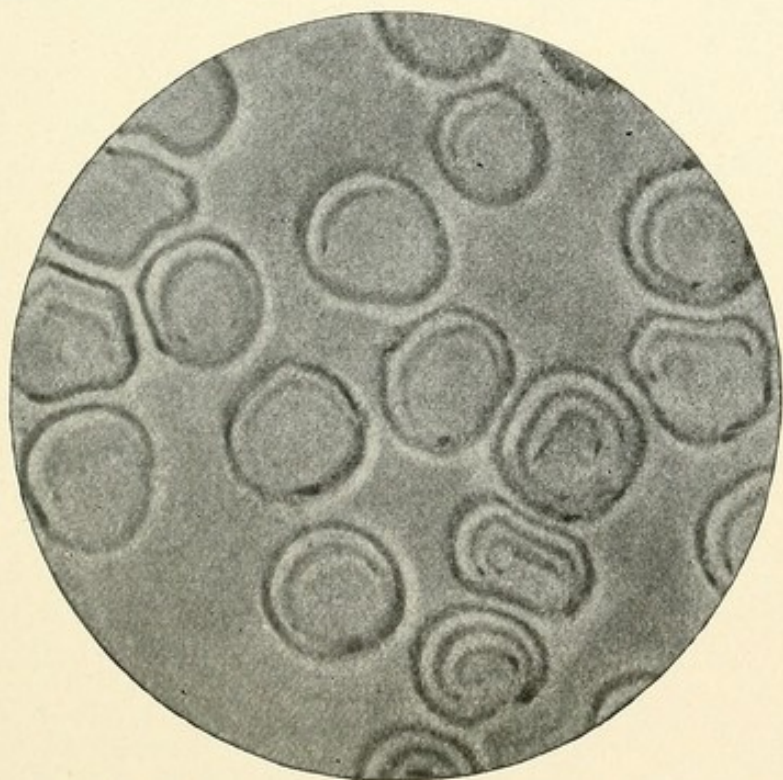
Ox blood.   Fresh, dry preparation, magnified 2000 diameters.   Both photo-
graphed under same amplification, $\frac{1}{18}$ Zeiss Hom. immersion and projection eye-
piece (Formad).
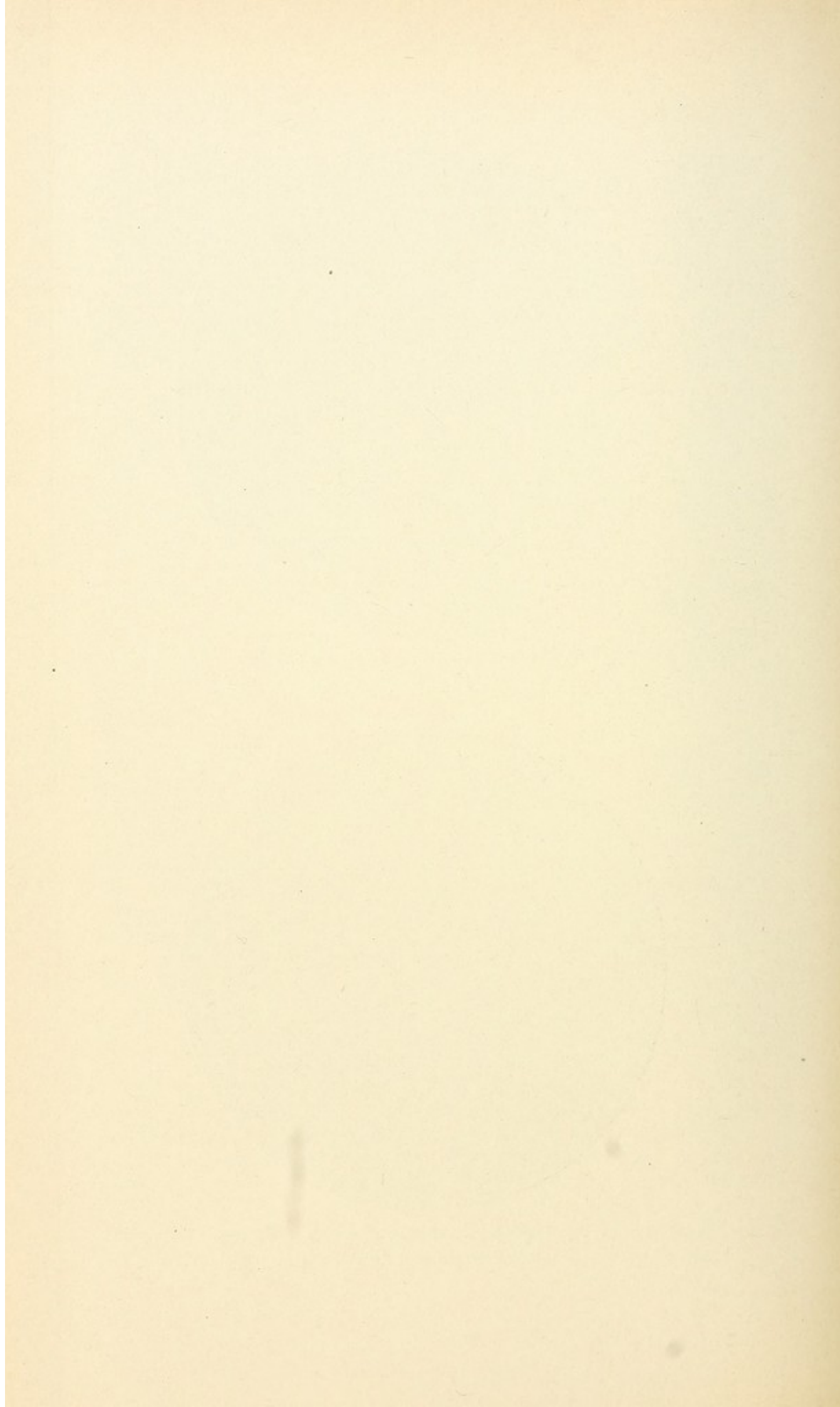
liquids as will restore and preserve the shape of the corpuscles. The following table is by Formad :

1. *Virchow or Molechott's Liquid :*
   Caustic potash . . . . 30 to 33 parts.
   Water 70   "

2. *Müller's Fluid :*
   Bichromate of potassium 2   "
   Sulphate of sodium 1   part.
   Water 100   parts.

3. *Wilbert's Fluid :*
   Bichlorid of mercury . . . . 0.5   part.
   Chlorid of sodium 2   parts.
   Water 100   "

4. *Pacini's Liquid :*
   Water 300   "
   Glycerin 100   "
   Chlorid of sodium 2   "
   Bichlorid of mercury 1   part.

5. *Ranvier's Liquid* (iodized serum) :
   Potassium iodid 2   parts.
   Iodin, sufficient for saturation.
   Water 100   "

6. *Malassez Artificial Serum :*
   Solution of gum arabic, sp. gr. 1020.
   Solution of chlorid of sodium, sp. gr. 1020.
   Solution of sulphate of sodium, sp. gr. 1020.
       Of each equal parts.

7. *Roussin's Liquid :*
   Glycerin 3   "
   Sulphuric acid 1   part.
   Water sufficient to make the liquid of specific
       gravity 1028.

8. *Robin's Solution* is a saturated solution of sulphate
   of sodium.

9. *Richardson's Salt Solution :*
   Chlorid of sodium . . . . 0.75   "
   Water 100   parts.
   Having the corpuscles isolated by this liquid, he
       stains them with a little anilin or iodin.

10. *Welcker's Fluid :*
    Glycerin 1   part.
    Water 7   parts.

11. He also used the following solution (artificial serum) :
    Chlorid of sodium 4   "
    Egg albumin 300   "
    Water 2700   "

12. *Malinin's Solution.*—Saturated alcoholic solution of
        caustic potash (90 per cent. alcohol).

The observer may now note the shape of the disks as they are separated under the action of the reagent. For this pur-

pose, for the preliminary examination, a relatively low power of amplification—say 300 or 500 diameters—is preferable. But for the main microscopic test—the measurement of the diameters—a higher power, one of 1000 diameters, is advised. With the micrometer eye-piece (1000 lines to the inch) we will determine the diameter, not of a single corpuscle, but of as many individual specimens whose outline is complete as can be found, rejecting all those which are crenated or irregular or abnormal. We can not make too many measurements. All these we will set down as we observe them, and at the end they can be averaged. If the average falls between $\frac{1}{3100}$ and $\frac{1}{3300}$ of an inch, the observer may conclude that what he has found is consistent with the belief that the stain was made with human blood; beyond that, he will not honestly venture.

Photography has come to the aid of the microscope in recent years, not only by making pictures of slide views, but by amplifying microphotographs to the size of 10,000 diameters; and very interesting contrasts are thus afforded. Single corpuscles are selected in the negative of a specimen of blood, and a microphotograph is made; a positive copy is taken, and this is then amplified to 10,000 diameters. Thus a single corpuscle of $\frac{1}{3200}$ becomes $3\frac{1}{8}$ inches in diameter. Corpuscles from other sources are treated in exactly the same way, and the results may be striking by comparison. Corpuscles so amplified appear as follows:

Human corpuscles	$3\frac{1}{8}$ inches in diameter.
Those of the guinea-pig	3 " "
Those of the dog	$2\frac{4}{5}$ " "
Those of the ox	$2\frac{1}{3}$ " "
Those of the sheep	2 " "
Those of the goat	$1\frac{3}{5}$ " "

Finally, however, we may regard the credibility of the microscope as a witness (and this is an open question for the future to settle more definitely). There are limits touching the identification of blood-stains about which there are no questions or doubts. There are no methods known to science by which we can determine, concerning a dried blood-stain, certain frequent inquiries. The expert may declare with positiveness in a given case, after various tests, chemical, spectroscopic, microscopic, of a suspected red stain, that it is a bloodstain. He may say that the microscope justified him in testifying that it may be of human origin; but he can not say from what part of the body it came; whether from a living or a dead body; whether it was arterial or venous blood; how old the person was; of what sex. If it is of menstrual origin,

PLATE VI.
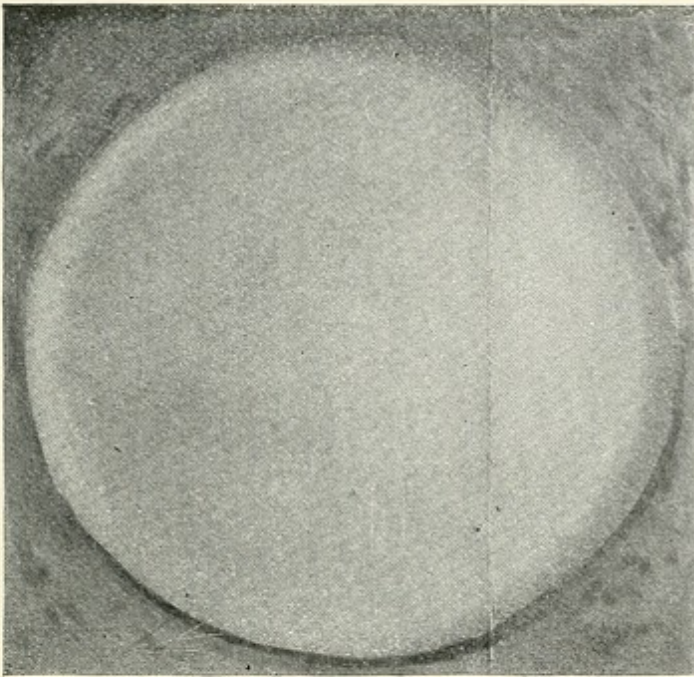
FIG. 1.—Man (1–2800), $2\frac{3}{8}$ inches.
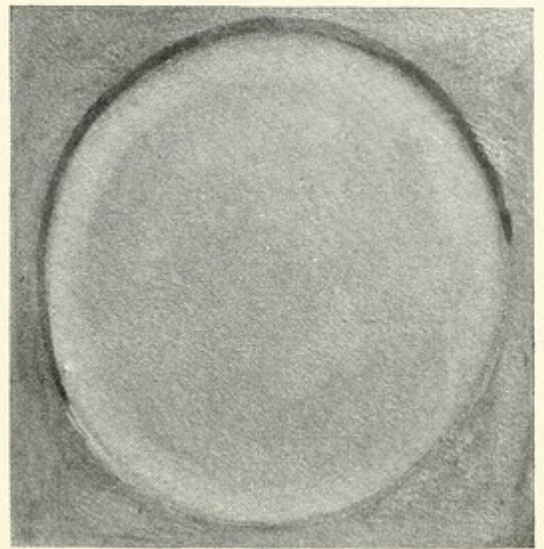
FIG. 3.—Ox (1–3700), $1\frac{1}{8}$ inches.
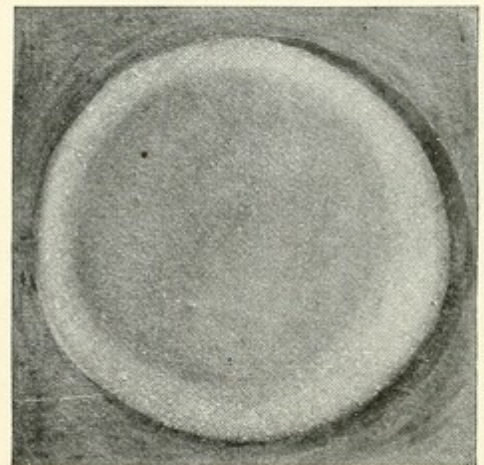
FIG. 4.—Sheep (1–4400), $1\frac{3}{4}$ inches.
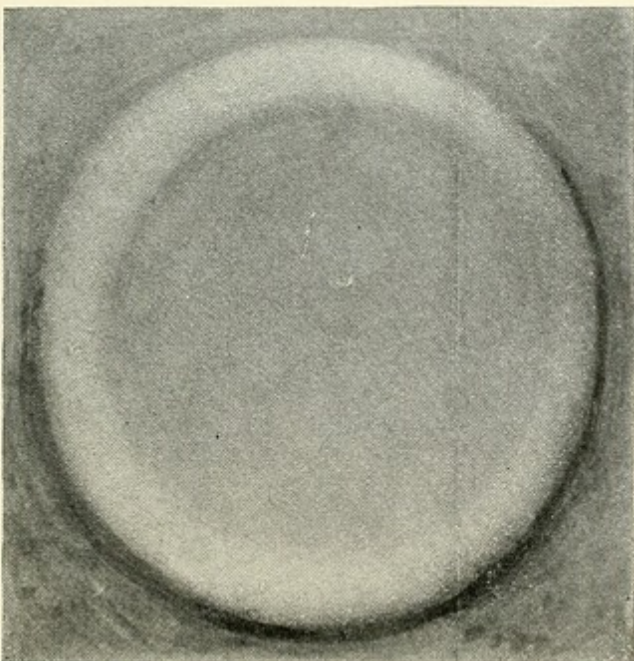
FIG. 2.—Dog (1–3000), $2\frac{1}{2}$ inches.
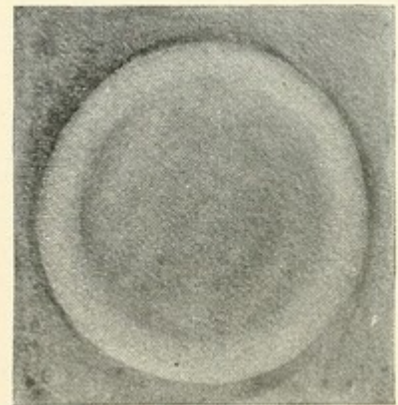
FIG. 5.—Goat (1–5400), $1\frac{1}{2}$ inches.

Single red blood-corpuscles of man, dog, ox, sheep, and goat, magnified all to the same scale, 9000 diameters. Average-sized corpuscles, selected from microphotographs made separately of each, under a uniform amplification of 2000 diameters, with $\frac{1}{18}$ Zeiss Hom. immersion, and then rephotographed all alike to amplification of 9000 diameters in each case. The gross measurement reached by each is indicated upon this plate in inches (Formad).

it would probably show an admixture with vaginal or uterine cells; if from nose-bleed, there would be epithelial cells from the nasal mucous membrane.

The Serum Test for Blood.—Recently a new candidate for favor and acceptance has been introduced as a trustworthy aid in identifying human blood in suspected stains. This is called the serum test, and the procedure, first elaborated and applied by Myers and Nuttall, undertakes to distinguish with authenticity human blood-stains from stains derived from any other source. The method bases its utility upon the behavior of specially modified blood-serum of rabbits as a precipitating reagent in the presence of human blood-serum. The modifications of rabbit blood-serum for the purposes of the test are described by Dr. Edward S. Wood,[1] as follows: "The method of humanizing a rabbit is to inject into the peritoneal cavity about 10 c.c. of human blood-serum at intervals of from two to three days, until the animal has received six or eight injections. It should be allowed to rest about a week after the last injection; the blood-serum for performing the test may then be obtained either by killing the animal, by bleeding it from one of the large vessels, or, without killing, by removing a little blood from one of the large veins of the ear. The blood thus collected should be put in a cool place and allowed to coagulate. The serum which separates from the clot may be used for performing the test.

" The blood to be tested should be prepared as follows: If it is fresh blood, it should be diluted about 1 : 100 with normal salt solution. Thus diluted it should have a light-pink color, and this diluted solution, if not perfectly clear, should be allowed to settle until it is clear, and the clear, supernatant fluid decanted into another test-tube. If the blood to be tested is a dry blood-stain, a little of it may be scraped off with the point of a knife on to a watch-glass, if the stain should be upon some hard surface so that the blood has not penetrated into the substance of the material; if the blood-stain should be upon cloth into which the blood has soaked, it will be necessary to cut out a few threads and transfer them to a watch-glass. These fragments of dried blood should then be treated with two or three drops of distilled water until the soluble portion of the dried blood has been dissolved. The clear solution is then transferred carefully to a very narrow test-tube, and to this should be added an equal volume of double salt solution. The clear fluid thus obtained, either

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[1] *Transactions of the Massachusetts Medicolegal Society*, iii., p. **161**.

by diluting fresh blood or by dissolving the blood-serum from the dried blood-stain, is then tested by adding to it a few drops of the serum obtained, as above described, from the humanized rabbit. If the human solution contains blood-serum, there will occur an immediate cloudiness which generally increases, so that there is a distinct precipitation within half an hour after the addition of the serum from the humanized rabbit. It is better to allow the antiserum to flow down to the lips of the test-tube, so as to form a separate layer under the solution to be tested, in the same way that we add nitric acid to urine in testing for albumin. In this case the cloudiness and precipitate may be seen very distinctly in the zone at the point of contact of the two fluids."

When the serum test is applied to blood-stains from sources other than human, under the conditions above set forth, the results shown by the application of humanized serum from rabbits are negative. Thus, solutions of blood from the dog, pig, ox, and sheep, for example, even the blood from other rabbits used as material for testing experimentally, failed to react to the rabbit antiserum. Various observers have conducted a long series of control tests, making comparative experiments with different kinds of blood, and they have found that the antiserum from the rabbit, prepared with human blood, gave satisfactory results in nearly every instance. Stern found, in 1901, that the blood of the humanized rabbit reacted feebly with the diluted blood of three species of monkeys. In 1903, Austin found experimentally certain limitations and restrictions which, he felt, impaired the credibiliy of the serum test to an appreciable degree.[1]

It is manifest that the value and utility of the serum test rest on its uniform and unfailing ability to do what it claims. If any doubt impairs this ability, the entire process suffers. If a man's life is in the scale, he may well demand proofs which are beyond reasonable doubts to convict him of alleged homicidal violence. A conservative and judicial reserve is, for the present, the best frame of mind in which to regard the serum test for blood as a medicolegal innovation.

[1] *Boston Medical and Surgical Journal*, March 12, 1903, p. 279.

CHAPTER XXVI.

DEATH BY ELECTRICITY.

IT is a noteworthy fact in human experience that forces and agencies which have been found useful to promote the most beneficent ends and to enhance man's comfort and convenience possess possibilities of the greatest harm. The mountain stream whose waters are impounded to make a wholesome water-supply or to turn the wheels of industry in a populous and prosperous community may take advantage of a contractor's blunder, and, breaking its artificial barriers, may rush down the valley carrying death and devastation in its terrific descent. Steam, under control, aids efficiently in industrial progress and in enlarging human happiness; but it has within itself a potentiality of destructive mischief which requires vigilant care to keep it within harmless limits. The mysterious fluid which we call electricity is being daily put in harness for the drudgery of useful service and hard work; but it delights in its ability to make spasmodic demonstration of its power to shock and to kill, frequently using the most unexpected tricks to serve its end.

Legal medicine has always regarded the fatal effects of exposure to natural forces as properly within the scope of its interest. There are several good reasons for this. Not infrequently deaths due to such causes are *indirectly* the result of human negligence, and the element of crime may be included. Again, such deaths overtake their victims with a suddenness which justifies a careful inquiry into the circumstances, and this inquiry is best made by the State's agents. Then, too, the victims are often destroyed when they are alone, away from home and help, and the finding of their dead bodies thus isolated calls for an investigation to eliminate the element of human agency, and to establish the fact that the forces of nature were alone the cause.

The writer asks attention in this chapter, therefore, to a consideration of death from heat and electricity, and he will take up, first, the latter of these two topics, because it has most contemporaneous interest. In this study he will limit himself to such effects of electricity as are fatal. Electrical accidents

from which the victim survives and recovers are interesting, but they are outside the scope of medicolegal interest. They are usually the subject of clinical observation and care, and will receive here only incidental attention, if any. It will be unnecessary, also, to spend any time upon the purely scientific relations of electricity, or upon an explanation of its technical terms, or upon the laws of its action, dynamic or static. We are concerned rather, with its effects and with the readily recognized manner in which those effects come to pass, without reasoning too closely as to fundamental theories.

The most frequent source of danger from electricity is in those mechanisms and appliances used in generating and distributing the artificial product. The currents used for mechanical purposes—for electric lighting, railway traction force, and the like—are the ones to be considered in this connection. These currents are derived from dynamos or storage batteries, and accidents are caused by them whenever, being diverted from their normal course along established wires, they pass through any part of the human body. Accidents also occur from direct contact with the batteries or dynamos, but most often the current is taken from the *distributing* system directly. Still another possibility of grave harm is in contact with metallic or other readily conducting objects which have received from an adjacent electric circuit the whole or a large part of the current, and, being thus charged, are a menace to life, the more serious because they show no sign of warning.

As a rule, those who receive shocks from dynamos directly are employés of electric companies, and are presumed to have a knowledge of the deadly character of the agent they are using and to be sufficiently warned as to the danger which lurks in heedlessness. But familiarity is the mother of carelessness. Many of the accidents on the line of wires, also, number workmen among their victims. Electric lamp trimmers, linemen, painters, and roofers, people, in other words, who go upon the tops of buildings and other structures to make repairs—these are generally the ones to suffer. So long as the wires transmitting the current are properly insulated and in their proper position with reference to other conductors, accidents are unusual. But, unfortunately, these safeguards are not diligently looked after. Proper insulation is not provided; and insufficient care is taken about placing wires designed to carry powerful currents so that they shall not touch a non-current-bearing, ordinary, harmless wire and make it the carrier of a dangerous force. The current, in this case, having once passed out of its proper circuit, of course follows the path of

best conduction, and so may suddenly appear at unexpected points and announce itself by the most alarming and even fatal effects.

As to insulation, it is well known that electric wires carrying very powerful currents can be insulated and can be kept safely insulated if sufficient pains and sufficient money are expended. But this life-saving expedient is not attended to as it deserves; only partial insulation is attempted. In most cases the wire is inclosed in a so-called insulating material which is either insufficient at the outset or soon becomes so after exposure to the weather, and a false sense of security is the result. And in installing a circuit insufficient care is taken to cover exposed *wire-ends*, and so to place the glass or porcelain insulators that the current shall remain in its own place.

How small a point of contact is enough to determine immediately fatal results under favorable conditions as to potentiality of current, condition of the victims, etc., is illustrated by a case which came under the writer's observation in November, 1895: A painter, in robust health, was at work painting an iron smoke-stack. He had used a ladder for the higher part of the work, but lower down the shaft an iron standard with iron cross-bars carrying electric light wires was conveniently near, and he left his ladder and sat upon one of the cross-arms. The wires were of the usual form, covered with insulating material and carrying a current of 2000 volts, normally; but on this occasion having an accidental charge of 4000. While he was in this situation and before his work had been resumed, his fellow-workman, standing below on the ground, heard a hissing or sizzling noise and an exclamation, "Oh! Oh!" Looking up, he saw his companion in a constrained and rigid posture. The man was immediately rescued from this situation, though not without considerable force, and there was no sign of life in him when he was let down to the ground. His left hand was severely burned between the thumb and index finger; there was also a much smaller burn on the side of the right middle finger. On examination it was found that the point from which he had received the current from the wire was an uncovered end of the wire, which had been left exposed in making a reverse twist around a porcelain insulator on the pole. The right hand had completed the current by coming against the iron standard, thus grounding the electricity.

The Symptoms and Effects of an Electric Shock.— What are the effects of the passage of a strong electric current through the human body? What happens when the human body or any portion of it becomes a part of the circuit? The

answer will differ somewhat according to the current ; whether it is constant or interrupted, continuous or alternating.

When a shock is caused by a continuous, constant current from an ordinary dynamo or other electric generator, it is caused by the opening or closing of the circuit ; or, what is essentially the same thing, the diversion of a part or the whole of the current from its proper path to and through some portion of the human body causes a shock at the moment of the entrance of the body into the circuit and another at the moment of its exit therefrom.   While the current is continuously passing through the body, although it may burn and cause other unpleasant effects, there is no proper shock.

With the alternating currents, the currents in use for street lighting, or wherever the arc lamp is employed, we have a different state of things.   The general principles are exactly the same ; but, inasmach as the reversal shock is stronger than the closure or the opening shocks of a constant current, we have, in an alternating current of the same force as a constant current, a stronger effect.   Moreover, since in the alternating machines the reversals occur with great rapidity, the person whose body is a part of the circuit gets a great number of strong shocks in a brief time.   It is in the shocks from those wires carrying the alternating current, therefore, that the greatest danger lies.

With other forms of electricity than those just described, we have no present interest.   Faradism, galvanism, and static electricity, which are used therapeutically or for purposes of diagnosis, rarely occasion serious accidents.   Never, so far as the writer is aware, do fatal effects follow their application.   We are concerned only with those currents which are taking such an important place in our life of to-day for mechanical and illuminating purposes, which, because of their very novelty, are not yet made subject to proper supervision by public authority.

Although the placing of wires under the ground has many obvious advantages, it must not be inferred that even this method offers an absolute guarantee of safety from accidental fatal shocks.   The current may be diverted from underground wires to gas-pipes or water-pipes or to any other conductors accessible to it.   Shocks have been felt by persons who have for the purpose of drawing water touched the metallic faucet upon a pipe thus charged.

There is one source of danger from electric light wires strung overhead which is not sufficiently recognized by persons generally.   It is popularly understood that the wires which carry electricity to the street arc-lights are the *dangerous* ones, while

the current to the Edison or incandescent lamps—the bulbs used ordinarily within doors—is insufficient to do harm to any one. That is true as a general statement. But it is not generally appreciated that for prudential, economic reasons it is the custom to convey currents of high potentiality from the central station where they are generated, to the outlying regions where they are to be used, and at these latter points, before their introduction into buildings, to change them by a reducing appliance, called transformers, so that within the building the electrical circuit suffices simply to bring the carbon filaments to a white heat.

It is a wholesome rule, which all persons will find safe and salutary, to regard with respectful distrust every wire which by any possibility has a connection directly or indirectly with a dynamo. This includes every wire which is strung along poles in the streets or over the roofs of houses. We never know, by any outward sign or condition, whether the harmless-looking strand is " dead " or whether it is exceedingly alive and carrying a current of electricity amply able to kill the one who heedlessly touches it. The wisest course is not to meddle with any wire which, however dead it may be presumed to be, is in bad company.

The external visible effects of the passage of a strong electric current through the human body are two in number:

1. **Muscular Contraction.**—The muscles which come in contact with the wire or other conductor immediately contract and remain so while the current continues to pass through them. If it should be the hands which are involved, the fingers are forcibly and uncontrollably closed on the wire and can not be loosened by any voluntary effort of the victim until the current is stopped. Under these circumstances any attempt by an outsider to release the prisoner requires much force, and it is done at considerable risk of a secondary shock to himself. Not only the muscles in immediate contact with the conductor are thus tetanized, but nearly all the voluntary muscles of the body may be involved. Therefore, the muscles of the trunk and limbs may be suddenly contracted and the person thrown violently upon the ground or against some object—thus causing serious injury. Sometimes the force is enough to fracture bones, dislocate joints, and rupture muscles or tendons.

2. **Superficial Burns.**—The other objective, visible effect of an electric shock is in the form of superficial burns—that is to say, burns on the surface of the body. The extent and gravity of these lesions depend on the degree of resistance which the tissue receiving the current—the skin—offers to the

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passage of the electricity. It has been found experimentally that of all the tissues, the skin offers the greatest resistance, and when perfectly dry it is able to present a barrier to currents of great strength. This explains the need of moistening the skin for the contact of the electrodes in the therapeutic use of electricity; and it explains the character and severity of the burns peculiar to the electric current. If the resistance of the skin is slight at the moment of entering the circuit of a strong current, the current will pass through it with comparative ease and without causing much injury. But if, on the other hand, the skin is dry and its resistance consequently great, the cur-
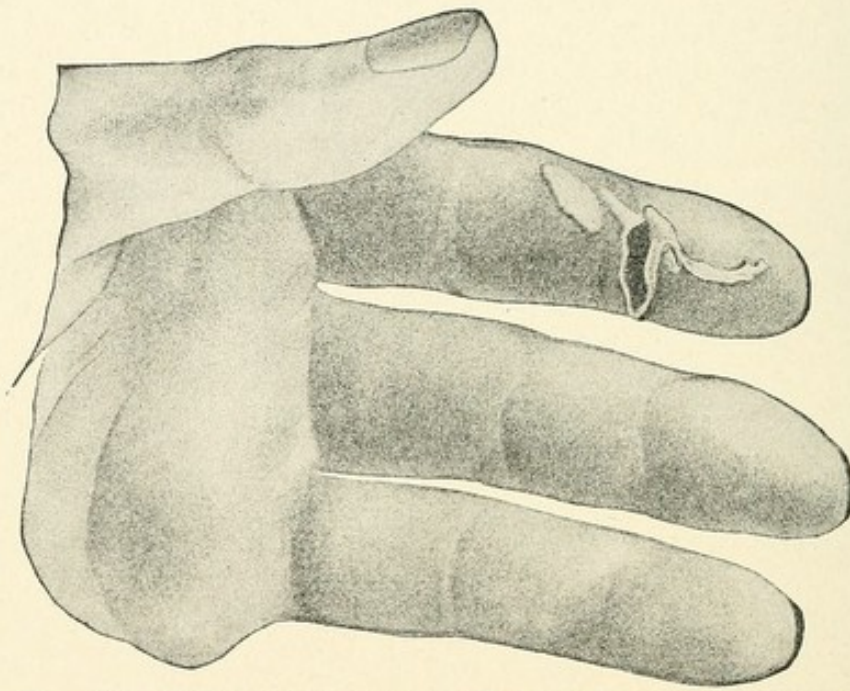
FIG. 31.—Burn of electrical current of 1800 volts and 14,000 volt-ampères, showing two blisters, one broken, at the site of the entrance of the current (Kratter).

rent will be retarded, heat will be developed, and there will ensue the characteristic burning and charring at the point of entrance and sometimes, also, at the point of exit of the electricity. In its most marked degree this burn is a deep eschar, with clearly defined, but not very regular, edges, giving the shape of the contact, and showing in its deeper parts a mass of blackened and roasted tissue, at the bottom of which tendons and other tough fiber may be seen crossing the bottom of the crater. The most common situation for these burns is on the hands, and especially the palms, this being the part most readily coming in contact with the "live wire" or other conductor. They may be found, however, in other parts of the body, wherever the current is admitted or dismissed.

Besides these objective evidences of the passage of an electric current of fatal potentiality through the body, there is the subjective effect, the instantaneous loss of consciousness, which is a characteristic symptom. If this loss of consciousness does not betoken a shock that is immediately fatal (and this instantaneous fatality applies to nearly all the cases which come within our present view), it may be accompanied and followed by a condition of collapse with perspiration, cold extremities, and feeble pulse—all calling for active stimulation and artificial respiration. The face is reddened and rather cyanotic; the pupils are dilated; and the respiration is stertorous, or nearly absent. This condition may last for hours before death; or death may be so early in possession as to render useless at once the efforts at restoration which in the other event are justifiable.

Electrocution in Judicial Cases.—The physical phenomena of a fatal electric shock have been studied, under favorable conditions, in the execution (in New York and Massachusetts) of murderers sentenced to death by this method. The culprit is securely strapped in a heavy chair; an electrode is adjusted so as to include and cover the forehead and temples; another electrode is applied to the leg; burns are prevented by keeping the skin wet. An alternating current of from 1450 to 1700 volts is opened, and maintained for from ten to fifty seconds; and for the purpose of making the fatal effect sure, this transmission of the current through the man's body is repeated two or three or more times. The effects which are caused are these: The instant the man's body becomes a part of the circuit, all the muscles are violently contracted; the whole body is straightened and made rigid; the face grows red and turgid; all consciousness is immediately lost, without chance to return. The body remains in this rigid, tetanic, and stiffened state until the current is broken, when all the muscles relax and the man's body sinks back into the chair in a state of complete muscular collapse. It may be found that at the end of this first contact there will be slight spasmodic movements of the chest, or possibly some irregular heart-beats, or fluttering radial pulse; in which case the current is renewed, with precisely the same phenomena. Some incredulous critics have indulged in an unprofitable discussion as to the possibility of restoration under these conditions. When the first case of restoration occurs and justice is cheated of its victim if will be time to interfere.

Anatomical Appearances in Electrical Shocks.— What are the post-mortem appearances after a death by elec-

tric shock? Are there any which are representative and conclusive? So far as the external signs are concerned, the burns on the hands and elsewhere are characteristic; and they are really the only significant, external evidence. They have been previously described. Rigor mortis has been believed to be an exceptionally early change, so early, indeed, and so transient, as to be regarded by some as not to have appeared at all. Autopsies on the bodies of men electrocuted revealed rigidity to be not radically unlike that ordinarily observed in time and degree. The bodies of electrocuted criminals have not shown any remarkable internal changes due to the passage of the electrical current in fatal force. A few minute, subpericardial or subpleural petechial spots have been observed. The organs have not been found to be extremely congested, and the vessels of the spinal cord and of the brain showed nothing extraordinary. The blood was dark and fluid. Microscopical examination failed to reveal any abnormal changes in the tissues or organs of the body examined.

Lightning.—The writer has remarked that the most frequent source of danger from electricity was found in the agencies for the manufacture, distribution, and use of this force, or fluid, or whatever it is, as an artificial product. But we are not limited to this in our study. The manifestations of energy shown by the natural variety are far more striking, if less frequent, than the fatal effects of shocks from manufactured electricity, and deaths by atmospheric electricity or lightning have an impressive interest peculiarly their own. Although these deaths are not numerous, considered comparatively, especially in our northern latitudes, they are sufficient to justify our attention for a few moments.

From the Weather Bureau Records (McAdie), it appears that in the United States, for the five years 1890 to 1904, 1120 lives were lost, or an average of 224 lives annually, in the whole country. This mortality was limited to the six months from April 1st to September 30th. It was greatest in the southeast section of the country. These data have been compiled and studied with much care by Professor McAdie of the Weather Bureau; and it will be instructive to add a few of his interesting conclusions in the way of a general consideration of our subject before passing to more special treatment of it. Professor McAdie calls attention to these facts: That lightning-stroke risk is five times greater in the country than in the city. That among the trees, the oak is the most frequently struck and the beach the least frequently. That trees struck are most generally those standing in the clear or at the

edge of forests. That it is not judicious to stand under trees
during thunderstorms, in the doorways of buildings (espe-
cially barns), or close to cattle, or near chimneys and fire-
places. On the other hand, there is not much sense in going
to bed or trying to insulate one's self in feather beds. Small
articles of steel, also, do not have the power to attract light-
ning, as it is popularly put, or to determine the path of dis-
charge. That, apart from the nervous depression which is
often experienced just in advance of thunderstorms, and which
is purely subjective, there is, besides, an apprehension or
alarm which is not necessary or well-founded. Grant that the
lightning may strike close to you or in your vicinity; there are
many flashes that are of less intensity than we imagine, dis-
charges which the human body could withstand without
serious or permanent results. One who lives to see the light-
ning flash need not concern himself much about the possi-
bility of personal injury from that flash.

A few other general considerations may be of interest as
preliminary observations: 1. Experiments show that the
lightning flash represents $\frac{1}{20000}$ part of a second. For this
reason, this brevity of duration, objects in motion when
observed by the flash appear motionless. 2. A flash of light-
ning represents a potential of 3,604,000 volts. 3. A large
majority of the victims of lightning are men, and the accidents
occur out of doors. 4. Lightning does not invariably take
the path of the least resistance in passing from cloud to earth;
it will sometimes forsake a relatively good conductor and
spring across a stratum of air which offers a resistance many
thousand times greater than the conductor which it has left.
5. The flash of lightning is the core of the electric discharge
—where its influence is at the maximum. On every side of
this central line is a zone or peripheral region of danger, within
which damage may be done.

What happens when a living human body is in the way or
course of a discharge of atmospheric electricity seeking to
reach the earth from a cloud? The consequences of such an
undesirable situation are so various as to seem almost para-
doxical. The freaks and vagaries of what we call a lightning-
stroke are extraordinary. Authentically recorded cases repre-
sent effects diametrically opposite in character, yet clearly
attributable to electric phenomena only. A recent writer (Dr.
John L. Sullivan [1]) thus graphically describes these effects on
the human body: " Lightning may heal as well as harm; it may
abolish sight, hearing, and the power of voluntary motion, or

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[1] *Transactions of the Massachusetts Medicolegal Society*, i., p. 142.

it may restore the lost senses and cure paralysis. It may strip the body naked and consume the clothing while the wearer escapes unhurt; or it may consume the individual and leave his garments untouched. One person who is fatally struck may be hurled violently to a distance, while another is left in the precise attitude and spot in which death surprised him. One case will present extensive anatomical changes, such as amputation of limbs, rupture of the heart, comminuted fracture of the bones; while in another case no injury whatever will be detected. One autopsy will reveal softening of muscles, collapse of the lungs, fluidity of the blood; and in another case exactly opposite conditions will obtain: engorgement of the lungs, coagulation of blood, and muscular rigidity. One cadaver undergoes rapid putrefaction; another remains for days unchanged, as if in defiance of the laws of decomposition. There may be sudden incineration of the body, or it may be consumed slowly, as if by spontaneous combustion. One subject will present all the signs of death by freezing; another, those of instantaneous petrifaction. Lastly, the immediate disappearance of the stricken person, without leaving a trace of his body or any of its parts has been an incident of record."

The following recorded example will illustrate the extraordinary vagaries of lightning: Mr. Wilks,[1] of Ashford, records that on June 8, 1878, four laborers were overtaken by a thunderstorm. Three of them took shelter in a shed while the fourth remained outside to urinate. Scarcely had the men entered the shed when the window was blown out by a " blaze of lightning," and when the three men went to look for the fourth, they found the tree, against which he had stood, stripped of its bark, his boots at the foot of the tree, and the man himself lying naked two yards off, with nothing on him save part of the left arm of his flannel shirt, although two minutes before he had been completely clothed in a coarse suit, including a pair of new hobnailed boots. The clothing was scattered about the ground in all directions. The man stated that while passing water he felt himself hurled in the air, but never lost consciousness. The eyebrows, whiskers, and beard were scorched, and the chest and belly displayed branching burns. Down each thigh and leg was a long burn. In the right heel was a wound through which could be felt a comminuted *os calcis.* There was a compound fracture of the right leg. The man made a good recovery.

With reference to his clothing, it was observed that the

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[1] *Medical Times and Gazette,* Nov. 1, 1879, p. 515.

jacket was split in two, and the shirt was torn to rags, and burnt where it had touched the buckle of the waist belt and the watch in the fob. The flannel vest was torn, and the trousers were in two bits, all below the knees being torn to ribbons. The belt buckle had burnt out. The boots had completely lost their laces; the eyelets were burst in places; the leather was torn; the right sole was rent and the right heel partly torn off and one nail missing. The watch was burnt through as with a soldering iron, and the chain almost destroyed. The man stated that he habitually raised his right heel when he urinated, and this helped to explain the queer course and vagaries of an interrupted electric current.

This variety in the recorded effects has its explanation, in a measure, in the differences which characterize lightning itself in its manifestations—differences which represent diversities in quantity and intensity of the electrical discharge. Sheet lightning, zigzag lightning, and ball lightning are terms used in scientific and popular language to designate the usual manner in which lightning displays itself. Of them all, ball lightning is probably the most destructive, because it is so violently explosive.

Anatomical Appearances of the Lightning-stroke. —When a human body has received a fatal lightning-stroke, what lesions are found upon or within the body as data for a post-mortem diagnosis? Recalling the fact that there is very great diversity in these effects and that a dead body may show many of them or none of them, we find that these injuries may be classified as: Burns; ecchymoses; erythematous markings; impressions of metallic substances on the skin; injuries to the hair; fracture of bones; lacerated wounds and punctured wounds; together with more or less characteristic internal change in the tissue. We will consider some of these a little more in detail.

Burns which have been observed after lightning-stroke differ in degree from mere superficial scorchings to extensive cauterizations or eschars. Their situation generally marks the track or course of the electricity from the head to the feet. Thus, these effects are found on the back, buttocks, and lower limbs of the person—sometimes, also, on the face and chest. Sometimes they assume a characteristic form, appearing as spots in which the skin resembles leather shrunk by the action of great heat. These various burns have been clearly shown to be the action of the electricity itself acting directly on the skin and not indirectly through clothing on fire. Numerous cases have been recorded of burns observed without any burning of the

clothing. At times the burn is at some distance from the point at which the electricity entered the body or found exit. Burns are found to be more severe and deep under metallic substances worn or carried about the clothing and becoming intensely heated by the current. The usually superficial characteristic of the burn represents the extremely rapid passage of the electrical current. The current is too quick to burn. It is analogous to the effects of the white-hot actual cautery, passed very quickly over the surface. If the burn is of deeper degree, its situation is either in close relation with metallic
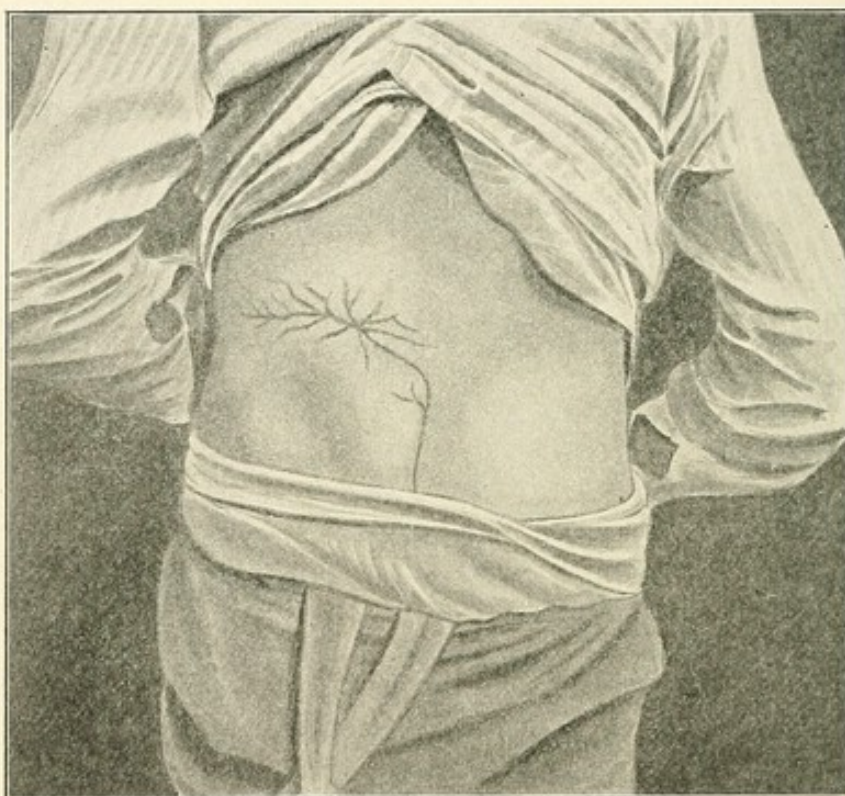
Fig. 32.—Lightning-marks (*International Text-Book of Surgery*).

bodies or it is beneath those parts of the clothing which are worn more tightly—as at the waist.

Simple ecchymoses and livid patches are found at times. The color of the spots is sometimes blue, sometimes red. They appear most distinctly over bone, and resemble the usual effects of a blow. Sometimes they are in long and narrow form, marking the passage of the current. These are especially common along the back, parallel with the spine. Sometimes these ecchymoses take the shape and mark the position of coins and other metallic substances in or about the clothing. It happens, too, that sometimes the heat is so intense as to fuse the coins together, and under these circum-

stances there is occasionally a metallic deposit on the skin beneath. The value of this in diagnosis is obvious.

Most people have heard, no doubt, of those strikingly curious, finely traced, arborescent markings, sometimes found on the skin. The imaginative, popular interpretation was that these markings were a more or less accurate representation of the tree under which the victim was standing when struck. This explanation is more fanciful than scientific. The resemblance is, as a matter of fact, remote at the best. Beccaria, more than a century ago, had another explanation, which has often been accepted as the true one. He said these arborescent tracings were marks left by the electricity in its passage through the smallest venous radicles under the skin, with arrest of the circulation in the fine channels involved. More modern authorities (Mann, etc.) say that these fine markings are not determined by blood-vessels at all, nor do they correspond with them; but they are made by what are called "divarications" of portions of the electrical discharge, producing a kind of erythema, indicating the paths taken by the electricity in the skin. They resemble in appearance and causation the well-known Lichtenberg figures of experimental electricity on plates. They are mostly found on the arms and the trunk, and they are almost conclusive of the lightning-stroke character of the death. Dr. Vivian Poore[1] suggests that they follow the irregular deposit of sweat moisture on the skin.

Wounds, like burns, occur usually at the points of greatest electrical resistance—that is, the places of entrance and exit, but they are not limited to these situations. They sometimes appear as clean-cut as if made with a sharp knife; again, they are lacerated and ragged, with edges bruised, torn, or burned. Sometimes they have an appearance as of holes, the punctures looking as if punched out.

If fractures are found, they represent—not the force of the electrical discharge upon the bone itself which is found injured —but the force with which the victim is thrown bodily against other objects, or the impact or pressure of heavy bodies, like the trunks or branches of trees, or the timbers of dwellings, struck and shattered by lightning. Like the contusions sometimes found, they may represent the violent way in which the electric discharge tosses its victim about, but more often they suggest blows from other sources.

The eyes sometimes become the seat of structural changes in fatal lightning-stroke. Rupture of the choroid, hemorrhage

[1] *Medical Jurisprudence*, p. 380.

from the choroid and retina, partial detachment of the retina, injuries like burns in the conjunctival epithelium, organic changes in the deeper parts of the conjunctiva, and instantaneous opacity of the cornea, giving it a bluish tint, have been observed. One pupil may be contracted and the other normal or much dilated. The contracted pupil marks the side on which the current has passed down the body from the head.

The internal changes from the normal which a lightning-stroke leaves in the organs and tissues are neither constant nor very characteristic. The heart sometimes displays some minute hemorrhagic dots upon its surface; generally there is engorgement of the right cavities. The blood in the heart and great vessels coagulates slowly—so slowly, indeed, that John Hunter laid down the dictum that it did not coagulate at all after lightning shock. In every death by lightning the color of the blood is found abnormally dark, but exposure to the air brings back the fresh arterial hue. In that extreme effect of complete disorganization, which is sometimes observed after the severest form of lightning shock, the blood appears to be thoroughly changed; it is almost black and gases are set free, as if very early decomposition had begun.

The lungs are usually unchanged; congestion is not common. Sometimes subpleural ecchymoses of small size are observed and are said to indicate the course of the current.

The alimentary tract is regarded by some authors as an excellent conductor of the electric current, and some abnormal appearances are ascribed to it. The walls of the stomach have been found ruptured, or reddened, or even softened, as in the earliest stage of gangrene. The intestines are sometimes intensely injected, showing a dark purple color, and suggesting sometimes the effects of irritant poisoning.

Rupture of the structure of the liver has occasionally been observed. The chance that this may have occurred by external traumatism, like a blow from a falling body, should not be forgotten. Congestion of the liver is not unusual.

The vessels of the peritoneum are injected, and lines of dark ecchymosed spots along the surface of this membrane appear to mark the direction of the current in some cases. The kidneys are found injected, but do not manifest any other change.

The brain generally shows the changes due to an over-supply of blood, if it shows any changes. The vessels and sinuses are congested. Sometimes, within the arachnoid spaces, a thin layer of blood may be found effused. Occasionally, larger apoplectiform hemorrhages are found. Exceptionally, much

more severe effects are found in the brain. Tidy reports two cases in which there was complete disorganization of the cerebral substance. The spinal cord usually escapes injury, and its vessels are not turgid.

The clothing worn by the subjects of lightning-stroke often represents, in its condition when the body is found, the wildest electrical vagaries. Sometimes it is set on fire; sometimes it is torn to shreds and stripped from the body, leaving the individual nude or nearly so. If the clothing is wet, it may serve as a more ready conductor of the current, and the person's life be saved. The amount of injury to the clothing does not necessarily measure the degree of injury done to the body. A person may be killed by lightning and his clothing show no mark of harm; or his clothing may be entirely ruined, partially burned, or scattered widely, while the body which it covered escapes.

Of all the portions of the clothing, perhaps the coverings of the feet are the most liable to injury, as the electricity is apt to take that course in leaving the body, and the resistance (speaking electrically) is considerable. Hence the boot or shoe frequently shows evidence of this exit. Sometimes the leather is pierced as if by a bullet; or a large rent is made in it; or it is torn to pieces, or thrown from the foot, leaving the latter either burned or uninjured. Sometimes, too, the leather is shrivelled and burned.

The author has mentioned the fusion and coalescence of coins carried in the pockets and lying in the way of the current. Another noteworthy effect is the magnetic polarity acquired by steel articles, like pocket knife-blades.

CHAPTER XXVII.

DEATH BY HEAT.

FROM the review of the fatal operations of electricity, the writer passes to some considerations relating to death by extremes of temperature. First, as to the effects of extreme heat. Legal medicine has an interest in the fatal cases only because these may occur with a suddenness and in situations and circumstances which call for an investigation to eliminate unlawful violence. Our chief duty, then, is to emphasize those data which help us in making a post-mortem diagnosis upon bodies found dead. With the treatment of cases under clinical observation we are not now concerned.

Nearly all the cases of fatality are the result of accident or indiscretion. In one case, recorded by Taylor,[1] the captain of a vessel was indicted for manslaughter in causing a man to be lashed near the stoke-hole of a steam furnace in the hold of a vessel; the man died, apparently from the effects of this exposure. The author knows of no other case in which the effects of great heat have been charged as a means of homicidal violence. The principal use of knowledge on this subject is to enable the investigator to eliminate the element of violence.

Exposure to excessive heat brings about two distinct resulting conditions in the human body—and these are in sharp contrast: 1. The first of these is a condition of profound exhaustion. The attack may come on slowly or it may be abrupt and alarming. Those in robust health are attacked as well as those of impaired vigor. The pulse is rapid and feeble; the surface cool, the temperature subnormal; the voice weak; the mind is usually clear, though unconsciousness sometimes occurs; the muscular strength is gone, and the relaxation is marked; the exhaustion is extreme, and syncope may follow. It is a state of collapse with palsy of the vasomotor system.

2. The second and by far the most common condition resulting from heat exposure is a true thermic fever. Its synonyms —sunstroke, insolation, sun fever—suggest that out-of-door exposure to the direct rays of the sun is necessary to place the victim in real jeopardy. But there is abundant clinical

[1] *Principles and Practice of Medical Jurisprudence*, ii., p. 137.

evidence that such is not the case. Bonniman[1] says : " By far the greater number of cases that occur yearly in India are of men who have not been exposed to the sun. It is not unusual for men to go to bed in apparent health and to be seized during the night; and patients in hospitals, who have been confined to bed for days previously, are frequently the subjects of attack." In our own community, indoor workers—employés in bakeries, laundries, and sugar refineries—are often overcome. Thus we may describe the general condition as " thermic fever " or " heat-stroke," or the effects of exposure to heat. And if the exposure has been out of doors and to the heat of the sun, it is correct to speak of the effect as sunstroke or insolation.

Although the immediate cause of the attack is exposure to extreme heat, there are several factors which deserve mention as efficient allies of the heat in bringing the victim into danger. These factors need hardly anything beyond their enumeration, they are so obvious. The subject of a heat-stroke has his chances of recovery lessened and his risk of dying increased if he has indulged in physical exertion while exposed. Heat exposure wants no better ally than muscular fatigue to bring its victim down. Intemperance is another agency which forcibly coöperates with heat to establish an unfavorable prognosis. Men far outnumber women as victims because their exposure and kinds of work predispose them. Similarly, the laboring classes are more commonly stricken than their prosperous and more careful neighbors.

It is prolonged exposure to heat which does the mischief. When, in mid-summer, a hot wave of several days' duration succeeds a period of seasonable, temperate weather, it is during the later days of the heated term that the death-rate from heat-stroke becomes significant; and the sudden and rapid change from temperate to very hot emphasizes this effect. It seems to disarrange that marvelous heat-regulating power of the body, which keeps the normal body-temperature close to 98.6° F. through all sorts of conditions.

That something more than simple elevation of temperature is required to do harm has been demonstrated by the cases of immunity under temporary exposure to excessive heat which have been recorded. Woodman and Tidy[2] say : " It is difficult to place any limits to the degrees of heat short of being absolutely burned or melted to death, which may be temporarily borne by the human body." In Turkish baths, properly administered and with carefully graded approaches

[1] Pepper's *System of Medicine*, v., p. 389.   [2] *Forensic Medicine*, p. 978.

to the maximum, persons have been able to endure a heat above the boiling point of water. There have been exhibitionists who, styling themselves " human salamanders," have demonstrated their ability to bear great heat. Martinez, a French baker, used to entertain the public by going into an oven heated to 338° F., and remaining there as long as fourteen minutes. Chamouni—" The Incombustible "—got his title by entering an oven carrying a raw leg of mutton and remaining there until the meat was well cooked. He eventually lost his life in one of these exhibitions.

In 1760 and 1761, Duhamel and Tillet were appointed to devise some method of destroying an insect which consumed growing grain in one of the French provinces. In their experiments to ascertain the precise degree of heat required to kill the insect, without hurting the grain, they were puzzled to invent a method for determining the temperature at the farther end of the great ovens which they were using. One of the girls employed in the laboratory offered to go into the oven and to mark with accuracy the height at which the thermometer stood. She remained in the oven two or three minutes, the thermometer marking 100° Reaumur, or nearly 260° Fahrenheit. She said she felt no inconvenience, and to demonstrate it she stayed in the oven ten minutes longer, during which the mercury reached 288° F., or 76° above the water-boiling point. On coming out of the oven her face was red, but her breathing was not quick or laborious.

Another girl remained in the oven as long as the first did, at the same temperature and with the same impunity. Indeed, for five minutes she breathed air heated to 325° F., or 113° above that of boiling water.[1]

Tillet speaks of a number of servant girls, employed by a baker, who endured a temperature of 270° F. for fifteen minutes; 279° for ten minutes; and 364° for a few minutes not recorded.

In the *Glasgow Medical Journal* for 1859 there is an account of a baker's girl who remained twelve minutes in an oven at a temperature of 274°.

Chantrey, the sculptor, and his workmen are said to have worked in a furnace oven at a temperature of 320°.

Dr. Fordyce and Dr. Blagden made some observations on themselves regarding this matter. They entered rooms artificially heated to a temperature of 240° and 260°, and stayed for a considerable time without difficulty. They found that the body heat as registered by the clinical thermometer under

[1] Watson's *Practice of Physic,* i., p. 106.

the tongue was scarcely increased. The respiration was but little affected; the pulse was much quickened. Their watch chains and other pieces of metal about them became so hot that the hand could not bear to touch them. When they breathed on a thermometer the mercury immediately sank several degrees. They cooled their fingers by breathing on them. In the same air which they breathed eggs were roasted hard in twenty minutes.[1]

In these cases of tolerance of excessive heat, as in the cases of impunity under ordinary summer exposure, much of the ability to endure is due to a *dry* condition of the atmosphere. A heat easily borne if the air is not saturated with moisture, is intolerable under the opposite conditions. And it is under these conditions that very many of the fatal sunstrokes occur, the evaporation from the skin in the form of perspiration being interfered with, and thus the action of the chief cooling agency being neutralized.

Some have maintained that the presence of an unusual amount of electricity in the heated air is favorable to the causation of insolation. But of this there is no conclusive proof.

Symptoms of Thermic Fever.—In a case of fatal sunstroke or thermic fever, which occurs under these favorable conditions, what happens? What are the characteristic symptoms? Sometimes it happens that the subject of the attack has symptoms which give warning of impending danger: A sense of weakness; disinclination to make any exertion; vertigo and headache; confusion of ideas; a feeling of oppression about the heart and epigastrium; abnormal vision (chromatopsia)—all things looking blue, purple, red, or green. But it happens much more often that the patient is found with the later and more profound effects of the exposure fully developed. These may be summarized as follows:

In cases that are to end badly, insensibility is a typical condition. The breathing varies; sometimes it is rapid, sometimes deep and labored, often stertorous. The pupils are fixed; sometimes dilated, sometimes (especially late) contracted. The skin is intensely hot to the hand, and generally dry, with a temperature ranging above 105°, and sometimes reaching 110° or more. The pulse is rapid and in later stages it is irregular, intermittent, and thready. Subsultus tendinum is common. Although coma is unequivocal, there is great involuntary restlessness. Spasmodic movements, epileptiform or tetanoid, are seen. The skin shows petechiæ and ecchymoses. There is a peculiar characteristic odor exhaled.

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[1] Watson's *Practice of Physic*, 1., p. 106.

Wood[1] says: "It is plain that the symptoms as usually seen may be summed up as those of intense fever, with profound nervous disturbance, arrest of glandular action, and changes in the blood. In this ordinary form of the attack death takes place by asphyxia or by a slow, consentaneous failure of respiration and cardiac action. There is a form of sunstroke in which death results almost at once, and probably always by cardiac arrest, and to this cardiac form those who are making great exertion in the heat of the sun, as soldiers in battle in mid-summer, are especially liable. But ordinarily death comes on gradually by arrest of respiration through direct paralysis of the respiratory centers by the effect of the excessive heat and the supervention of apnea."

The post-mortem appearances which are observed after a death by exposure to heat are in harmony with what we know of the symptoms: Phenomenal heat persists many hours. Rigidity occurs early and disappears early. The skin shows many persisting petechiæ. Putrefaction comes on promptly. The heart shows a contracted left ventricle, with distended right auricle and ventricle. There is venous fulness everywhere. The blood is dark and fluid, with little tendency to coagulate. Wood noticed a feeble alkalinity, even an acidity of reaction; it resembles blood of low fevers in its characters. Levick described corpuscles as shrivelled and crenated. This observation has not been confirmed.

It is the belief that the engorgement of the various organs is a purely venous and not a capillary or arterial phenomenon. Hence the distention is described as affecting the veins of large and small caliber, but not extending to the capillaries. Therefore the lungs, though giving exit, when cut, to much blood from the branches of the pulmonary artery, do not show parenchymatous or vesicular hyperemia. The same observations apply to the solid abdominal viscera, the spleen, liver, and kidneys, and to the brain and its meninges. The congestion is venous rather than parenchymatous.

If the fatal heat-stroke takes the form of syncope or profound exhaustion, the anatomical appearances will probably be almost wholly negative, the autopsy giving little information as to the cause of the death.

[1] Pepper's *System of Medicine*, v., p. 391.

CHAPTER XXVIII.

DEATH BY COLD.

THE victims upon whom we have the chance to study the effects of cold are, in nearly all cases, subjects of accident or mischance. They are persons who, at a distance from home and shelter, succumb to a low temperature under circumstances which they cannot control. Occasionally, however, an instance occurs in which something other than chance is found, and in which carelessness, neglect, or malicious purpose is an element, and a death by exposure to cold becomes the occasion of an inquiry as an example of homicide. Women in childbed out of wedlock have sometimes abandoned their illegitimate offspring and have been convicted and punished for it. Older children have perished as the result of malevolent exposure to cold as punishment inflicted by heartless parents or guardians. Insane and idiotic persons, incapable of self-help, have perished from cold through the carelessness and negligence of their keepers. These are some of the examples which are found in the records of criminal courts and in the literature of legal medicine ; and they justify some consideration of the subject at our hands.

A man and his wife, at Lyons, were tried for the murder of their daughter, eleven years old. On the 28th of December, at a time when there was a severe degree of cold, the woman compelled the girl to get out of bed and get into a tub of ice-cold water. The girl complained, very naturally ; presently, she said she was unable to see, and was all tired out. The inhuman mother then threw a pail of iced water on the girl's head, and soon the girl died.[1]

That the influence of a cold temperature is an important factor in the matter of the public health has long been known. A study of vital statistics shows that the mortality goes up as the cold weather advances toward its maximum. It is a matter of common knowledge that the old, the feeble, and the subjects of chronic exhausting diseases perish in much greater numbers as the temperature of mid-winter approaches the zero point. There is something in continued cold which co-

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[1] Wharton and Stillé: *Medical Jurisprudence*, section 883.

operates with other debilitating influences to increase the death-rate and destroy the lives of those enfeebled by disease. It is not, however, with this class of cases that we are specially concerned at present. We are interested, rather, with the subject of death by cold, considered as an independent medico-legal topic.

It is not easy to establish that degree of cold in the presence of which, as a temporary exposure, a human adult in good health must, of necessity, perish. Nature has not yet succeeded in reducing the temperature of the atmosphere to such a point that, in and of itself, it will inevitably freeze to death the person who is temporarily exposed to it. But nature can create combinations in which cold is only one of the elements, in which human life is never safe from early destruction. The experience of every person is a witness to this. The cold of a still, bright, dry winter morning, however intense it may be, measured by the thermometer, is exhilarating to one in good condition, properly clad, and well nourished. But if one goes out into an air disturbed by wind-currents blowing a half gale and rendered damp by an approaching northeast storm of snow, even a moderately cold temperature becomes insufferable. This is especially true if one is hungry at the time.

Habit and environment, also, have an important bearing upon the matter of human endurance of cold. The natives of the most northern countries, accustomed to the cold, are inured to its influences. The Russian peasant works with arms and breast uncovered "in a temperature many degrees below zero."[1] To the same purport are the accounts of tolerance of cold by Arctic explorers. Captain Nares and his men, in the expedition of 1875, lived for weeks with the thermometer at 68° below zero. Lieutenant Greeley's party thought the weather *warm* at any temperature near zero, and many days showed a record of from 50° to 55° below zero. The mercury froze again and again in their thermometers, and one day a minimum of 64.8° below zero was registered. Yet on these days the men went out hunting. There was comparatively little suffering in the party until, many months later, their supplies gave out and impending starvation became the ally of the cold in increasing the distress of the brave band.

For the harmless continued tolerance of freezing cold certain favorable conditions of the individual who is the subject of the exposure must be present. He must be in the rugged health of middle life. His circulatory system must be unimpaired. His skin must be kept healthy by being kept clean and well

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[1] Gould and Pyle: *Anomalies and Curiosities of Medicine.*

clad. His appetite and digestion must be normal, and he must be regularly and amply fed. His use of alcoholic beverages must be reduced to the minimum or dispensed with wholly.

On the other hand, the most ready victims of cold are those who illustrate conditions in strong contrast with these. The very young—newborn babies and those below the age of adolescence; the very old; those exhausted by chronic disease, or worn out by fatigue, or suffering from impairment of nervous energy; those who are ill-nourished habitually, or who are fasting and hungry at the time of exposure; those who are wounded or in any way unable to move briskly; and those who are overtaken by intense cold while asleep. Alcohol is, of all agents, the most efficient ally of cold in producing fatal consequences. The subjects of alcoholism, acute or chronic, are especially easy victims, because, as has long been known, alcohol absorbed into the blood retards those processes by which animal heat is produced and stored. The use of distilled liquors as beverages is, therefore, of no service "to keep out the cold," or to prepare a man to endure a low temperature.

The symptoms resulting from exposure to extreme cold are the following, stated in their chronological order: Purple lividity of the skin; headache; a hard, quick pulse, growing feebler; vomiting; the skin, at first livid, becomes pale; numbness and anesthesia of the surface; unsteady gait; stammering talk; progressive muscular stiffening; loss of will-power; temperature lowered at the surface and heightened in the mouth; thirst; giddiness; dimness of sight; uncontrollable tendency to torpor; delirium; lethargy deepening to coma; clonic spasms of the limbs; suspension of the respiration; cessation of the heart's action; death.

If we search for a reasonable explanation of the way in which cold kills, we shall find it largely in the effects wrought in the blood. A very low temperature interferes with the ability of hemoglobin to give up its oxygen. This, with a coincident lowering of the activity of the tissues in using such oxygen as *is* available, affords an explanation of the progressive and general depression of the systemic powers and, also, of the manifestation of disturbance of the nerve centers. We should not forget, moreover, the effects due to the contraction of the blood-vessels of the skin; their paralysis through lack of tonicity; and the resultant internal congestions. Pouchet (Hofmann) has found that cold destroys the red blood-globules, and this fact should be included in the list of the phenomena.

If it is difficult to designate a degree of low temperature

which is inevitably and absolutely fatal to human life; it is also, and for the same reason, difficult to describe that degree of freezing from which resuscitation by the application of proper remedies and measures is impossible. This means that any standard mortal danger-line, to pass over which would mean death by cold, has never been fixed; nor can it be. A degree of cold that would destroy one person would have no ill effect upon another prepared to endure it; and the same individual who at one time finds nothing save a little discomfort in a very low temperature would, at another time, readily perish by freezing under different circumstances. This is attested by the extraordinary instances of toleration and of restoration which are recorded.

Tidy says: " I have known an omnibus driver frozen to his seat and the reins to his hands, and at the same time rendered partially insensible by exposure to cold on a severe winter's night, and yet recover after treatment." Belgrave cites a case in which a man who was immersed in water at the freezing-point for twelve minutes was restored. Reincke says: " A man twenty-four years old was picked up intoxicated at midnight, with the thermometer at $2°$ below freezing. His rectal temperature was $75°$. Two hours later it rose to $77°$. Twelve hours after he was found it was $82°$. Reaction then set in and the temperature rose above normal. He recovered perfectly." Magnall observed a case in which the temperature was found to be $78.8°$ after exposure. Pinel states that the insane bear the effects of cold better than their normal fellows, other things being equal, and mentions the escape of a lunatic, naked, in January, with the temperature at $4°$ below zero. He ran into the snow and rubbed himself with it as if he liked it. There was no after-effect that was appreciably harmful.

Certain experiments on animals are in the same direction. Dr. Richardson states that he has known a kitten to recover after two hours' immersion in ice-cold water. He has also demonstrated that a carp, solidified and absolutely stiffened by cold, and apparently dead, may be restored to life and activity by cautiously raising the temperature of the ice-cold water by the addition of warm water.

Captain Ross, when he went to the Arctic Sea, took a box containing silk worms. He exposed them to a temperature of $43.6°$ F. below zero, and froze them thoroughly, so they could easily be broken by the fingers and were like pieces of wood in appearance. He warmed them cautiously and the greater number of them were restored to active life. He repeated this freezing and thawing process three times, and there were some

survivors after the last one which were lively enough to pro-
duce silkworm moths.

What are the anatomical appearances left upon or in the
dead body of a person who has succumbed to freezing cold?
The external inspection finds cadaveric rigidity marked in
degree. This is to be distinguished from the condition of
solidification and stiffening due to freezing of the tissues, which
leaves the body like a marble statue. Cadaveric rigidity is
found when the body is thawed, although the period after death
when it usually ceases has long since gone by.

Another external appearance which is regarded as a sign of
death by freezing is the presence of post-mortem discolorations
of a cherry-red hue on those parts of the body exposed to the
air, and not necessarily on the dependent parts. They are the
ordinary cadaveric lividities, but of a brighter color than the
ordinary patches. This change in color is explained by Falk
in this way: When the hemoglobin of the blood is exposed to
an extremely low temperature, it loses its power to part with
oxygen, but retains its ability to take on oxygen. This applies
to the dead body as well as to the living. So when a recently
dead body is exposed to a temperature below freezing, the blood
in the superficial vessels acquires oxygen and retains it, assum-
ing the bright red hue of arterial blood. If a body so exposed
and displaying this aspect is thawed, the hemoglobin parts
with its oxygen and is reduced by the oxidizing properties of
the tissues, and the bright-red stains darken and become more
like the familiar lividities.

The dead body of a person who has perished by cold
decomposes rapidly when exposed to the influence of heat,
moisture, and access of air, which promote putrefaction under
the usual post-mortem conditions. It may be remarked in
passing that continuous exposure of a dead body to cold at
or below freezing is a sure prevention of decomposition, as
everybody knows. Hence, the discovery of a cadaver frozen,
but with the signs of decomposition present, at once suggests
the presumption that the death was not caused by cold, but
by some other cause, with subsequent refrigeration. The
internal appearances may be comprehensively described as
resulting from changes in the blood color, and unequal and
abnormal distribution of the blood. The blood has a brighter,
more arterial hue than usual, for reasons already stated. This
gives to the tissues, and to the lungs especially, a cherry-red
color that is quite striking. Then there is a marked tendency
of the blood to accumulate in certain parts and to establish
hyperemia, for example, in all the cardiac cavities (both sides)

in the abdominal viscera; in the brain and its membranes; and in the blood-vessels outside the viscera.

It is, however, only simple honesty to remark of all these appearances, external and internal, that they do not make a very strong collection of anatomical data by themselves, considered singly or collectively, upon which to make a post-mortem diagnosis. A cherry-red condition of the blood is found under other circumstances, as, for example, in water-gas poisoning. So are bright red patches on the skin. So is congestion of various viscera.

If, however, we add to these data which the autopsy reveals, certain other affirmative facts found in the history of the case, such as the place where the body was found, the season of the year, the prevailing temperature, and the duration and other circumstances of the exposure; and, if at the autopsy we determine the *negative* fact that there was entire absence of any other cause of death, then the concurrence of all the evidence will permit a diagnosis of a death by exposure to cold.

CHAPTER XXIX.

DEATH BY STARVATION.

In determining what subject to consider in connection with death by cold as a medicolegal topic, there is a certain obvious propriety in choosing death by starvation. The step from one to the other is a short and natural one. To be cold and hungry is a common expression of human misery and wretchedness. One state promotes the other, and there is reasonable harmony in a discussion of these two themes.

Death by starvation as a crime is an unusual incident in civilized society. Its victims are necessarily such as, by undeveloped or stunted intellect, are unable to provide for themselves or to protect themselves. They belong to the purely dependent classes. Dr. Vivian Poore, in 1902, mentions the case of a woman in England who starved her servant girl to death and got seven years' imprisonment as the result.

The opportunity to study the effects of starvation comes more often as a matter of misadventure than as a matter of malicious purpose. Accident rather than malevolent intent affords the occasion most frequently. At long intervals, indeed, a suicide by starvation occurs, but this is the rarest of all incidents in this relation. Much more often the student of legal medicine finds the victim of starvation in some one who through accident has suffered from prolonged privation. Stowaways aboard ship; persons lost in the woods; sailors shipwrecked; explorers, like the Greeley sufferers at Sabine Island; the victims of widespread famine; the victims of tyrannical persecution, like the reconcentrados of Cuba, in 1898, when 200,000 are said to have perished as the result of Spanish neglect—these are examples.

Starvation is either acute or chronic in its form. By *acute* starvation we mean the effects of the sudden and complete withdrawal of all food, fluid or solid; while *chronic* starvation results from the gradual or partial deprivation. This is a purely arbitrary distinction. The end is the same in both forms, if the starvation is not relieved; and many instances occur in which it would be rather difficult to decide in which

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class they belong, unless we were in possession of all the facts in the clinical history.

It is very obvious that the one function of the human body which suffers most when food is withheld is the function of nutrition. The imperative demands of assimilation and repair are not met. The equilibrium of constructive and destructive forces is upset and the body consumes itself. The more we analyze the phenomena and consequences of starvation, the more does this fact impress itself. Common sense and common experience both give assent to the proposition that continued health depends upon the food-supply, and requires that this food-supply shall be sufficient in quantity, acceptable in quality, properly cooked or prepared, and served at correct intervals. Otherwise, *export* will be greater than *import*, and nutritive insolvency will be the inevitable result.

It would be interesting and instructive, but out of harmony with the real subject of the present chapter, to study somewhat in detail these several elements. The question of food-supply is a far reaching one. It dominates the movements and operations of great armies. It controls the progress and prosperity of whole nations. It is intimately related to the advance of civilization itself. But we are concerned with the topic in a very limited sense. Our study relates, not to the requirements of the most perfect nutrition of the human body, but to the effects of enforced withdrawal of subsistence; to the way in which Nature shows resentment when food supplies are cut off. Therefore we must not pause to consider the components of an ideal food, the constituents of standard dietaries, the amount of food required at different ages, the relative values of different kinds of food, or the correct preparation of food; but we are to inquire into the symptoms and phenomena which belong to the process of starving to death, and the anatomical changes which such fatal starvation leaves on the human body, by which we can make a post-mortem diagnosis.

Acute Starvation.—First, what are the effects and symptoms which an adult shows when all supplies of food and drink, all forms of nourishment, are absolutely cut off? They may be profitably considered in, approximately, their chronological order.

Hunger.—As a matter of course, the first effect observed is a sensation of hunger. It is a mistake, though a very common and natural one, to believe that this sensation persists as long as any consciousness remains. It is temporary and of comparatively short duration, continuing about forty-eight

hours and rarely beyond that. Tidy says that in this primary stage, before the consequences of privation declare themselves, a loathing of food is more marked than a desire for food. Coincidental with the hungry feeling is a sense of pain in the stomach, a subjective feeling which is relieved by pressure.

Thirst.—If hunger is a symptom of relatively short duration, thirst is not. The desire for water to drink is persistent and intolerable. Cases are reported in which the patient, to relieve the torment of the thirst which he suffered during starvation, has resorted to drinking his own urine. The cause of this imperative demand for water is not far to seek. Water is an integral constituent of all the tissues, essential to the proper form, consistence, and function of all organized structures. It is necessary for nutrition. It must be supplied; otherwise extreme distress results. Physiologists tell us that the demand on the part of the system for water is much more urgent and imperative than it is for solids. In this respect it is second only to the demand for oxygen.

Emaciation.—Soon after the starvation begins the body shows that it is consuming its own tissues and emaciation is evident. Chossat has shown experimentally that an animal subjected to acute starvation loses 40 per cent. in its weight before death. This loss falls chiefly upon the fat, blood, pancreas, spleen, liver, intestines, heart, and muscles of locomotion; and less severely upon the skin, kidneys, respiratory organs, and bones; least of all upon the nervous tissues. The loss of weight of 40 per cent. has been found to be applicable also to the human subject, although there are exceptions on both sides of the line. The wasting shows itself especially in the nates, thighs, orbits, about the zygoma, in the neck, and on the thorax. The features are pinched; the eyes are sunken, wild, and staring; sometimes the conjunctivæ are injected; and the malar bones are prominent. The abdominal wall becomes concave, so that the bodies of the vertebræ are readily felt. The degree of emaciation depends largely upon the bodily condition at the time the starvation begins.

Extreme muscular weakness is another marked symptom. It may become so great that the person is disabled, as if by paralysis, and is unable to move at all. There is languor, slowness, and hebetude. With this great weakness goes a peculiar hollowness of the voice.

The skin, besides showing the deep folds and wrinkles of progressive wasting, is dry and harsh. Very frequently it is "covered with a brownish, filthy-looking coating" almost as tough and resistant as varnish. Sometimes purplish petechial

spots are seen on the skin. The whole body exhales a fetid odor ; sometimes this odor suggests the odor of ether. At a later stage the exhalation is almost putrescent.

The mouth is dry and parched, and the breath is offensive. The saliva is thick, tenacious, and scanty. The mucous membrane of the body outlets, the anus, vagina, urethra, and nostrils, is frequently found red and inflamed.

Constipation with feces which are small, hard, dry, and dark-colored is the rule. Not infrequently the bowels cease to act altogether.

The urine, if passed at all, shows a high degree of concentration. It is scanty, high-colored, and turbid. Its specific gravity is raised. Albumin is absent, as a rule. A peculiar aromatic odor has been observed. The daily excretion of urea is diminished. In a few instances entire suppression has been observed. Some authors maintain that this progressive retention of urea sets up a uremia which is represented in the delirium exhibited in some of these cases.

The secretion of the gastric juice does not show uniformity in its characters. By passing a tube into the stomach, in experimental starvation, Pick sometimes obtained only a few drops ; at other times, twenty-eight cubic centimetres or more. The juice thus obtained was often without hydrochloric acid. If to the juice, thus devoid of hydrochloric acid, a little of the acid was added, it behaved, as to its digestive power, like normal gastric juice.

The pulse is usually slow and compressible at first, but on the approach of a grave stage in the starvation it becomes much faster. Palpitation is sometimes present to a distressing degree.

The temperature is not greatly changed at the outset. Instead of being depressed it may show a rise in the first four or five days. But later the rule is, that as the inanition progresses, the temperature is lowered. For several days before death the breath is described as remarkably cold ; the patient complains, too, of feeling cold.

With these various physical and rational signs are certain well-recognized and easily understood *mental* and *nervous* symptoms : Despondency, tinnitus aurium, giddiness, double vision, fainting, illusions and hallucinations, temporary blindness, and incoherency of thought and speech. In later stages, convulsions, active delirium, and coma are observed.

Mental Effects.—Sometimes the mind remains clear to the end. More often it shares in the physical weakness and may be enfeebled to imbecility. Dreams of surfeit and feasting are

mentioned by survivors as a tormenting incident of their experience.

As the inanition progresses and matters look desperate, the purely animal instincts assert themselves, and all moral sense is overthrown. Suspicion and ferocity add to the torments of hunger. Even murder and cannibalism have been resorted to when starvation was imminent; and successful theft is a virtue in starvation. There have been a few instances of sublime resignation in the face of this terrible distress of mind and body in starvation—these were cases of voluntary self-sacrifice in suicide. Examples of the other sort are numerous enough to establish the rule.

It is to be remembered that the cases of which the symptoms have been considered are the uncomplicated cases of acute starvation—individuals, previously well fed, now deprived absolutely of all nourishment, fluid and solid, and starved to death. These symptoms have been derived from the observation of persons seasonably recovered, whose privation was relieved before it was too late; from other persons found in extreme want, but too late to be restored; and from laboratory observations.

A very natural question in this connection is: How long can an otherwise healthy person endure acute starvation before he is released from his sufferings by death? The number of instances of authentic, accurately observed, well-attested cases of this sort, unmodified by conditions of environment which would impair their value as laboratory experiments, is too small to enable one to answer the question unreservedly. Each case of endurance has factors of its own which do not apply to any others. But, studying the records of instances of acute starvation which medicolegal literature gives us, we say that a fair answer to the question is, that a man, healthy and well nourished at the beginning of his fasting, will starve to death, probably in ten days, if food and drink are wholly withdrawn.

Some authorities, Flint, for example, insist that the limit of endurance is much shorter, and declare that death results at the end of from five to eight days of full starvation.

Thomas King Chambers writes: " When entirely deprived of nutriment we are capable of supporting life for little more than a week."

Woodman and Tidy, averaging the conclusions of the older authorities—Orfila, Casper, Taylor, and Guy—say: " The average period for death in complete privation of food would seem to be from seven to ten days."

Vivian Poore, writing in 1902, states : " Whereas a person will live only a week at the outside when both food and water are withheld, we know as a result of music-hall experiments that a man may go on living for six weeks with no food or with very little food indeed."

We are somewhat aided in our estimates by authentic recorded instances of survival after a longer period of fasting than those above cited.

This conclusion, however, is in great measure provisional, and is based on certain well-recognized factors. For example : If a person is fat, he will endure privation of food longer than a lean though healthy person would. The usefulness of adipose tissue in such a crisis is demonstrated in the case of the Dover pig which has been made historic in the *Transactions of the Linnæan Society :* By an accidental landslide this pig was buried in its sty for 160 days, under thirty feet of the chalk of Dover Cliff; the animal was dug out alive, reduced in weight from 160 pounds to 40 pounds.

If a person is kept warm, he will be longer in starving to death than he would if he were coincidently exposed to cold. The depressing effect of cold is a powerful ally in reducing the strength and vigor. If the starvation occurs in a pure atmosphere, in a well-ventilated room, it will be faster in reaching the end than it would in the contrary condition, as in mines, the hold of a vessel, or the squalid tenements of the poor.

Incidentally, it may be mentioned that the effect of inanition is to diminish the exhalation of carbonic acid (Flint). Experimentally, it has been demonstrated that this diminution is gradual, and that just before a death by starvation it is reduced to a little more than half the usual amount.

It is remarkable that even a moderate allowance of water to drink, all food otherwise being withdrawn, will mitigate suffering and enable life to be prolonged far beyond the limits which have been stated. An Italian named Succi undertook a voluntary fast of forty days in 1890, under constant inspection; he allowed himself some simple liquids and a narcotic from time to time. He was successful in his venture. Ten years earlier, in 1880, a Dr. Tanner did the same thing, fasting forty days, with only an allowance of water. In some experiments on horses, relative to starvation, it was found that they would hold out for *twenty-five* days if water was given them ; but they lived barely *five* days if deprived of water. Luff mentions the case of a man who, though deprived of food, had access to water and who survived sixty-four days.

Miners imprisoned in damp, mining galleries have had much

relief in their inanition, because the walls and air of their prison were damp. Even wetting the skin with sea water has been found useful by whipwrecked sailors.

Chambers mentions the paradoxical observation that if the stomach is fed with blood out of the body of which it is itself one of the starving tenants, life will be prolonged very materially. He cites the case of a man who was twenty-two days in an open boat without food. He fought with his comrades and was wounded so that he bled freely. He lapped up the blood and swallowed it as it came from the cut, and he experienced real relief. A French physiologist, Anselmier, tried the scheme on dogs. He fed them on the blood taken from their own veins. The tendency to subnormal temperature was postponed. The dogs so fed survived fourteen days; other dogs starved, without blood, in ten days. The former class lost 60 per cent. of weight; the latter, 40 per cent.

Among other factors which influence the duration of life when all food is withdrawn, we may mention these: Age is of considerable importance in this connection. Young children die quickly; adults endure the peril much longer. Women bear abstinence better than men, as a rule. Good nutrition and vigorous health at the beginning of the fasting do not specially promote endurance, as one might think. Invalids will bear abstinence better than strong people. M. Savigny has told the story of the wreck of the frigate *Medusa*. After the wreck 150 persons of all ages were exposed on a raft for thirteen days, with scarcely any food. Only fifteen survived, including Savigny himself. The children and the aged were the first to succumb.

The mental state of the person starving, whether sane or insane, seems to have influence on the power of endurance. The cases of longest survival are found among the insane, the victims of religious delusion.

Those persons who are prevented from making any active physical exertion, or any attempt in that direction, bear abstinence better than those who waste their vigor by activity, promoting metabolism of the tissues and hastening waste. Chambers speaks of a surgeon, under his care, whose power of swallowing was completely lost by cancer of the esophagus. He was cheerful and happy as long as he lay in bed. One day he took a river trip to Greenwich, and he died immediately after the exertion. Chambers sums up the matter well when he says: " In order to preserve life as long as possible, when sufficient food for subsistence cannot be obtained, our aim

should be to secure water, warmth, and complete inaction of the muscles."

Anatomical Appearances after Starvation.—What are the anatomical appearances which the body of a person starved to death will show to demonstrate that kind of death? The first and most natural effect to notice will be the wasting of the tissues, which the external inspection reveals. Here we must be on our guard lest we be misled by theoretical notions. In acute starvation, the emaciation, though unequivocal, is not extreme, especially if the person starved is in good condition when the food is first withdrawn. In one recorded case (the Welsh fasting girl), in which death occurred after eight days' entire abstinence, the body was described as "plump."

Voit demonstrated by careful analysis the relative losses which the various tissues suffer in starvation, and he has expressed these percentages in a graphic form.

Fat . . . . 97.0 per cent.
Spleen . . . . . 66.7   "
Liver . . . . 53.7   "
Testis . . . . . . 40.0   "
Muscles . . . . 30.5   "
Blood . . . . . . 27.0   "
Kidneys . . . . 25.9   "
Skin . . . . 20.6   "
Intestine . . . . 18.0   "
Lungs . . . . . . 17.7   "
Pancreas . . . . 17.0   "
Bones . . . . . . 13.9   "
Nervous system . 3.2   "
Heart . . . . . . 2.6   "
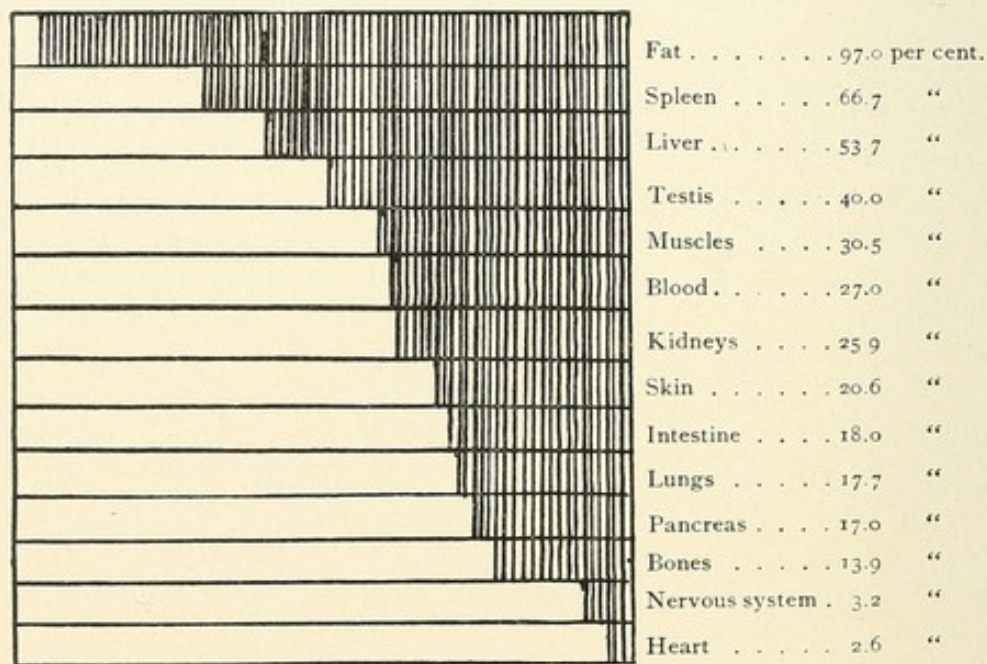
FIG. 33.—A diagrammatic scheme of the constituent structures of the human body lost in starvation (Voit).

Michael Foster suggests that the great contrast which the skeletal muscles show in comparison with the heart in the matter of wasting may be explained by the necessity of this organ to the life of the body as a whole; it is, in fact, fed on the rest of the body. The same remark applies to the brain and spinal cord. In order that life may be prolonged, these important organs are nourished at the expense of far less noble organs and tissues.

The skin is shrivelled and wrinkled; it emits a fetid odor; it

sometimes has a coating of dirty-brown matter; it is tightly adherent to the parts beneath it; it has a rough, scurfy surface; the subcutaneous fat is absent. Viewed as a whole, the body has a fairly close resemblance to the mummies found in the catacombs. Post-mortem rigidity is described as pronounced. Putrefactive changes are said by Hofmann to begin early and to progress rapidly.

The heart is usually contracted, containing only a moderate amount of blood. Sometimes a distinct *atrophy* of the heart is present, but this is uncommon for reasons already suggested. The lungs are found in a normal condition, though somewhat lessened in bulk, and somewhat anemic,

The blood is less in amount than in health, and although it has been deprived of the water which is so essential to its integrity, it appears thin and fluid because of the anemia and the relative impoverishment of its solid constituents. Its specific gravity is unaltered.

The spleen is not noteworthy. The pancreas is always atrophied, sometimes to its practical disappearance. The omentum is transparent and destitute of fat. The liver is unaltered, except in the size, which is lessened. The gall-bladder is usually full of bile and its contents stain the adjacent tissues.

The stomach is described as small and contracted and its walls are thin. Its mucosa is corrugated and pale, or if reddened, only faintly so. Its contents consist of a small quantity of dark, gelatinous fluid.

The intestines are usually contracted as to their lumen and length. They are thin and transparent when the light is allowed to shine through them. Their atrophy in these directions is characteristic. Sometimes they are empty and sometimes they contain a little dirty mucus. Occasionally their vessels have been described as injected. The colon and rectum contain scybalous lumps which are indurated and sometimes coated with mucus. Anatomically, the large intestine is like the small intestine.

The kidneys do not seem to suffer impairment. In some cases they are recorded as pale, and in others they are called congested. The bladder is invariably empty (Tidy) and sometimes much atrophied.

The brain appears to suffer in its nutrition the least of all the organs. There is no sign of atrophy, and the blood-supply is unaffected.

Chronic Starvation.—Turning from this review of the symptoms and post-mortem appearances observed in acute

starvation to the effects of the partial withdrawal of the food-supply, the amount available being wholly inadequate for the needs of nutrition, and the fatal ending being the demonstrated result of the inanition, we say that the distinction between the acute and chronic forms of starvation is a wholly arbitrary distinction; that the differences are such as grow out of the fact that the end is simply postponed, and the symptoms are therefore distributed over a period more or less protracted, according to circumstances. The symptoms are essentially the same in kind, whether the starvation is absolute or the privation is real, though partial. The main difference is one of degree.

Thus, in protracted or modified privation, as in unequivocal acute starvation, we come upon these characteristic symptoms: Emaciation; a dry and rough skin; exceedingly fetid exhalations from the body; a dirty-brown coat on the skin, not due to filth; a faintness of the voice; great muscular weakness; dejections which are dry, dark, and infrequent; scanty and high-colored urine. All these mark the later stages of the inanition and usher in the final chapter. Meanwhile the pulse is increased in frequency and lessened in force. Sometimes the pulse becomes slower as well as weaker. With this impairment of the circulation from anemia purpuric petechiæ show themselves.

The temperature is subnormal, a reasonable result of the profound disturbance of the functions of nutrition. As a grave stage approaches, the diurnal variation is greatly in excess of that of health, and shortly before death from chronic starvation the temperature has been noted as low as 66° F. Mr. Brett, describing the famine among certain prisoners at Cawnpore, in the East Indies, includes among the effects of prolonged starvation: Inflammation and ulcer of the cornea; copious lachrymation; the tears acrid; blindness from the destruction of the eyeballs. Magendie mentions the same effects in dogs starved to death experimentally.

Mental symptoms, too, are observed in this form of privation—chiefly toward the end. Delirium, illusions, convulsions, and coma have all been recorded as significant features.

So far as the pathological effects which this form of starvation leaves are concerned, they do not vary materially from those already described. Wasting of the tissues, disappearance of the fat, atrophy of the muscles, marked thinning of the walls of the stomach and intestines, with contracted lumen, a disturbed gall-bladder, diminished bulk of the liver and pancreas, and diminished amount of the blood make up the list of

abnormal appearances which, at the autopsy, establish death by chronic starvation.

Of those who perish by starvation by far the largest number are the victims of accident and mischance, as the author has said. Examples of this sort of casualty present themselves in the cases of shipwrecked mariners; travelers losing their way or overtaken by storms; victims of famine and siege. In all these cases other depressing causes besides privation are operative; for instance, mental anxiety, bodily discomfort, and fatigue; these coöperate with abstinence in exhausting the vital powers.

Many of the cited cases of accidental starvation give us most important information of the endurance of which men are capable in continuous, unrelieved inanition. In a Scotch coal-mine in 1835, a man, sixty-five years old, vigorous for his years, was accidentally shut up. He had access to some dirty water carrying iron in solution; but this relief lasted a few days only. He was found twenty-three days after he was incarcerated and was brought out alive. He survived his rescue only three days.

In 1878, the *British Medical Journal* published the report of the case of a man, twenty-eight years of age, who was ship-wrecked, and survived twenty days of starvation.

The *Annual Register*, Volume I., gives an account of three persons who were buried five weeks in the snow, and survived.

Somis, physician to the King of Sardinia, relates the story of three women of Piedmont, who were rescued from a bank of snow thirty-seven days after the fall of an avalanche.

In 1878, John Donnelly, twenty years old, a stowaway on the steamer *City of Chester* (Dumbarton to New York), on a voyage of eleven days. He had nothing to eat or drink, except some salt of which he ate two handfuls, and his urine which he drank from a flask he had. When found he was insensible, emaciated, cold, and nearly pulseless. He was taken to St. Vincent's Hospital, and recovered.

Collette states that a girl, sixteen years old, was buried under the ruins caused by an earthquake. She remained under ground without food or drink for eleven days, holding in her arms an infant that had died on the fourth day. When rescued the girl was alive and in such a posture that she could not have ridden herself of the baby's body, which was undergoing decomposition (Dixon Mann).

Guy cites two shipwreck cases in one of which thirteen men were without food and water for twelve days; three died and the rest survived. In the other case eighteen sailors were cast

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away at sea without any food, and seven of them survived as follows: One, eleven days; one, twelve days; one, fourteen days; two, fifteen days; one, eighteen days; and one, twenty-eight days. The other men are not accounted for.

The story of Greely and his brave band of Arctic observers at Cape Sabine is an excellent record of chronic starvation. So long as these men had plenty of supplies, and cold was their only discomfort, they got along very well. But when the expected supply ship did not come and the promised relief failed them, and they resolved to make their best endeavor to reach, overland, a place where food could be obtained, then their sufferings began. Greely has told the story of this journey and of the almost indescribable miseries which he and his heroic comrades experienced. One can hardly find in literature any more graphic or more pathetic account of fatal inanition, with all the attendant wretchedness of cold, homesickness, and hope deferred.

The literature of legal medicine has a few records of authentic cases of suicide by starvation. It seems almost incredible that a person inspired by a suicidal impulse would have the persistence to carry him through day after day of distress to a fatal ending. One would more readily believe in a timely surrender to natural craving under such conditions, rather than in a wilful, obstinate perseverance. Reference is not made here to men who for hire, notoriety, or to win money by wager undertake prolonged fasts under more or less rigid supervision, but to persons, sane or insane, who deliberately and incorrigibly starve themselves to death. There are some cases, too, of fraud and imposture, in which, until proper supervision has exposed the cheat, the persons have pretended that they lived an indefinite period without food, and have made a good living by exhibiting their skin and bones. Many of these cheats are women—victims also of hysteria and other functional neuroses. They declare that they are nourished by angels or devils—sometimes one, sometimes the other. The protracted fasts of the Indian fakirs are undoubtedly instances of skilful juggling.

In these fraudulent cases of self-starvation, in which the minimum of food, or, as the pretender affirms, with no food at all, life goes on, the endurance is sometimes extraordinary. Ann Moore, of Tutbury, lost her appetite because she had to wash the dirty linen of a person troubled with ulcers. She began to starve herself. She was watched for three weeks, and it was then publicly proclaimed that she "lived entirely without food." She kept on this way and secured more than twelve hundred and fifty dollars in donations from visitors. This

lasted two years. Another watch was set, and this resulted in a confession that she had been cheating and had managed to get a little food from her daughter. This alleged starvation lasted six years. Her last abstinence, under observation, was of nine days' duration. Louise Lateau—a case of ecstasy—was said to have endured without food twenty months.

The case of Sarah Jacob, the Welsh fasting girl (December, 1869) shows that a watch too strictly kept may result disastrously. This girl, twelve years and a half old, is stated to have voluntarily abstained from any kind of food for a period of two years and two months. She kept her bed during that time, lying on it decorated as a bride. She was visited by hundreds of persons, and was publicly exhibited by her parents as a girl of miraculous powers. Her lips were moistened with water once in two weeks, but if her parents were to be believed, no food was taken. Four professional nurses were set to watch the girl, and under their observation she actually starved to death, dying on the ninth day. She refused all food, and voluntarily accepted death rather than confess the fraud. Her parents and those about her allowed her to die. An inquest was held and the verdict was that the parents were guilty of criminal neglect, and they were indicted, tried, and convicted. The father was sentenced for twelve months and the mother for six months.

The authentic cases of suicide by starvation relate chiefly to prison convicts and lunatics. Dr. Benjamin Rush relates the case of a man, a hemiplegic, who, becoming discouraged by the non-success of his treatment, resolved to starve himself to death. He totally abstained from food for sixty days, taking only a little water and chewing apples, of which he rejected the pulp. He died, according to his wishes.

Richardson had a case in 1848 of a man, thirty-three years of age, who would take nothing but water; he absolutely rejected food because, in his belief, he had no gastric juice to digest it. He died after fifty-five days of abstinence.

Collins reported the case of a woman, eighty years old. She refused all food and continued to do so for thirty-three days, when she died. She was delirious. She slept seven or eight hours every day, and took a wine-glass of water daily.

Christina Marshall, fourteen years old, went fifteen months and two weeks without taking any solid food. She slept little and seldom spoke. She took sweetened water with beef-tea at intervals, occasionally a bit of orange. She died after a long confinement in bed.

Gadermann reported a case in 1848 in which, so the reporter

stated, there was not the slightest suspicion of deception. A man became determined to kill himself by starvation. For a period of twenty-three days he refused all liquids and solids. Then he surrendered and ate and drank greedily. He died shortly afterward, nevertheless. The body was reduced to a skeleton.

A prisoner at Toulouse resorted to starvation to avoid punishment. He drank water occasionally. He kept it up for fifty-seven days.

Valentin reports the case of a woman who lived seventy-eight days on lemon-juice and water.

Bérard tells of a convict who died of starvation after sixty-three days' abstinence; he drank water, but took no solid food.

Homicide by starvation is relatively a very rare incident. Its victims are chiefly infants who are put out of the way at baby farms. Occasionally an adult is the victim. In such a case the conditions must necessarily favor the continuous process of neglect and abuse. For example, the subject of the crime must be mentally unsound or feeble; a dependent, or one over whom absolute control is exercised; or an infirm and decrepit person.

It is to be borne in mind that in dealing with these cases of homicidal starvation the law does not require proof of the entire and absolute withholding of food, of literal starvation. It is enough if evidence is offered to show progressive decline and finally death as the result of an insufficient supply or a poor quality of food, the absolutely indispensable element in the proof being the fact that a malicious and evil purpose was present in the affair, or that the neglect was wilful and wicked.

A common defense in the presence of an accusation of this sort is that the starvation, as demonstrated, was the result, not of wilful neglect or malicious purpose, but of incurable, perhaps obscure, disease affecting nutrition. It is a defense easily set up and is met with some difficulty.

It will be useful to recall here the principal organic diseases which cause fatal inanition, closely resembling appearances of starvation. In a case of imputed starvation it will be well to search carefully for the signs of these diseases, so as to be able to meet the contention of the defense in an intelligent manner. They are: Stricture of the esophagus, malignant disease in any part of the body, tuberculous disease, diabetes, dysentery or chronic diarrhea, and Addison's disease of the suprarenal bodies. In addition, there are certain neuroses like hysteria,

or some forms of insanity which have no pathological lesions, but which may have been attended with much emaciation.

The Staunton Case.—The case of Regina *v.* Staunton is a good example of the difficulties attending the medical investigation of a case of homicidal starvation; the necessity of thoroughness in such an investigation; the usual defense under an imputation of this kind; and the inherent complications of the proof if the medical men are not thorough.

Harriet Staunton was the name of the victim. She was thirty-five years old and of weak intellect. Her husband had formed illicit relations with a girl named Alice Rhodes. It was claimed that Staunton and this girl had conspired to put the wife out of their way, and with the aid of accomplices (Staunton's brother and his wife) had actually succeeded in doing so by starvation and neglect. The testimony showed that the deceased had been kept in close confinement for some time. When in a most reduced condition she was removed some distance from her home to Penge, where she died the day following her removal. She was seen by a physician a few hours before her death. The *autopsy* found her body greatly emaciated and alive with vermin. Its weight was seventy-four pounds. Two years and a half before, she weighed one hundred and nineteen pounds. The skin was harsh and dry and the muscles were atrophied. There was total absence of fat. The stomach was contracted and its walls were thin. The intestines were shrivelled, empty, and translucent. The rectum was hyperemic. The only signs of disease found were: A small patch of tuberculous deposit at the apex of the lungs and a few miliary tubercles on the arachnoid membrane of the left side of the brain, but without meningitis. The medical men for the prosecution testified that there was no disease sufficient to account for the extreme emaciation, or sufficient to cause death, and that the appearances indicated death by starvation.

For the *defense* it was urged that the tuberculous meningitis was quite adequate to account for the emaciation and other appearances.

The verdict, based on the general evidence, was that all the prisoners were guilty of wilful murder.

The evidence was much discussed and criticised by medical men. For weeks the Staunton case was the chief topic in the English medical journals. There was a feeling by many that proof of death by starvation had not been established, and that proper and careful search for other possible causes of death had not been made. Among points of neglect in this direc-

tion, it was urged that the esophagus had not been examined for stricture; that no test for sugar in the urine had been made; and that no examination of the suprarenal bodies had been attempted. The result was that there was some reactionary feeling in favor of the defendants. This became so strong that the Government pardoned Alice Rhodes and commuted the capital punishment of the other three to life imprisonment.

CHAPTER XXX.

MURDER BY POISONING.

THIS chapter will be devoted to some very practical questions relating to toxicology. The writer will try to set forth in their true light the medical practitioner's obligations when he is brought into the care of a case of homicidal poisoning. What is the physician's duty in such a relation? This is a simple topic, but it has the gravest significance and importance to every medical man. It does not go deeply into or touch very intimately the scientific or more technical side of toxicology—it is a practical concern purely.

The writer will avoid, therefore, all discussion of definitions and classifications of poisons; all mention of the *mode of action* of poisons in the human system; all comments about absorption, elimination, or localization; all criticism of the value of chemical evidence; all description of technical chemical methods for the recovery of poison from dead organs and tissues; all inquiry into the effects of individual poisons, except as these shall incidentally illustrate some general principle.

How soon a call may come to any one of the readers of this book to serve as the medical attendant at the bedside of the victim of a murder by poison, it is impossible to prophesy. But it is not difficult to realize that the responsibility resting on such attendance is of the gravest kind. The ordinary anxieties of clinical service are intensified; the crisis is novel and imperative; the patient's welfare demands promptest action, energetic skill, and assiduous attention. A halting uncertainty will be sure to meet the blasting criticism which it deserves. Errors of omission and commission will not be lightly forgiven and forgotten. And then when we have the added element of suspected *crime* in the case as its cause, all these urgent features of the emergency are greatly emphasized. It is well understood that in capital trials for murder by poisoning the *medical* (including the chemical) evidence is often, indeed it is generally, the controlling and preponderating evidence. The testimony of lay witnesses is always secondary to that of the physicians in the minds and eyes of the jury in such a trial, because of the technical nature of the proof, the

intimate relation of the physician to the victim, and the exact results of the chemical analysis. Hence the medical attendant's observation of symptoms in the patient, his detection of collateral facts, his wise and skilful attempts to save the threatened life, his preservation of suspicious matter, with his manner of presenting his testimony in court, deservedly impress the jury and affect the verdict. This fact being readily appreciated imposes on the medical attendant a tremendous weight of responsibility.

Murder by poison is not a very common form of homicide, fortunately. The use of tangible weapons is much more frequent than the use of toxic agents in the destruction of human life. But poisoning is a crime which has unique features and peculiar characters. There is nothing heroic about it to extenuate it. The motive usually springs from the lowest level of human passion. Revenge, cupidity, jealousy, and disappointed lust are the evil spirits which inspire and incite the cowardly act. The destroying agent is but too readily obtained, for the sale of poisons over the druggist's counter is not hindered, as it ought to be, by statutory restrictions. The very choice and purchase of the poison are evidence of premeditation, deliberation, and malicious purpose.

The present law in Massachusetts relating to the sale of poisons is as follows:[1]

" Whoever sells arsenic (arsenious acid), atropia or any of its salts, chloral hydrate, chloroform, cotton-root or its fluid extract, corrosive sublimate, cyanid of potassium, Donovan's solution, ergot and its fluid extract, Fowler's solution, laudanum, McMunn's elixir, morphia or any of its salts, oil of pennyroyal, oil of savin, oil of tansy, opium, Paris green, Parson's vermin exterminator, phosphorus, prussic acid, "rough on rats," strychnia or any of its salts, tartar emetic, tincture of aconite, tincture of belladonna, tincture of digitalis, tincture of veratrum viride, or carbolic acid, without the written prescription of a physician, shall keep a record of such sale, the name and quantity of the article sold, and the name and residence of the person or persons to whom it was delivered, which record shall be made before the article is delivered, and shall at all times be open to inspection by the officers of the district police, and the police authorities and officers of cities and towns; but no sale of cocain or its salts shall be made except on the prescription of a physician. Whoever neglects to keep or refuses to show to said officers such record shall be punished by fine not exceeding fifty dollars. Whoever sells any of the poisonous

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[1] *Revised Laws*, 1902, chapter ccxii., section 2.

articles named in this section without the written prescription of a physician, shall affix to the bottle, box, or wrapper containing the article sold a label of red paper, upon which shall be printed in large black letters the word Poison, and also the word Antidote, and the name and place of business of the vendor. The name of an antidote, if there be any, for the poison sold, shall also be upon the label. Every neglect to affix such label to such poisonous article before the delivery thereof to the purchaser shall be punished by fine not exceeding fifty dollars. Whoever purchases poisons as aforesaid and gives a false or fictitious name to the vendor, shall he punished by fine not exceeding fifty dollars. But nothing in this Act shall be construed to apply to wholesale dealers and to manufacturing chemists in their sales to the retail trade, nor to the general merchant who may sell in unbroken packages containing not less than one-quarter of a pound, Paris green, London purple, or other arsenical poisons for the sole purpose of destroying potato bugs or other insect life upon plants, vines, or trees : *Provided*, that such merchant complies with the provisions of this section in respect to recording such sale and labelling each package sold."

The writer supposes that if a person is determined to get a poison for the purpose of deliberate murder, he or she will find out a way in spite of this law. But undoubtedly the statute is of some value in giving a hot-tempered, impetuous sinner a little time for reflection.

Nature of the Crime.—There is no hot-blooded impulse in such an affair, like that which urges on the murderer to shoot, stab, club, or strangle his victim under the influence and provocation of uncurbed frenzy. There is plenty of time for retreat from the evil purpose. Everything about the case is cold-blooded, calculating, and cowardly. The execution of the plan, like its invention, affords added evidence of deliberate malice. The murderer mixes the poison with the food or the drink of his victim, and the latter dies miserably after a longer or shorter interval of suffering.

What wonder, then, that as the physician stands at the bedside of the victim of such a crime, he should be almost overwhelmed as the true nature of the case becomes open to him, and should ask himself seriously : How can I best fulfil my duty (1) to my patient, to save him from impending death ; (2) to the State if, in spite of my efforts, death is the result ?

It is obvious that the immediate primary duty of the medical attendant called into the care of a case of suspected poisoning is to solve the question of diagnosis. He must try to answer

the fundamental inquiries: 1. How do I know that this person is suffering from the effects of poison? 2. What are the data which distinguish this attack from an attack of sudden illness due to natural causes? These questions are not so simple and so easy to answer as they appear. It is not at all a difficult thing to go astray in diagnosis; mistakes are possible in either direction. There is so close a similarity, amounting almost to identity, between the symptoms of some poisons and those of some diseases that the latter, being more frequent and familiar, the more readily occur to the mind of the attendant. Thus it has unquestionably occurred that through mischance in diagnosis crime has escaped detection and murderers have gone clear.

Recall, for example, a recent notorious case in Massachusetts, the infamous Robinson case of poisoning. In this case, a woman, urged on by the low motive of cupidity, killed one after another of her kindred by arsenic, in order to get the money coming from the insurance of their lives upon policies in which she was named as beneficiary. In the course of a few years nine persons, including two of her own children, died in her house under her immediate care, and in the bodies of all save two (a brother-in-law and a niece) arsenic was found at their exhumation at the time of final detection of the repeated murders. In every one of the cases a reputable physician was in attendance. The woman's method was to await the occurrence of some comparatively slight illness in her victim, then to call a physician; and after his mind was pretty well established upon a diagnosis of a perfectly innocent character, she would give the arsenic in small and carefully graduated doses at first, so that the transition should not be too sudden to a serious and alarming condition, and finally she pushed the poison to a fatal issue. It thus happened that the deaths were postponed for periods of from six days to six weeks after the attack began. In every case except the last, the physician was deceived by the clinical course. Looking backward, it is easy enough to interpret these singular symptoms which at the time were somewhat anomalous as incidents in pneumonia, typhoid fever, meningitis, and Bright's disease, from which these patients were believed to be suffering, and from which, according to the death certificate, they died. At all events, educated and experienced physicians, one after another (for the same physician was not called twice in this family), missed the true diagnosis and cause of death, and Mrs. Robinson went on poisoning her relatives until she over-reached herself, and was detected in the poisoning of her own son.

The more recent performances of the nurse, Jane Toppan, whose murders by poisoning are fresh in memory, are illustrations of the same sort.

Such cases teach us not to be over-confident about our readiness to detect poisoning at first sight. They tell us that the picture presented by a person suffering from the effects of some toxic agent is not so characteristic as to announce at once either the general or specific cause of the trouble. The diagnosis of poisoning is, in truth, not so easy that mistakes are inexcusable. Suppose, for example, one is called to the bedside of a man in a state of coma. The attendant can not rouse him; the pulse is slow; the respiration is irregular; the skin is livid and cool, or it may be hot.

Is it a case of opium-narcosis, or apoplexy, or uremia, or the second stage of an epileptic seizure, or compression of the brain from a blow, or alcoholic intoxication ?

Or the physician finds his patient vomiting; complaining of great pain in the abdomen; tormented by thirst, but unable to retain water; weak and faint; with diarrhea, perhaps; tender over the belly; the pulse quickened and weak; the face pinched; and the skin cold and clammy.

Will he say this is surely a case of irritant poisoning, like arsenic? But why may it not be cholera morbus; Asiatic cholera; strangulated hernia; rupture of some of the viscera or of an aneurism; a tubal pregnancy; a pancreatic apoplexy; or appendicitis ?

Difficulties of Diagnosis.—These hypothetical cases will serve to suggest the practical difficulties which attend a diagnosis of poisoning. In truth there is almost nothing about a case of poisoning which at once establishes its true character and leads directly to correct treatment. Nothing is pathognomonic of poisoning in general or of specific poisons in particular. There is no demonstrative, objective, physical sign—as in measles, diphtheria, or a broken bone—which enables us to say at once and correctly that the patient is suffering from poison. The diagnosis is not perfectly obvious. But, on the other hand, it may be said of every case of poisoning that once we strike the trail, and catch the clew, the thing is tolerably clear to any intelligent observer. What are some of the pointers which will set one on the right track in such an emergency and save him from embarrassing and lamentable error ?

The clinical history of the case may arouse suspicion. If the symptoms appear suddenly in a person otherwise healthy, it is certainly suggestive. It is the common character of most poisons when taken in the large doses in which they are usually

administered with criminal intent, to produce serious effects either immediately or within a very short period after they have been swallowed. Different persons differ in this respect, and the extremes are quite far apart. Thus, prussic acid acts instantly; oxalic acid and strychnin act in a few minutes; and arsenic and other irritants act within half an hour. But the rapid onset of symptoms is, as a rule, characteristic. Yet this rule has limitations and exceptions that should not be overlooked. The action of poison may be delayed by conditions that postpone the effects, as will be seen later. Certain diseases, such as intestinal perforation, exanthemata, apoplexy, cholera morbus, epilepsy, and even epidemic influenza manifest their initial symptoms with great suddenness at times. Moreover, the patient may be suffering, not from one large dose given with unlawful intent, but from repeated small doses with similar criminal purpose. Under such circumstances the mistaking the case for one of disease would be all the more easy.

The relation of the symptoms to the last meal of food may be suggestive of poison. In the majority of cases of murder by poisoning (the class we are considering), the lethal agent is administered in food or drink, so as to avoid the suspicions of the victim and insure his swallowing the noxious material. Nearly all the celebrated cases of this kind have this history in common, that the poison was taken in food or in drink. Taylor says this is by far the most important point to observe in studying the symptoms and fixing the diagnosis of acute poisoning. Occasionally a medicinal draught has served as a vehicle, but generally, the person to be destroyed being in health, gets his fatal dose in a more commonplace way at his table. Therefore, one will not forget to inquire just the time that the symptoms presented themselves after the last meal or last ingestion of fluid. If the fact can be established that no food or drink has been taken for many hours before the attack, the probability is that some natural cause resembling poisoning lies at the bottom of the symptoms. The caution in applying this observation too strictly is indicated in the fact that these same natural causes—some of them at least—frequently develop after a hearty meal and may arouse false suspicions. For instance, apoplexy, resembling opium-poisoning; or cholera morbus, resembling an irritant. Moreover, poisons *may* be administered in some other way than by the mouth, and therefore have nothing to do with the food. In one case arsenic was introduced into the vagina of a woman and she died in five days. But such instances are extraordinary varieties and do not much affect the general rule which has been stated.

If several persons partaking of the same drink or food show subsequently, after about the same interval, similar symptoms of sudden illness, it amounts very nearly to a demonstration of poisoning. Perhaps in such a case a portion of the company show the effects and the rest escape; then inquiry may lead directly to the noxious article of which the sick ones partook and others did not.

Taylor[1] relates the story that, at a dinner party, a portion of the guests took port wine, the rest abstained. Those who drank the wine soon showed symptoms of some irritant poison; the rest of the company remained unharmed. Analysis of the remaining contents of the bottle showed it to contain a large amount of arsenic.

It is well to bear in mind that, while the symptoms following a meal and affecting a larger or smaller section of the company may strongly suggest malicious poisoning, the toxic effects may be wholly innocent of crime, and may be due to the unwholesome character of the food itself—the development of *ptomains*.

The character of the symptoms, aside from the manner and time of their onset, is another diagnostic aid. In spite of the similarity, almost identity, which exists between the symptoms of some poisons and of some diseases, there is yet in a case of poisoning, generally, some element or feature which is striking and peculiar—something quite distinctive and pathognomonic, if it is only detected.

This can be illustrated in a general way only: Contracted pupils are a clue to opium. Vomiting, with persistent burning pain, suggests arsenic. Widely dilated pupils indicate belladonna and stramonium. Numbness of the tongue and throat and vomiting are signs of aconite. Repeatedly recurrent convulsions, with perfect mental action in the interval, tell of strychnin.

Certain *objective* additional aids are sometimes available: For example, in carbolic acid, the bleaching-white of the lips and mouth, and burning on the skin of the chin; sulphuric acid, with its black stain; and nitric acid, with its yellow stain. These caustic agents, however, are almost never used for homicidal purposes. In these *objective* evidences of poisoning we must not forget to include vomited matters, intestinal discharges, and urine. In the sediment of the vomitus we may be fortunate in finding with the naked eye or with a lens the very toxic agent, arsenic, for instance, which is doing all the mischief. Diarrheal dejections containing blood are also sug-

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[1] *Principles and Practice of Medical Jurisprudence*, i, p. 192.

gestive. *Chemical* aid in the diagnosis of vomitus and urine is obvious.

In this study of the clinical diagnosis of poisoning we should not omit from our consideration the fact that additional difficulties arise from various conditions and circumstances modifying the action of poisons in the human system. If the symptoms of poisoning were always the same in degree and kind for the same class in all persons, however they might resemble innocent disease, we should be in a better position for correct conclusions. But in making up the case from the data in our possession in a given instance, we have to take into account the directions and degrees in which the action of poisons is affected (1) by the state of the poison itself; (2) by the state of the person receiving it.

As a rule, the greater the quantity of the poison which is swallowed, the more severe are the symptoms and the more rapid is their progress. Again, the dose of the poison largely determines and regulates the nature of the symptoms, as well as their degree. Many poisons which in larger doses act on the nervous system, in small doses affect the alimentary tract as irritants. Oxalic acid in a large dose kills by shock; in a small dose, it acts fatally on the heart; in a smaller dose, it affects the brain and the nervous system, causing spasms; and in a still smaller dose, it causes death by coma.

The *physical or molecular state* of the poison which is administered determines its activity. A poison in a state of vapor is of all forms of toxic agents the most active. A poison in solution comes next, because absorption is easier and contact with a larger surface is more surely secured. While, lastly, an agent or poison that is insoluble in water or the fluids of the digestive tract is probably inert or nearly so.

In close relation to this fact is the fact that whatever chemical combination modifies the solubility of poison, modifies its activity. Morphia as muriate or acetate is more active than the salt alone. It is obvious, too, that the dilution of the poison, as a rule, affects its action to lessen it, although there are some important exceptions, like prussic acid. Again, the mechanical state of the poison, not less than its chemical, is important to its activity. If the poison is given in a kind of food or fluid which covers and protects it, the toxic effect is delayed and diminished. Arsenic has been given in a suet dumpling and has proved harmless. Poison given in mucilage or oil is slow in action. Carbolic acid in jelly has been demonstrated to be innocent. In accordance with this principle is the fact that poison administered to a person who has just eaten a hearty

meal will do its fatal work slowly; while the action of the same agent taken into an empty stomach is rapid and sure.

The *avenue* by which the poison reaches the blood modifies its rapidity and vigor of effect. First in order in this respect is: 1. Hypodermic administration, insertion of poison in a wound, or inhalation, as a gas. 2. Application of the poison to a *serous* membrane, like the peritoneum. 3. Absorption by way of the mucous membrane, as when it is swallowed and taken up from the stomach or intestines. 4. Application to the unbroken skin. Here action is very slow or wholly negative, except in cases of corrosives.

Besides these various conditions pertaining to the *poisons*, we may discover *certain states in the person attacked*, which will modify one way or another the noxious power of the agent used.

Habit.—Broadly stated, we know that the habitual use of a poison tends to diminish its activity and potency with regard to the person using it. This is especially true of organic poisons. Familiar examples are opium, morphin, alcohol, and tobacco. Whether the same rule applies to the metallic *inorganic* poisons, authorities differ. The stories of the Styrian arsenic eaters are doubted by some eminent toxicologists.

Idiosyncrasy.—Without any relation to habitual use of poisons, there resides in some individuals a power of resistance to the effects of poison which we can best describe as idiosyncrasy. Christison tells of a man who took an ounce of solid opium without any effect, although he was quite unaccustomed to use opium in any form. Idiosyncrasy, too, plays tricks in the other direction and lends increased potency to poisons sometimes. With some persons a small dose of mercury, just enough ordinarily for a laxative, will cause alarming salivation. The same thing is observed in a very familiar, commonplace way in the effects of alcohol. Peculiarities due to idiosyncrasy sometimes result in paradoxical effects. There are cases on record of sulphate of magnesia acting as a narcotic, and of opium acting as a purgative.

The state of health of the person to whom the poison is given may have an influence on the activity of the poison; and this in either direction to increase or to diminish. Certain diseased states create a tolerance of both organic and inorganic agents. Thus, in dysentery, tetanus, cholera, hysteria, and delirium tremens opium is borne in *large* doses. In spinal paralysis strychnia is also tolerated in full doses, and in syphilis iodid of potassium seems to have no limit. On the other hand, the susceptibility to poison may be *increased* by

disease. This would naturally follow where poisons are administered whose action would intensify symptoms of disease already present. Thus, arsenic plus gastric or intestinal irritation or inflammation; or opium plus cerebral congestion or apoplexy, are clear contraindications.

Advancing age increases the person's susceptibility also. It is a well-known fact that all drugs, especially those of the narcotic group, should be given to aged patients with caution. It hardly needs to be said that at the other extreme of life, in infancy and childhood, the susceptibility is very great also.

Sleep retards and impairs the activity of poisons in the human system, at all ages.

The state of the stomach of the person poisoned, whether full or fasting, has a decided influence on the rapidity of the absorption of the toxic agent; and this apart from the mere mechanical mixture of the poison and food already alluded to, as affording a shield to protect the tissues from the toxic effects.

Treatment.—Now, having by a study and comparison of the symptoms of the patient, the time of their onset, their mode of attack primarily, their progress, and their special character, reached a diagnosis of poisoning, the attending physician is brought squarely to face the next problem in the case—what to do to avert further disaster, to combat tendency to death, to save the patient. In other words, What will be the treatment? For, although there may be a strong and well-founded suspicion that the poisoning is felonious, with a malicious purpose to murder, the duty to do everything practicable to save human life is made none the less urgent by that fact. Rather it is a more solemn duty placed upon him to at once bring the patient to health again and to thwart a villainous intent. This matter of the treatment of poisoning is in the domain rather of therapeutics than of legal medicine, so that it will be alluded to in a general way only.

The indications are these: 1. Get the poison, the unabsorbed portion, out of the stomach as soon and as completely as possible. 2. Neutralize what cannot be removed. 3. Favor the natural elimination. 4. Be on the lookout, by expectant treatment, to combat any special, dangerous conditions as they arrive.

The author will not enter upon any discussion of the details of treatment in fulfilment and application of these principles. Legal medicine is but remotely interested in the proper choice and dose of emetics; the proper method of using the stomach-pump; the distinction between chemical, mechanical, and physiological antidotes; or the correct mode of selecting and administering antidotes.

One or two considerations, however, having a medicolegal value may be appropriate at this point : The attending physician should take care in his treatment not to add to the patient's risk and danger of dying. It is better to do nothing than to do harm. Especial care should be taken in the management of homicidal poisoning, for every act of commission or omission in the treatment will have to be related and will be subject to criticism more or less severe, according to its nature. On this account it is best to follow a conservative course and not to go outside the well-established lines of experience in pursuing a course of treatment. The trial of new methods and of new antidotes ought not to supplant orthodox and well-tested procedures. Reserve, therefore, observations upon the antagonism of organic poisons for cases of accident and suicide that will not become the subject of fiery criticism at a capital trial. When the author of this volume has heard of the bold manner in which powerful poisons like atropia and strychnia have been injected in deadly doses under the skin to serve as antidotes for other equally poisonous agents taken into the system through the stomach—the supposed antagonism being founded on some experimental observations on the lower animals, and the words antagonist and antidote being regarded as synonymous—he has wondered whether even desperate conditions justify the taking of such desperate chances. It is certain that we should not be so heroic in our treatment of homicidal poisoning, lest we be open to the charge of finishing successfully what a murderer had begun, but might have failed in completing if cautious treatment had been followed.

In Case of Death.—Let us suppose, however, that in spite of the best efforts, intelligently and zealously used, but with due conservatism, to save the patient's life, a fatal result ensues. What is now the physician's duty in the matter, with reference to the future management of the affair, assuming that there has been *reasonable* ground for a suspicion that the case was one of poisoning ? The word " reasonable " is emphasized, for in such a serious matter as a case of poisoning haste and error are themselves almost crimes. There can hardly be imagined a state of things more hurtful of a physician's reputation than a false diagnosis in this emergency and direction, and a garrulous announcement of suspicions. If, in a given case, the attendant thinks that his patient has been poisoned, a judicious reserve in expressing his thoughts will do no harm. The time for publicity will come in due course and soon enough. This reserve, however, is subject to one exception. There is no occasion in medical practice which better illus-

trates and justifies the usefulness of consultations than this. Hence, for both his present comfort and future peace in the management of a case of poisoning (or one *presumed* to be such), the attending physician should use the aid which is afforded by taking counsel with a medical friend in whose ability and discretion he can confide. Whether he is certain or uncertain in his own mind as to the nature of the case, this sharing of his responsibility is clearly prudent and proper. This is especially important in helping to direct his conduct in the event of the patient's death. In that event three courses are open: 1. To write the usual form of death certificate, giving a candid opinion of the cause of death " to the best of one's knowledge and belief," without evasion. 2. To give information of the case to the police authorities. 3. To report the affair at once to the officer, coroner, or medical examiner who, in any event, whether the knowledge of the matter comes to him directly from the attending physician or indirectly through other channels, such as the local board of health or the police, must undertake the official investigation. It is a death under suspicious circumstances and the body cannot be disposed of by burial or cremation until either it has served as evidence to confirm the suspicions, or the doubt has been removed in some other way.

Inasmuch then, as the medical examiner or coroner will, in the natural course, be called into the affair, it will be the most prudent thing to do if the initial report goes directly to him, and the attendant thus avoids taking any responsibility after the patient's death. Such an open method will place him in the best possible relation to the affair in all subsequent proceedings. It will relieve him from any imputation of a wish to evade or conceal. There is much to commend it, nothing to discredit it.

In this transfer of responsibility, however, at the point where publicity is inevitable in a certain official way, where, at all events, the case passes from private hands to public hands, the attendant does not transfer also his personal interest in the matter.

It is the duty of the public officer into whose control the investigation of the affair now comes to ask and to answer, if he can, the question, " What are the cause and manner of this death ?" The attending physician suspects that his patient has been poisoned. The very first thing to do is to determine if the dead body shows any appearances, external or internal, to verify that suspicion. This duty rests on the medicolegal pathologist, acting for the State. Meanwhile, in the interval

between the death of the patient and the delivery of the body
into the hands of the proper officer of the law, care should be
taken that nothing is done to the body that may in any way
impair the value of subsequent observations. Icing may be
permitted, but the use of any other preservatives should be
interdicted; above all, the undertaker should be forbidden, for
obvious reasons, to enter upon any embalming performance.

It follows, then, as a matter of course, upon the attendant's
statement that the death was, in his belief, due to poisoning
through the unlawful act of a third person, that an autopsy
must imperatively be had. The obvious purpose of this is to
confirm and control the clinical and other evidence. It is a
search for new facts. It is a fascinating, but not always a
fruitful search. It is a search, however, that is clearly neces-
sary. The physician's relation to the patient as his medical
attendant brings him by courtesy if not by right to have a
share in it. If residing where coroners are in office, as they
are in England, it is not unlikely that the attendant himself
will be called upon to make the examination. In Massachu-
setts, Rhode Island, and Connecticut, where, under the law, a
medical examiner conducts the autopsy, the courtesies of an
invitation include the family physician.

Many facts might readily be offered to illustrate the rule
that post-mortem appearances in cases of poisoning are cor-
roborative, not conclusive or demonstrative proof. At the best,
we are in a position to say, in general, after an autopsy, that
whatever we have found is suggestive of poisoning or consist-
ent with a clinical history of poisoning. But we cannot say
that the appearances constitute positive *objective proof*, except
in rare instances in which certain odors confirm what the eye
has seen. It would surely never be safe or right to go before
a jury in a case of suspected murder by poisoning and expect
to get a verdict with only clinical and anatomical data. We
want one other kind of evidence, and that is the discovery of
the poison in the tissues. For this we seek the aid of chemis-
try. Whatever we have found or have missed finding in the
post-mortem examination of the body of one believed to have
been murdered by poison, our duty is not done until we have
submitted in proper form, to a trustworthy chemist, all avail-
able material for satisfactory chemical analysis.

The author thinks it is proper to remark right here that he
does not think any person ought to undertake a toxicological
analysis for judicial purposes who is not a chemist; that is, no
one should undertake it in a case of murder who does not make
chemistry his profession, his first work in life. There are no

more difficult technical problems than the detection of an alkaloid in a liver or in the contents of the stomach, and such analyses have to be done with extreme care ; and unless a man is working all day and every day in the laboratory he ought not to undertake such work for judicial use.

How to Manage Material for Chemical Examination.—As this later duty of preserving and transmitting anatomical material for chemical analysis in a proper manner is a most important one, though often performed carelessly, so as to embarrass and hinder if not absolutely to annul the value of the chemist's work, it is worth while to give a few moments' attention to this matter, and to formulate some useful, practical rules that may serve us in time of need. The need of irreproachable cleanliness of utensils and surfaces coming in contact with suspected matters submitted as toxicological material is obvious. It is best to have new basins and bottles. At all events, manipulation of organs at the autopsy should be such as to leave it certain that any poison found in them got there from sources wholly foreign to the examiner. His relation to the case should be above all question or suspicion.

What organs or parts of the body should be sent to the chemist ? It is a safe rule to follow that one cannot easily send *too much.* A common mistake is to transmit the stomach alone, as if that were enough. The chemist regards this organ as of secondary value toxicologically. It contains the *unabsorbed* residue of poison ; it does not demonstrate the real cause of death. Whatever, then, can be used for chemical analysis to aid in solving this question should be saved and sent.

The writer's custom is to deliver the following in separate bottles: The liver. The spleen and kidneys. The stomach and contents. The intestines and contents. The brain. The urine or blood. Muscle sometimes is added when special reasons are present.

These materials are not to be treated as ordinary pathological specimens are treated. They are not to be carelessly wrapped up in a newspaper and sent off to the laboratory. They are evidence, and special precautions for their identification, preservation, and defense against meddling are imperatively required. The old way was to use an empty pickle bottle, to fasten down the cork with a rubber cover, secured with string and knots, the latter covered with sealing-wax. The modern way is to employ the readily available glass preserving jars, found in every grocery store, and so securely closed that only glass is in contact with the contents. Into these, six in number (three two-quart jars and three one-quart),

we place the several organs; we use no preservative; we avoid sealing-wax. A label gives the name of the organ inclosed; describes the source (the name of the deceased); gives the date of the autopsy and the name of the examiner; and the date of the delivery to the chemist.

If the precaution is used to lock these bottled specimens in a closet or cupboard of which the custodian keeps the key, any method of so-called sealing is superfluous. This precaution of keeping material under a lock is always useful if not essential. It enables the examiner to state under oath that the material for chemical analysis was wholly in his control; out of the reach of interference, until he transferred it. It is better to deliver the bottles in person to the chemist, without the intervention of a third party. This enables the examiner to describe to the chemist what he has found anatomically, learned clinically, and desires chemically. It is more direct and saves the need of tracing the organs from the autopsy room to the laboratory through any devious way. If personal service is impracticable, a trustworthy private messenger should be employed; better *two*, to save all chance of misadventure. It is never prudent to use the ordinary express service.

In a case of any importance it is much better to have the assistance of two chemists for the search for poison in the organs, than to rely on one only. Indeed, the prosecuting officer would probably require this if it were left to him. This affords opportunity for *control* analysis. It averts accidental mishaps and it prevents the possibility of disaster by death or sickness. Therefore, in a homicidal case the anatomical material should be divided between two chemists. Care should be observed in taking note and making a memorandum of the time when the delivery was made.

It is not alone, however, in the chemical analysis of anatomical material that the services of a skilled chemist are required in a case of homicidal poisoning. If the medical attendant has been properly appreciative of his true relation to his patient and to the State, he has been on the alert for every kind of evidence that came in his way during the patient's life and after his death. While the physician is not to assume the rôle of a detective in its offensive sense and make himself unnecessarily officious, it is still his duty to observe and save all proofs which he can. Hence, he will take into his possession and, under the instructions of the prosecuting officers of the State, will deliver to an expert chemist all matters in any way under suspicion, or that may be useful as chemical material, which he finds about the premises. For example: Vomited matters;

urine (which has a paramount value); all powders and solutions that are clearly not above suspicion; unwashed wineglasses and tumblers; remnants of food. Concerning these he will use the same precautions relating to cleanliness, safe-keeping, identification, and transmission to the chemist, as in the case of post-mortem material. In this preservation of sick-room matters, the coöperation of a trustworthy and intelligent *nurse* is of obvious importance and assistance.

The author has said that the physician should not be a detective. Clearly his primary duty is to relieve the distress of his patient and to avert death, if possible. But in this course of duty he may, in the search for facts relating to diagnosis, come on other facts of the greatest value as proofs of the homicidal character of the case before him. It is obvious that the medical man has no right to ignore these data; it is his duty to take note of all things that have any bearing on his case. By taking note is meant that he shall make written memoranda of every detail which may be of any value in bringing a murderer to deserved punishment—memoranda not only of the patient's condition and of the medical attendance, but of what the patient has taken as food or drink just before the symptoms began and since. And of these points: Who has prepared or given food or drink just before the onset of the symptoms? How does this person act? Is he truthful and candid in his manner? Or is he evasive and reticent? Does he show a *special* desire to prepare the patient's food or to serve it to him? Does he show a disposition to interfere with the medical treatment? Are there any indications of enmity between the two parties? Does any motive appear in the behavior of the suspected person to do the patient mischief? Is there any interest in his death? Does he hinder friends or kindred from seeing the patient? Does he show a desire to get rid of matters (such as urine or vomitus) that may contain proof of crime? Or does he object to their examination?

If the patient dies, is there any attempt to hurry the funeral? Or any marked desire for early embalming? Or any attempt to get a *false* certificate of the cause of death? Or any urgent motion for cremation?

Upon these and various other allied matters, the attending physician in a case of homicidal poisoning has it in his power to be of the greatest assistance to the officers of the law. His failure to observe the conduct of suspected persons, his indifference to this side of the affair, may readily be misinterpreted as showing an unjustifiable sympathy for an accused person, and may easily put him into a false position.

CHAPTER XXXI.

DEATH BY CERTAIN NOXIOUS GASES.

As an appropriate supplement of the topic considered in the last chapter, the writer asks attention in this chapter to some of the toxic gases, the inhalation of which is a source of very real danger and not infrequently death. These gaseous agents are often spoken of as causing death by suffocation, as if that were their only harmful power. But we shall see, the writer thinks, as we go forward, that their capacity to act as poisons, completely altering the character and functions of the blood, and destroying life in that way, is demonstrated; and we shall understand that they accomplish much more than to bring about asphyxia by the exclusion of atmospheric air from the lungs; and that they are, therefore, really genuine poisons. First let us study that widely distributed and best known of all the harmful gases—carbonic monoxid as it is found in illuminating-gas. This product the chemist's skill has extracted from two of the most abundant of Nature's materials, from coal and water. If kept in proper subjection and properly used, it is an important agent, as artificial light, in promoting human welfare and comfort. But at the same time it has a poisonous quality which is dangerous, and which is becoming recognized as an available means for the accomplishment of evil purposes.

The writer's attention has been directed to this subject very forcibly by the increasing number of deaths which official investigation has found in recent years to be due to the inhalation of this gas. The writer has made a tabular statement of all the deaths from gas-poisoning in the southern district of Suffolk County which have been called to his notice as medical examiner during the past twenty-six years. This table brings out some remarkable contrasts; it suggests a mortality which is preventable, and indicates to what degree an unrestrained indulgence in commercial thrift may do mischief to the public health:

DEATHS BY ILLUMINATING-GAS.[1]

Year.	Suicides.	Accidents.	Totals.
1877			
1878		2	2
1879			
1880			
1881		1	1
1882	2		2
1883			
1884			
1885		1	1
1886			
1887			
1888		1	1
1889		1	1
1890		4	4
1891	2	1	3
1892	10	5	15
1893	3	3	6
1894	9	9	18
1895	5	9	14
1896	7	24	31
1897	12	21	33
1898	12	23	35
1899	21	14	35
1900	6	6	12
1901	4	6	10
190-	12	15	27

The manifest difference between the earlier and the later years of the period included in the table is sufficiently noteworthy to suggest an inquiry into its cause. The writer thinks the explanation is found in two facts. One is that the company which supplies the illuminating-gas to Boston consumers distributes at present a more poisonous product than formerly came from the street mains ; and the second is that enterprising, but not always discreet journalism, widely advertises a reliable means of self-destruction every time the details of a suicide by this method are published.

The Manufacture of Gas.—In order to understand more fully the difference between these two gases it will probably not be out of place to give a brief view of the processes of manufacture.

Coal gas is made by the destructive or dry distillation of some form of bituminous coal, the coal being heated in closed retorts to drive off volatile matter, while coke remains in the retort as a residue. Upon the management of the heat used, as to intensity and the rapidity or slowness of the process, the

[1] These deaths occurred in a population of about 250,000. In recent years they have been more numerous as causes of suicidal deaths than any other causes except pistol wounds.

amount and nature of the gas depend, especially as to richness in illuminating power. The gas carries with it from the retorts a number of by-products which must be removed in the purifying. Some of these by-products, such as coal-tar and ammonia, are valuable commercially; while others, carbonic acid, sulphuretted hydrogen, sulphur, etc., are useless and harmful.

On the other hand, the water-gas process consists in a large upright, firebrick-lined, iron generator, so constructed as to admit of anthracite coal or coke being placed in the lower part and brought to nearly a white heat, when water in the state of steam is blown through. In the presence of this highly-heated mass of carbon, a decomposition of the steam takes place, the ultimate elments of the water, hydrogen and oxygen, are set free and proceed to form new combinations, a little of the hydrogen taking up carbon to form carburetted hydrogen, the greater part going off free; while the oxygen present in the steam passes off almost entirely in combination with the carbon as carbonic oxid, the result always of the incomplete combustion of carbon.

The mixture of gases so far produced is known as the " body gas," and consists of marsh gas, carbonic oxid, and hydrogen, with a little carbon dioxid, sulphuretted hydrogen, etc. This " body gas " burns with a blue flame and has but feeble illuminating power, requiring to be enriched in order to burn with a white flame for illumination.

The enriching, or carburetting, as it is sometimes called, is carried out in the upper part of the generator or in separate retorts, by pumping in crude petroleum or some of its products rich in carbon, such as crude naphtha. The intense heat of the chamber decomposes this crude oil into permanent gases, especially the heavy hydrocarbon gases, known as illuminants, which mix with the body gas, and the entire volume of gases is conducted off to be purified and stored for use There are no by-products of value.

The candle-power of coal gas depends upon the quality of the coal used and the care taken in the distillation; while the candle-power of water gas is dependent upon the amount and nature of the crude petroleum or naphtha used in the enrichment.

There exists a very general and quite erroneous idea that water gas is odorless; the body gas may have but little odor, but considering the odoriferous material used to enrich it, the finished product must have odor, and a far more disagreeable, penetrating, and lingering odor than coal gas.

Chemical Composition of Illuminating-gas.—There is a con-

siderable difference in the composition of these two gases, and it is here that we can look for the positive cause of the great increase in the number of cases of gas-poisoning and the greater fatality attending them, since the introduction of what the gas engineers call the " New Process Gas." For the purpose of comparison the Massachusetts State Inspector's reports will be used, giving an analysis of the coal gas used in Boston some years ago and of the water gas used at the present time:

	Coal Gas.	Water Gas.
Illuminants	6.19	14.39
Marsh gas	35.77	23.43
Hydrogen	49.39	31.20
Carbonic oxid	6.70	29.30
Nitrogen	1.37	1.34
Oxygen	.03	.03
Carbonic acid	.55	.31
	100.00	100.00

In the manufacture of either gas there is a variation in the finished product from day to day, or even hour to hour; but the variation is not very great, so the figures obtained by an analysis at any time represent quite well the general composition of the gas. In the analysis here given special notice is called to the fact that the illuminants are present in the water gas to nearly three times the amount in the coal gas, and the carbonic oxid is more than four times as abundant. If we deduct a conclusion upon the basis of the relative amounts of the poisonous carbonic oxid present, it would seem that water gas is four times as poisonous as coal gas, but, judging from experiments upon the lower animals and from actual cases of poisoning, water gas appears to be more fatal than in this ratio.

The injurious quality of either gas is generally considered to be due almost entirely to the presence of carbonic oxid, the other ingredients acting only as negative poisons, in that they do not support respiration and by their presence diminish the supply of oxygen.

Feeble poisoning qualities are attributed to marsh gas by some writers, but in consideration of the fact that, since the introduction of the safety lamp to prevent explosions in mines, miners can work where this gas is present in mixture with the air in more than explosive quantities, and feel no bad effects from respiring it, the presence of marsh gas can hardly be considered as a factor in cases of poisoning from illuminating-gas.

The illuminants, consisting chiefly of olefiant gas, with small amounts of acetylene and other heavy hydrocarbons, are not looked upon as poisonous; but it is by no means positive that

they are harmless, and it may be that the large amount of these in water gas may have something to do with rendering this gas more poisonous than the proportional increase of the carbonic oxid over that of coal gas.

There is no question that carbonic oxid is a very active and fatal narcotic poison when respired in sufficient quantity, and experiments on the lower animals point to 0.5 per cent. as the maximum amount of this gas to be present to reach the danger limit. Actual cases of poisoning show also that the presence of this amount will prove fatal, since deaths have occurred from the continued breathing of a mixture of coal gas and air, where the gas was present to an extent less than 9 per cent., for at about this amount the mixture becomes explosive; but in the rooms in which these cases of poisoning occurred a candle had burned out and a stove had a live fire in it, still there had been no explosion; consequently, upon the basis that 8 per cent. of coal gas was present, 6.5 per cent. of which was carbonic oxid, a simple calculation would give 0.52 per cent. as the actual percentage of carbonic oxid present.

The only excuse for making and distributing this very poisonous illuminant is the economic excuse—the excuse of thrift. Water gas is four or five times more dangerous to the public than coal gas, but it costs much less in the manufacture; and the custom of combining the two so as to form a compound of greater value for domestic lighting does not materially modify the possibilities for mischief which reside in the undiluted product.

Attention is called again to the fact that the introduction of water gas has been followed by a noteworthy increase in the number of carbonic-oxid deaths each year since the change. This increase is not a surprise to those who uttered emphatic warnings and publicly prophesied the impending harm when the subject was discussed at the time when a legislative sanction was sought for the new enterprise of giving the people water gas; nor can it appear extraordinary when the conditions and circumstances usually attending the fatal events are studied.

Anatomical Appearances after Fatal Poisoning.— From the considerable number of these fatal cases which are available, the writer has selected one which is typical to serve as a representation of the entire group:

John P., a house-painter, fifty-seven years old, was sent January 16, 1892, to do some inside work in an unoccupied room which had been leased as a store or office, in the second story of a building the first story of which was used for the sale of clothing. P. was alone at his work until half-past two

in the afternoon, when a gas-fitter went to the place and connected the meter in the hallway with the fixtures in the new store, the supply having been cut off since the place was vacated many weeks before. The gas-fitter's work was finished in half an hour, and at 3 o'clock, having tried the three gas-fixtures and found all of them tight and secure, he left the premises with P. in sole possession. He was positive that no gas was escaping when he went away.

Three hours and a half later persons passing on the sidewalk outside the building noticed the odor of gas and notified the clothier, who proceeded at once to investigate. He went upstairs, found the door of the room in which the painter had been at work locked on the inside. The odor of gas was very strong in the entry way. A wrench was found and the gas-supply was cut off at the meter. It was now after 7 o'clock, and quite dark. The room was filled with gas. The man groped about the room and found the keys at the three bracket fixtures turned on full. The windows in the room were closed. P. was found lying on the floor in the middle of the room, limp and warm, but without sign of life. The interval, then, in which the painter was alone in the room and within which fatal toxic effects followed the inhalation of the gas was four hours; the actual time of exposure was probably shorter.

The autopsy was made thirty-eight hours after the death. External inspection found a diffused fresh pink discoloration of the skin upon the dependent parts, in marked contrast with the usual dull-blue lividities. The face had a fresh color, unlike the commonly observed cadaveric pallor. The conjunctivæ were slightly injected; the corneæ were bright. The lips were of a life-like tint. The tongue was behind the teeth and not between them. There was a little vomitus on the beard. A slight odor of illuminating-gas (naphtha) was exhaled from the body.

The internal examination disclosed characteristic appearances. The muscles had a fresh florid color. The structure of the heart was normal; the cardiac cavities contained blood of a bright cherry-red color, nearly fluid, but showing a few small, soft, stringy clots. There was no engorgement of the right auricle and ventricle. The lungs presented the anatomical alterations due to chronic, quiescent phthisis, with foci of cheesy degeneration bounded by a periphery of indurated tissue. Both lungs showed the characteristic red color everywhere manifest. There was slight reddening of the bronchial and tracheal mucous membrane, and the air-passages contained blood-stained froth. There were no punctate ecchymoses,

either subpleural nor subpericardial. The spleen was large, soft, soft, and bright red.

The stomach was empty and of healthy appearance. The intestine showed a reddening of the mucous membrane in the jejunum and upper part of the ileum. The pancreas was of a pale reddish color. The liver contained more than the usual supply of blood, and, like the other organs, had a distinctly heightened color. The kidneys were injected, slightly above the normal size, and of a cherry-red color. The capsules came away with difficulty, and the cut section showed anatomical elements obscurely outlined. The bladder was empty. The scalp and skull were intact. The vessels of the pia were injected, and bright red puncta appeared abundantly on cut sections of the brain-substance.

The case may be regarded as an illustrative example of its entire class. It has the advantage of presenting data as to the time of exposure which are not usually available. The anatomical appearances were characteristic. The one central fact which dominates all the rest was the peculiar change in the blood; this change explains the altered aspect of the tissues, and makes manifest the true cause of the death. It is a common custom, both in the profession and among the laity, to speak of these cases as examples of asphyxia or suffocation by gas. But the fatal consequences of inhaling illuminating-gas are not due to any obstruction to the entrance of air to the lungs, such as brings about the phenomena and post-mortem changes ordinarily observed in asphyxia. They are produced rather by genuine toxic effects upon the blood wrought by the introduction through the respiratory organs of carbonic oxid to a degree that is incompatible with life. The method by which the fatal result is accomplished offers one of the most interesting problems in physiological chemistry. It is so graphically described by Michael Foster[1] that the writer can not do better than to quote his words:

"The red corpuscles, by virtue of their hemoglobin, are emphatically oxygen-carriers. Undergoing no intrinsic change itself, the hemoglobin combines in the lungs with oxygen, which it carries to the tissues; these, more greedy of oxygen than itself, rob it of its charge, and the reduced hemoglobin hurries back to the lungs in the venous blood for another portion. . . . Hemoglobin combines in a wholly similar manner with other gases (besides oxygen). When a known quantity of carbonic oxid gas is sent through a hemoglobin solution, it will be found on examination that a certain amount of the gas

[1] Foster's *Physiology*, 1897, p. 456.

has been retained, an equal volume of oxygen appearing in its place in the gas which issues from the solution. . . . In fact, hemoglobin combines loosely with carbonic oxid, as it does with oxygen; but its affinity with the former is greater than with the latter. While carbonic oxid readily turns out oxygen, oxygen can not so readily turn out carbonic oxid. Indeed, carbonic oxid has been used as a means of driving out and measuring the quantity of oxygen present in any given blood. This property of carbonic oxid explains its poisonous nature. When the gas is breathed, the reduced and unreduced hemoglobin of the venous blood unites with the carbonic oxid, and hence the peculiar, bright, cherry-red color observable in the blood and tissues in cases of poisoning by this gas. The carbonic oxid hemoglobin, however, is of no use in respiration; it is not an oxygen-carrier; nay, more, it will not readily, though it does so slowly and eventually, give up its carbonic oxid for oxygen when the poisonous gas ceases to enter the chest and is replaced by pure air. As Bernard phrased it, 'the corpuscles are paralyzed.'"

Such is the accepted view of the mode in which carbonic oxid kills.

The *symptoms* which precede the fatal ending and lead up to it are as follows: Dizziness, headache, nausea and vomiting, great weakness, tinnitus aurium, mental apathy, progressive stupor, and complete coma.

There is no indication in the attitude or appearance of the bodies of those who have succumbed to carbonic oxid poisoning that there was distress or suffering of any kind in the process. Generally, the cases occur at night when the victim has retired to bed. When discovery of the fact is made, the dead body is found in a perfectly natural posture, with the bedclothing in place, an expression on the face as of one asleep, and an entire absence of evidence of any consciousness of unpleasant sensations before death.

That the death is a sure and speedy one under favoring conditions has been demonstrated experimentally. In 1885 the State Board of Health of Massachusetts undertook an investigation of this subject, and among other instructive results it determined that animals placed in a chamber containing 1140 cubic feet of air space and 55 cubic feet of water gas died after only an hour and a half of exposure.

One noteworthy observation in connection with many of these deaths is that they occurred in an atmosphere amply charged with carbonic oxid, quite sufficient in amount to kill human adults, yet not in proportion to make an explosive

compound. In a number of instances which the writer has investigated, gas has entered the room freely and in fatal amount for its occupants through one or more wide-open tips; while, at the very same time, a light was burning in the room, in some cases at the same fixture at a tip only a few inches away from the leaking jet.

The time required for the fatal consequences in the human subject will vary with all the circumstances under which the exposure occurs. It is a common experience in these cases to find the victim of imprudence or of suicidal purpose in bed, in a small room, with all chance of a renewal of the air by ventilation through windows, doors, or artificial openings obstructed; with the atmosphere of the room fully charged with the gas, which is freely escaping at the wide-open key at the fixture. Sometimes, in cases of suicide, special provision is made to insure successful results.

The first instance of suicide from this cause which came to the writer's notice many years ago was that of a man who had removed the perforated tip from the gas-fixture in his bedroom, and in its place had adjusted a piece of rubber tubing long enough to reach the pillow at the head of his bed. Having made all the necessary preparations and written his farewell letters, he turned on the gas to the fullest, lay down on the bed, inserting the free end of the tube in his mouth, covered his face with several thicknesses of towelling arranged to keep the tube in position, and thus he quickly fulfilled his purpose. In other instances the careful and methodical sealing of all holes and cracks in the bedroom is accomplished with paper and mucilage, or cotton, or articles of clothing. But observation of many cases shows that these precautions to prevent interruption and to secure the desired end in suicidal cases are not essential, for the majority of the fatal instances are found without them.

The fact that a number of the available gas-burners, if not all of them in the room, are turned on, is quite enough to determine a suicidal motive and serves to distinguish these deaths from accidental cases, without the added evidence of suicidal predisposition, written avowals left in the room, and the like.

Attendant Circumstances of Accidental Cases.—The attendant circumstances of the deaths by accident offer a wide variety. Sometimes the casualty springs from the presence of an old, loose stopcock which turns with great ease, so that the hand with which the light was extinguished and the gas turned off, when the occupant of the room was about to go to bed, innocently and heedlessly turned the stopcock on again and

opened the tip for the escape of gas into the dark. The person goes to bed and to sleep before gas enough has escaped to attract attention, and that is the end. Or, again, the stopcock is one of those old-style abominations which turn all the way around, without any stop. It is easy to see how such a key could be left, in the act of turning off the gas, so that a danger- ous escape of the gas would inevitably continue.

In some cases the bracket fixture has this reprehensible arrangement : In the shank, close to the wall, where the stop- cock for the burner-tip is placed, a second stopcock is often inserted very near to the one just mentioned—designed to con- trol the gas passing through a drop-light tip and thence through a rubber tube to a gas-stove or gas-heater. The two keys are close together, one on the side, the other just above or below its mate. In trying to light the gas in the dark the occupant of the room turns on the wrong key, the one for the drop-light, applies the lighted match to the burner-tip, fails to get a light ; the match goes out, and, without turning off this stopcock he gets another match, turns on the right key and lights the tip. The gas still escapes through the gas-stove, but he undresses and goes to bed without noticing the presence of gas in the room ; he goes to sleep and the subtle gas does the rest.

Heedlessness, absentmindedness, and lack of prudence are the underlying mental states which usually attend these mis- adventures. But there are other conditions which are equally fruitful of mischief. In many of these accidental affairs, alcoholic liquor, which is responsible for such an enormous amount of the misery, crime, and death of the every-day world, is an important ally. When to the heedlessness of sobriety one adds the condition of inebriety, there is a combination which is very favorable to all sorts of misadventure ; and many a man who has gone to his room drunk has paid the forfeit with his life ; and his dead body, lying on his bed, not undressed, is found hours later. The air of the room is saturated with gas ; the key at the burner turned on ; and the whole environment indicates clearly the manner in which the deadly carbonic oxid accomplished its work.

Then there is another mischance in the use of illuminating- gas which deserves mention. The gas is sometimes left burn- ing in sleeping-rooms when the occupants go to bed. In the night, when they are sleeping soundly, there is an interruption in the pressure of the gas-supply and the light goes out. Later the pressure is renewed, the air of the room is poisoned, and the usual result follows. In some instances whole families

of children have been carried off in this way. The interruption of the pressure occurs in two or three ways: In hotels, gas is shut off at the meter after a certain hour and is renewed at a later hour, without proper inspection. The slot machine for supplying a limited quantity of gas is fraught with danger. Unequal pressure at the gas-works may sometimes occur to create the mischief.

Chronic Poisoning by Illuminating-gas.—This study of the poisonous effects of illuminating-gas upon the human system will be incomplete without an allusion to another aspect of the subject. The writer refers to what may be described as chronic poisoning from this source; and he means by this the consequences of a prolonged exposure to an atmosphere containing a small but appreciable contamination by coal gas or water gas. These consequences are not demonstrable; but they are intelligible and credible. The air of an ill-ventilated room into which, continuously, there is escaping from piping-joints or leaking fixtures a steady stream, however small, of carbonic oxid urged forth under pressure, is not without a menace to health. This state of things is common enough in well-ordered dwellings; it is much more common in the tenements and workshops of the poor, who pay rent to landlords who are slow and careless in making repairs. The habitual use of such an atmosphere for purposes of respiration must, one would think, make an unfavorable impression on the health of the person exposed. May we not find in it one of the factors in the etiology of the headaches, the neuralgias, the loss of appetite, the debility, the gastric derangements which we are too ready to diagnosticate comprehensively and hastily as neurasthenia, but which are only an expression of chronic poisoning by carbonic oxid?

The preventive remedy for the ills and risks described is plain. It consists in the rejection of water gas and coal gas, so far as is practicable, from the class of agencies for artificial illumination. Human ingenuity will find the substitute which will replace this useful but dangerous product. The favorite illuminant of the twentieth century will be electricity, an agent which does not introduce itself to notice by a vile stench; which does not carry a menace of death into every sleeping-room, and make easy victims of the heedless; which does not lend itself to the purpose of the suicide; which does not waste, heat, or vitiate the air while doing service in illumination; which is clean, wholesome, and cheerful. Such a domestic servant is to be welcomed, and the herald of sanitary progress will not fail to appreciate the great gain to the public health

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which will follow the general introduction of the incandescent system of electric lighting into our dwellings at such reasonable rates as to compete successfully with illuminating-gas.

Carbon Monoxid from Furnace Fires.—There are some other sources than illuminating-gas from which carbonic oxid is readily derived in an amount sufficient to bring about fatal results to those who inhale it. The furnace fire in dwelling houses is a familiar example of this sort of danger. The fire-pot in these furnaces is never absolutely tight at its joints ; indeed, if it was, the iron casting itself is so far porous as to permit the escape of gas. Most commonly, through prolonged use and in spite of inspections, the casting has a crack or two from repeated overheating. And when to this defect is added carelessness of service in the management of dampers, the conditions favorable to carbon-monoxid poisoning are entirely adequate.

It happens in this way : The furnace fire as arranged for the night is a good example of a smothered fire where the supply of oxygen is limited in order to have slow combustion, and the incomplete combustion of some of the carbon with the production of carbonic oxid must follow as a result. The average servant considers it especially necessary to close the chimney-damper in order to lessen the draught when the fire is banked for the night. By this proceeding the gaseous products of the smoldering fire are cut off almost entirely from the chimney, and are pent up in the fire chamber, to leak out through cracks and pass into the hot-air distributing flues. In the case of the carbonic oxid gas, even if there are no cracks, it has the power, as has just been said, of passing through the pores of heated cast-iron, and by this means will reach the flues. Hence on cold nights, when the heat of the furnace is all turned into the flues leading to the sleeping chambers, a faulty furnace may prove the cause of active gas-poisoning, and such cases are now and then reported. Cast-iron coal stoves, of small size, such as are used in the ill-ventilated dwellings of the poor, or in the forecastle of ships, are a similar source of danger.

Slow and smothered combustion has *another* illustration at times in the burning of dwellings and other buildings. Here, again, *carbonic oxid gas* is the agent which kills those who can not escape the deadly exposure. We often speak of these fatalities as deaths by burns, by inhaling flames, and the like. This is an error. Most often the death results before the flames do any burning. Sometimes abundant smoke or soot makes respiration impossible and the victim of the affair dies

by true suffocation. But many dead bodies have been found in partially burned buildings after the firemen have extinguished the blaze, and these dead bodies, while showing no sign of burning, do show the characteristic appearances of carbon-monoxid poisoning.

Poisoning from the fumes of burning charcoal partakes very much of the nature of coal-gas or water-gas poisoning, since charcoal fires are not usually very brisk, but are more of the nature of smoldering fires which give off considerable quantities of carbonic oxid. On the continent of Europe, and especially in France, the vapor of burning charcoal is used for purposes of suicide by inhalation. In this country a death in this way is extraordinarily rare.

Finally, in this group of carbonic oxid factories, I include lime-kilns. These are another example of smothered combustion of carbon. The fire is started in the retort and when it is well alight, the material to be used in the production of the lime is piled on, and the effect on the fire is to favor the production of carbon monoxid. These great fire chambers are open at the top, and if they are seen by homeless vagrants they tempt the tramp to a warm but dangerous hospitality. The vagabond goes to sleep on the top of the stack of retorts and in a few hours is dead.

Carbonic Acid.—Next to carbon monoxid, in this group of poisonous and irrespirable gases which we are studying, stands carbon dioxid, its kindred and companion. The two are frequently in associated company.

Carbonic acid gas is derived from slow combustion of coal or wood; it is given out in the process of fermentation and burning of lime; it is collected in coal pits, mines and caves, and in graves, wells, and cellars as "choke damp"; it is exhaled in the process of respiration; it is one of the components of illuminating-gas; and it is a product of decomposition.

The circumstances attending the discovery of fatal cases never leave any doubt concerning the manner of the death. Every case is readily assigned to its proper class, either as an accident or as a suicide, most frequently the former. Cases of accidental death by carbon-dioxid poisoning have been reported in which the victims were found in mining shafts, imprisoned with many others in small apartments without ventilation, or at the bottom of wells.

In whatever way it may be derived, however, its power for mischief is decidedly less than that of carbonic oxid. It is generally much slower in its effects. Its volume in the air must be larger before dangerous effects result from its inhala-

tion, because experiments have shown that warm-blooded animals which would succumb to 1 per cent. of carbonic oxid in the atmosphere, would tolerate as much as 20 per cent. of carbon dioxid. When an individual is exposed to very much concentrated masses of carbon dioxid, as when a man is lowered by a rope into a well or vat where the gas is in large amount, the effects are much more prompt than they are under ordinary conditions of respiration, and rescue must be immediate.

Moreover, its mode of action is different and peculiar. It does not poison the blood in the same direct way in which carbon monoxid does; its action as a toxic agent is indirect. It is an irrespirable gas. When one attempts to inhale it in its pure state, it produces an irritation of the glottis which renders breathing impossible. When, however, as is usually the case, it is mixed with the atmosphere, it may be inhaled; but its inhalation prevents the normal renewal of the blood by oxygenation, because it has taken the place of the oxygen in the air and has thus become fatally obstructive to aëration of the blood in the lungs. The result is a poisoning of the blood analogous to what occurs in asphyxia when air is excluded from the lungs by mechanical or other external interference. Bernard called it a negative poison.

The symptoms which result from the inhalation of carbon dioxid may be set down in this order: Heaviness and tendency to stupor; a sensation of weight or pressure in the temples; ringing in the ears and vertigo; headache; skin dusky or livid; nausea and sometimes vomiting; respiration becomes slower, laborious, and stertorous; the pulse, at first, tumultuous, becomes irregular and slower; the muscles lose their power to move or to hold the body up; sometimes there is delirium; finally, coma supervenes and is the last stage. Of course, these symptoms will vary somewhat, accordiug to the amount and concentration of the gas in the air, and the gases associated with it.

The post-mortem appearances may be summarized in a few words: Externally, there may be observed, sometimes, marked pallor; sometimes, a red and swollen face, with red spots on different parts of the body. Rigidity of the limbs is common. The cornea is bright and glistening. There is no suggestion of distress or struggle. Decomposition is slow, and the body cools slowly.

Internally, the heart is filled with dark liquid blood. The lungs and mucous membrane of the air-passages are congested. The trachea and bronchi contain frothy mucus. The abdominal

viscera are injected. So, also, is the brain, superficially and in its substance.

Sulphuretted Hydrogen.—The last in the series of noxious gases to which attention will be called, and the inhalation of which is readily fatal, is sulphuretted hydrogen. Its offensive and characteristic odor announces its presence immediately and unmistakably. As an agent causing loss of life it is found accumulated in privy vaults, wells, cesspools, foul drains, and sewers. Concentrated in these inclosed places this gas, if inhaled, causes symptoms which rapidly end in death, and it is reckoned a quick poison. It is to be noted that this is not the only gas which organic decomposition evolves. In the places where it is found it is in association and composition with other gases, such as ammonia and nitrogen, which are more or less irritant, but which are wholly secondary and insignificant when compared with sulphuretted hydrogen as agents of mischief. In nearly every instance of fatality the problem of the manner of death is a simple one. The victims are workmen who have heedlessly and imprudently ventured into places in which they perish solely by misadventure. It has been observed that the air of a cesspool may be breathed without harm until the contents are stirred up in the act of removal; then a large quantity of the noxious vapor is set free and those exposed to it are in imminent danger.

Relative to the mode of action of this gas in the human system, theoretical considerations prevail, and there does not appear to be settled unanimity. Some authorities teach that the agent when inhaled produces asphyxia, the result of the action on the hemoglobin and on the tissues, whereby they are made incapable of yielding and receiving oxygen. Others attribute death to disturbance of the nervous system, deranging pulmonary and cardiac innervation. Kaufmann and Rosenthal demonstrated that sulphuretted hydrogen, when inhaled by animals, lowers the blood pressure and lessens cardiac action by stimulating the vagus center. Pohl believes that the presence of sulphuretted hydrogen in the blood determines the formation of sodium sulphide, which causes paralysis of the central nervous system. Lehmann thinks that death is not due alone to changes in the blood and paralysis of the central nervous system, but also to edema of the lungs.

The symptoms which result from sulphuretted-hydrogen poisoning are these: Sharp and oppressive headache; giddiness; pain at the epigastrium; nausea; coldness of the surface; the pulse small and irregular; the respiration hurried

and labored ; insensibility ; great muscular prostration ; paralysis of motion ; lividity of the face ; dilated and immobile pupils ; convulsions with tetanic spasms ; then death.

Here, again, the course and gravity of the symptoms depend on the degree of concentration of the gas in the air. If the concentration is marked, fatal effects of inhalation are very speedy and are described as " immediate."

The post-mortem appearances after fatal poisoning with this gas are described as follows : The body putrefies rapidly, and exhales the characteristic odor. The right cavities of the heart are overfilled. The blood is dark, almost black, and indicates that the gas has really been absorbed. The mucous membrane of the nose, pharynx, and bronchi has a deposit of a brownish, viscid fluid on it, readily wiped away. The muscles early lose their contractility by electric stimulus and have a dark color. The lungs, liver, spleen, and kidneys are injected with dark, liquid blood. The brain, too, is congested and is sometimes of a dirty grayish-green.

It has been a popular belief for centuries that the emanations given off by putrefying dead bodies in tombs, vaults, and graves were very poisonous when inhaled. There is every reason to believe that the stories of the mischief alluded to from this source have been greatly exaggerated. Of course, sulphuretted hydrogen is one of the group of gases evolved in decomposition, but the records fail to show authentic cases of actual disaster from the accidental exposure of persons to it under these conditions.

It will be noted, finally, that in this review of poisoning by gases the author has not attempted anything like a *full consideration* of the subject. He has purposely left out all discussion of the purely chemical relations of the three gases, because those relations are clearly outside the scope of our study. And he has refrained from doing anything beyond incidentally *allude* to the effects of a chronic exposure to one of those gases (carbon monoxid), because that matter is so clearly in the field of hygiene.

CHAPTER XXXII.

THE PHYSICIAN'S LEGAL RELATIONS TO HIS PATIENTS.

THIS chapter has as its purpose a review of the relations and obligations which the common law lays upon medical men, and the duties imposed by statute law in the course of their professional employment.

Let us ask at the very outset what is meant in law by the word "physician"? Who are, and who are not, physicians in a legal sense?

The term "physician" is applied legally to any one who publicly announces himself to be a practitioner of the art of medicine and who undertakes to treat the sick or the injured, either for or without reward. This is the definition under the common-law rule and it is of universal application in English speaking countries. Under it there is no distinction of schools, or sects, or systems of medicine; all are treated alike in law, and the best trained graduate of the highest university will have no advantage, so far as his legal rights and obligations as a physician are concerned, over the medical adventurer who has no diploma at all.

This comprehensive definition is, however, properly deemed too broad for the best interests of the people and the conservatism of the public health. It permits the freest kind of free trade in medical practice. Therefore, civilized communities the world over have restricted and regulated the practice of medicine by legislation. The common law is thus limited by statute law. Nearly all the States of our Union have in this way supplemented the common law by more or less stringent statute regulations. The design of these statutes is to establish a principle of selection, whereby only those persons shall be permitted to practice medicine who shall give evidence of their fitness to do so. Education, character, and training are the tests and these alone. To this end, examining boards have been instituted in the various States to examine applicants desiring to practise medicine, and to give registration certificates to those found worthy. Those undertaking

to practise medicine *without* this certificate do so at their peril. They are liable to punishment for their audacity.

The statute law, however, like the common law, is exceedingly lenient in the matter of therapeutics. It takes no account of schools or sects in medicine. All kinds of " pathy " stand in equal dignity at the State House, as well as in the court house. Legislation, like jurisprudence, does not discriminate. Indeed, the Statute providing for the registration of physicians and surgeons takes special pains not to mention Therapeutics among the subjects embraced in the required examination. This delicate subject is carefully (and, as the author thinks, properly) turned down. The Commonwealth desires simply to establish a moderate standard of general fitness based on medical instruction, and, with that established, it leaves to the public to choose how it will take its pills—whether homeopathically or otherwise.

The following section of the Massachusetts law[1] is of special interest :

" Section 8.—Whoever not being registered as aforesaid, shall advertise or hold himself out to the public as a physician or surgeon in this Commonwealth, or appends to his name the letters ' M. D.,' or uses the title of doctor, meaning thereby a doctor of medicine, shall be punished by a fine of not less than one hundred nor more than five hundred dollars for each offense, or by imprisonment in jail for three months, or both."

Having established a place of business, an office, and having by the display of a sign proclaimed readiness to be employed, does any legal obligation rest upon the physician to answer *every* call that comes to him ?

Suppose a patient, a long distance away with a bad reputation as to paying, or other reasons to discredit, sends for him, he is under no necessity, imposed by the law, to respond to the summons. A doctor is not a public servant—as a policeman is.

The sentiment of philanthropy, a recognition of selfish interest, a purpose to extend his practice, to avoid offending neighborhood sentiment, to encourage a good opinion, may all urge him to that out-of-the-way and unprofitable client. It is purely a personal matter ; he strikes a balance—personal ease and convenience *versus* humanity, expediency, and enterprise. Most energetic young doctors would go under such circumstances ; some would send the case to a neighbor. However one might manage the dilemma, the fact remains that the law

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[1] *Revised Laws*, 1902, chapter 76.

has no control over the physician in this matter; he may go
or not, as he wishes.

The question here mentioned, whether a physician or sur-
geon is bound to respond to a call for his services, especially
in a case of great emergency, is discussed by the Indiana
Supreme Court in the recent case of Hurley *vs.* Eddingfield.
In this case, a person being dangerously ill, a doctor was
summoned. No other doctor could have been procured in
time to be of service, and the sick one relied upon this
particular physician. Apparently without any reason, how-
ever, the doctor refused to render any assistance, and death
ensued, apparently wholly from the medical man's refusal to
attend. The counsel, in the suit brought against the doctor,
argued that under the Indiana Statute regulating the practice
of medicine, providing for a board of examiners, licenses, etc.,
a doctor was bound to render professional service to all who
apply. The decision of the Court was to the effect that a
doctor is not liable for arbitrarily refusing to respond to a call,
even though he is the only doctor available. The Court said:
" In obtaining the State's license (permission) to practise medi-
cine, the State does not require, and the license does not
engage, that he will practise at all or on other terms than he
may choose to accept. Counsel's analogies, drawn from the
obligations to the public on the part of innkeepers, common
carriers, and the like, are beside the mark."

If, however, the physician *does* respond to a call upon his
medical skill and *does* undertake the care of a sick or injured
person, no matter *who* he is, how does the law regard his rela-
tion to that person ? It is the relation of an implied contract,
less formal, perhaps, but not less exacting than one in writing.

The physician announces himself as a physician and sur-
geon, ready to assume the responsibilities of his profession.
His diploma, sign, and title, his medical society affiliations
and certificate of registration, are evidences of that profession.
He *professes* to be ready and able to undertake the medical
care of any person in physical distress. What does the law
require of him in fulfilment of this implied contract, in his
relation to that patient ? Let the author quote the words of
Hilliard[1]: " The law requires of a physician or surgeon in the
treatment of a case, such reasonable skill and diligence as are
ordinarily exercised in his profession by thoroughly educated
medical men ; and in judging of the degree of skill required,
regard is had to the advanced state of the profession at the
time. . . . He is responsible only for ordinary or reasonable

[1] *Law of Torts*, 2d edition, i., p. 253.

care and skill and the exercise of his best judgment in matters of doubt—not for want of the highest degree of skill."

That is the whole case. Three things, it will be seen, the law requires of a medical man in his professional employment: 1. A reasonable degree of the learning and experience ordinarily possessed by the medical men of the time and neighborhood. 2. Reasonable and ordinary care in the treatment of the case committed to him. 3. Exercise of his best judgment in cases of doubt. These promises he takes with him to every sick room.

In addition to these fundamental requirements which underlie the relation of the physician to his patient, there are certain other principles which the law recognizes in this relation, as incidental to it. As the physician or surgeon takes his place at the bedside of his sick or injured patient, the law requires of him:

1. That he shall continue in attendance and shall not abandon the case or desert the patient without reasonable cause or until sufficient time has elapsed for the procurement of another physician to take charge.

2. The physician or surgeon does not insure and warrant that all the results of his treatment shall be satisfactory, that the patient shall have a perfect recovery, or that the management of the case shall effectually stand in the way of accident or harm as complications.

3. The physician or surgeon is not held accountable for the results that follow a mere error of judgment.

4. But the law requires of him that in his surgical operations his instruments and appliances are free from septic danger and are suitable and proper for the uses to which they are put.

Now, even in an implied contract, there are two parties to the engagement, and if the law holds the physician to a strict regard for his obligation, it also imposes some duties upon the patient as an offset. The requirements are thus reciprocal. Thus, the patient must give the physician information of the facts and circumstances of the disability to be treated. He must offer full opportunity for proper treatment. He must obey the physician's instructions and directions in carrying out that treatment.

Such are the principles established by the common law as the intangible environment of every physician and surgeon for his guide and control under the ordinary circumstances of his employment. They are the rules which underlie and govern those prosecutions commonly called malpractice suits wherein the claim is set up that negligence and unskilfulness on the

part of the medical attendant have caused injury and distress to his patient, and that money will be the proper remedy to heal the imputed wrong. Some of these principles of law are vague and obscure. What, for instance, do lawyers mean when they use such terms as " ordinary skill " and " reasonable diligence "? A leading authority[1] discusses this topic as follows:

" The general rule is that a medical man who attends for a fee is liable for such a want of ordinary care, diligence, and skill upon his part as leads to the injury of his patient. To render him liable, it is not enough that there has been a less degree of skill than some other medical men might have shown, or a less degree of care than he himself might have bestowed; nor is it enough that he himself acknowledged some degree of want of care; there must have been a want of competent and ordinary care and skill, and to such a degree as to have led to a bad result. A professed physician or surgeon is bound not only to use such skill as he has, but to have a reasonable degree of skill. . . . The standard of skill may vary according to circumstances, and may be different even in the same State or country. In country towns and unsettled portions of the country remote from cities, physicians, though well-informed in theory, . . . do not enjoy the greater opportunities of daily observation and practice which large cities afford. It would be unreasonable to exact from one in such circumstances that high degree of skill which an extensive and constant practice in hospitals and large cities would imply a physician to be possessed of."

Even these authoritative statements of what the law regards as professional skill and proper care leave the matter in an indefinite state. The terms " ordinary," " reasonable," and " proper " which the lawyer likes to use with so much iteration are relative terms. Who shall decide—when lawyers are obscure—what is " ordinary " and what is " reasonable "? It is clear that the decision rests ultimately (in actual litigation) with the jury, and is registered in the jury's verdict.

It is probable, also, that in most instances the individual juryman is influenced in his conclusions upon these matters less by the definitions and instructions of the learned judge in his charge than by other considerations, such as the sympathy-compelling pathos of the plaintiff as he or she tells the story of alleged injuries and sufferings; or the clearness and emphasis of the testimony with which the witnesses, including the ex-

[1] Shearman and Redfield's *Treatise on the Law of Negligence*, 1888, ii., section 606.

perts, unfold the evidence in the case; or the eloquence more or less effective of the counsel. And in this connection it is reassuring to record the fact that the principles of law above set forth, however difficult they may seem to be as practical guides, have been in effect a shield rather than a menace to the interests of defendant physicians, and that the cases are fortunately few in number in which it can be said that unjust or unfounded verdicts have been returned by juries upon the issue of imputed negligence or unskilfulness. Where verdicts against a defendant physician have been recorded, the testimony has left little question that the decision was right, because the negligence charged was really inexcusable on any sensible and reasonable grounds.

Malpractice Suits.—Although the jury's verdict is, in the end, generally favorable to the defendant physician who is sued for malpractice, there is unhappily no bar or hindrance to the primary bringing of the suit with all its miserable attendants. Let us suppose that he has done all that the law requires in the care of his case; that he has to the best of his ability used ordinary and reasonable diligence and skill and has avoided measures that could be called novel or experimental—he may nevertheless find himself a defendant in an action brought by his patient to recover damages for alleged malpractice. The Colles's fracture results in a permanent deformity; the dislocated shoulder remains stiff; the compound comminuted fracture of the leg issues in no union and results in amputation; the fractured femur comes out with a deplorable shortening. In puerperal cases, perhaps, his patient on her recovery finds that her perineum was inadequate in the last childbirth to sustain the pressure and the dilatation forced upon it by the advancing head, however persistently and skilfully he may have tried to avert the disaster. Perhaps, as she convalesces, she finds a disgusting leakage of urine through a fistula in the vesico-vaginal septum, and she remembers that her physician used forceps to deliver her; but she forgets that she consented to their use only after hours of ineffectual labor, during which the child's head lay low down, without progress, pressing on the very spot that is now the seat of her misery.

In any of these events, whatever has happened out of the ordinary course, it is easiest to blame the attending physician; and the next step is generally easy—the initial step in the proceedings for " getting satisfaction " by invoking the aid of the law. However clear the physician's conscience may be that, whatever has happened, he is not blameworthy, this will not save him from the trouble and expense of defending himself

against the charge of negligence and unskilfulness as it is formulated and made openly in court.

The story is an old and familiar one. Too often, the motive that initiates the suit and urges it forward is a most unworthy one, and it is scarcely to be distinguished from the wickedness of blackmail. Too often, it is stimulated and nurtured by lawyers more hungry for plunder than ambitious for a good name. Too often, it is abetted by medical men ready to share with the lawyer the chances of pecuniary gain to be secured in the event of a verdict for the plaintiff, and willing, therefore, to put the needed emphasis into this partisan testimony. Sometimes, no doubt, a case of tort is well founded; but such instances are exceptional and bear no comparison with the number of actions brought with discreditable motives. Over these suits the physician is powerless to bring any control. However good his defense may be, he cannot prevent a trial, with all its annoyances and costs, except by adopting the course of paying money to settle the claim out of court—a course which any self-respecting medical man, with a clear conscience, will not adopt, though sorely tempted to escape thereby all the wretched risks and miseries. This constant menace of unjust lawsuits, which every physician, and especially every surgeon, has constantly before him, as the law is practised now, is one of the chief evils to which medical men are exposed.

The first intimation which a physician or surgeon has of a purpose on the part of his patient to bring a suit is frequently in the form of a threatening letter from a lawyer asking the physician to call at the attorney's office concerning the claim in question and, so, save himself from further trouble. Possibly, also, an attachment is placed on the physician's property as a preliminary step. His best course, under such circumstances, is to take a good lawyer into his confidence and place his defense unreservedly in the attorney's hands. In such a matter the best advice is the cheapest.

Criminal Malpractice.—The incivilities of the so-called civil proceedings, like those just considered, do not exhaust the interest which the law takes in our profession. There is a kind or a degree of negligence or unskilfulness which, while it offers no bar to an action of tort, is also sufficient ground for the State's interference and may become a subject of investigation on a criminal charge. It is when the death of a patient is charged to the carelessness or ignorance of the attending physician that the machinery for criminal prosecution is set in motion for his discipline. All law writers use nearly identical terms in their definition of the degree of neg-

ligence which should constitute criminal malpractice, and this general definition is so well expressed by Mr. Bishop in his work on *Criminal Law* that I quote it: " Every act of gross carelessness, even in the performance of what is lawful, and every negligent omission of legal duty, whereby death ensues, is indictable either as murder or manslaughter. If a man takes upon himself an office or duty requiring skill and care —if, by his ignorance, carelessness, or negligence, he causes the death of another, he will be guilty of manslaughter. . . . If a person, whether a medical man or not, professes to deal with the life or health of another, he is bound to use competent skill and sufficient attention ; and if he causes the death of another through a gross want of either, he will be guilty of manslaughter."

It is, then, that degree of malpractice which the law characterizes as " gross " which renders the practitioner liable to punishment under a criminal charge. As in the law of civil malpractice, here, too, definitions hardly define; for the term "gross " conveys a relative and not an absolute meaning ; and in many cases in which a man's liberty, or perhaps his life, depended on the decision, a real difficulty might arise. When we remember that such a decision is to come from twelve jurymen of the ordinary type, we may well contemplate with gratitude the immunity of medical men, and may rejoice that *all* deaths are not made the subject of judicial investigation. On the other hand, however hard the law may be in theory, the leading cases demonstrate that in practice medical defendants under a charge of criminal malpractice have been dealt with leniently, and this fact should reassure us.

For example, a physician named Williamson, was indicted for the murder of his patient whom he had delivered and who died in consequence of his attempts to drag away a prolapsed uterus by great force, mistaking it for a part of the placenta which he supposed to be retained in the vagina. The womb was lacerated and the mesenteric artery was torn asunder. The physician, in his defense, said that he had acted according to the best of his judgment, and he called fourteen women to testify to his skill and kindness when he attended them in labor.

Chief Justice Ellenborough, in his instructions to the jury, said: " There has not been a particle of evidence adduced that goes to convict the defendant of the crime of murder; but still it is for you to consider whether the evidence goes so far as to make out a case of manslaughter. To substantiate that charge, the defendant must have been guilty of criminal misconduct arising either from the grossest ignorance or the

most criminal inattention. One or the other of these is necessary to make him guilty of that criminal negligence and misconduct which is essential to make out a case of manslaughter. It does not appear that, in this case, there was any want of attention on his part; and from the evidence of the witnesses on his behalf, it appears that he has delivered many women, at different times, and from this he must have had some degree of skill. It would seem that, having placed himself in a dangerous situation, he becomes shocked and confounded. I think that he could not possibly have committed such mistakes in the exercise of his unclouded faculties; and I own that it appears to me that, if you find the prisoner guilty of manslaughter, it will tend to encompass a most important and anxious profession with such dangers as would deter reflecting men from entering into it." The prisoner was acquitted.

The Thompson Case.—Take, again, the case of Thompson in Massachusetts, often cited as a precedent and as a basis for later decisions:

In 1809, Samuel Thompson came to Beverly, Massachusetts. He advertised and professed his ability to cure all fevers, "black," "gray," "green," or "yellow." He used a limited number of drugs to which he gave grotesque names. To this pretender there came a call from a patient named Lovett, a young man of Beverly, who had been several days confined to his house with a cold. Thompson began giving him powders which had a violent emetic action; he gave three in half an hour, meantime sweating him. This emetic was afterward proved to be lobelia. Next day the operation was repeated; and again the third day. The fourth, fifth, and sixth days the treatment was intermitted and the patient had a rest. But on the seventh day he was so weak that he sent for Thompson. Two more lobelia powders were given and, as the last did not operate, Thompson followed it with pearl-ash mixed with water, and presently gave another dose of lobelia. The patient said he was dying, and was evidently in great distress. Thompson asked him how far down the medicine had got. The patient replied by putting his hand on his breast. The so-called doctor then remarked that the medicine would soon get down and unscrew his navel. That night the sick man was seized with convulsions. Even in this state of the patient, Thompson did not desist, but forced two more lobelia doses down his throat. Next morning the regular physician of the town was sent for; but it was too late, as the young man sank and died that night.

Thompson was arrested, indicted, and tried for murder, and it would seem that if ever a man deserved severe punishment for gross malpractice, here was one. But he was acquitted and left the court room a free man. The jury had no alternative but to acquit after the instructions which were given by Chief Justice Parsons, of the Supreme Judicial Court.

Judge Parsons said: "That the deceased lost his life by the unskilful treatment of the prisoner does not seem to admit of any reasonable doubt; but of this point the jury will judge. . . . But whether this treatment by which the deceased lost his life is or is not felonious homicide, is the great question. To constitute the crime of murder with which the prisoner is charged, the killing must have been with malice either expressed or implied. There is no evidence to induce a belief that the prisoner by this treatment intended to kill or injure the deceased. On the contrary, it appears that the intention was to cure him. . . . The prisoner's ignorance in this case is very apparent. . . . But the Court is unanimously of the opinion, notwithstanding this ignorance, that if the prisoner acted with an honest intention and expectation of curing the deceased by this treatment, although death unexpected by him was the result, he was not guilty of homicide."

Such was the law in Massachusetts for seventy-five years concerning criminal malpractice on the part of physicians. It seems to place a premium on the densest ignorance, and to declare that if a man means well, he is innocent of wrongdoing, however numerous the victims of his ignorance may be. It may be sound law, but it fails to touch a sympathetic chord of harmony in the ordinary physician's organ of common sense.

The Pierce Case.—It should be stated that a recent decision of the Supreme Court has somewhat modified this earlier rule relating to malpractice.

A quack doctor named Pierce was convicted of manslaughter upon evidence that he had covered a woman all over with flannels saturated with kerosene oil. After thirty days of this she died. There was evidence at the trial that Pierce had made similar applications with what he called favorable results in other cases; although in one case the effect had been to burn and blister the skin, as in the present instance. He carried his case to the Supreme Court, on exceptions based on the rulings in the Thompson case. But the Court held that the conviction was proper, on the ground that the death was the result of reckless and foolhardy presumption judged by the standard of what *would be* reckless in a man of ordinary

prudence under the same circumstances, there being no emergency to demoralize him.

The author has dwelt thus somewhat at length on the general relations which the law recognizes as existing between the physician and his patient, and has stated the principles and rules, the violation of which constitutes malpractice, either civil or criminal. There are certain *special* features in medical practice which the law also undertakes to regulate; certain emergencies which it controls.

In a Case of Contagious or Infectious Disease.—Suppose the patient is found to have a contagious or infectious disease when a Massachusetts physician is called to him; or he develops such a disease in the course of the attendance. Does the law require anything of the attendant in such a case?

Chapter 75 of the *Revised Laws*, 1902, is in the following words, and is an answer to this question:

" Section 50.—When a physician knows that a person whom he is called to visit is infected with small-pox, diphtheria, scarlet fever, or any other disease dangerous to public health, he shall immediately give notice thereof to the selectmen or board of health of the town; and if he refuses or neglects to give such notice, he shall forfeit for each offense not less than fifty nor more than two hundred dollars."

Under the provisions of the statutes, local boards of health may designate what diseases are dangerous to the public health; and, in accordance with that, physicians in Boston are directed to report cases of the following, in addition to small-pox, diphtheria, and scarlet fever; Asiatic cholera, typhus fever, measles, typhoid fever, yellow fever, membranous croup, chicken-pox, and tuberculosis.

In Case of Insanity.—Suppose the patient goes *insane*, what does the law require of the physician before the patient can be admitted to a hospital for the insane for treatment? What steps must be taken for his commitment?

He must be examined by another physician, who will sign an independent certificate with the ordinary attendant, stating that the person examined is, in the opinion of *each*, insane and a proper subject for treatment in a hospital for the insane, and specifying the facts on which such an opinion is founded. The examination must be made within five days next preceding the date of the certificate. The law, however, is very explicit as to the required qualifications of the physicians upon whose certificate an insane person may be sent to a hospital. According to a statute enacted in 1895, each of these phys-

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icians must certify under oath that he is a graduate of a legally-chartered medical school; that he has been in the actual practice of his profession in this Commonwealth for at least three years since his graduation, and for the three years next preceding his making such oath; that he has been duly registered and continues to be so registered. Moreover, he must satisfy the judge before whom the case comes as to his standing, character, and professional knowledge of insanity. Another requirement is that neither of the physicians signing a certificate shall hold any office, appointment, or position connected with any hospital, asylum, or other place where insane patients are treated.

Then *application* is made for the commitment of the person. This application is made by the attending physician or by some member of the patient's family, and must state various details as to age, birthplace, and occupation; whether the patient is mild, violent, dangerous, homicidal, suicidal, paralytic, or epileptic; how long his mental disease has lasted, and what its supposed nature and cause are; the hereditary predisposition; the habits as regards temperance; and various other details, set forth in the blank to be filled. This application is addressed to the mayor, or one of the selectmen, of the place of the patient's residence. In Boston the Commissioner for Public Institutions acts for the mayor, and has a staff of medical officers always ready to examine patients, and help in the process of commitment.

The next step is that of examination and commitment by a judge. Any judge of any court may act in this relation. A *probate* judge is the usual one in Boston. The two physicians and their certificate come before the judge; usually the patient is also brought. If the latter is not brought, the judge must certify in his final order, *why* not. After examination of the two physicians under oath, as to the details of the case, and of the patient if he deems it necessary, the judge makes out commitment papers and sends the patient under guard of officers to the hospital designated to receive him.

This is the usual process of commitment. One exception is provided. When two physicians certify separately that a patient is the subject of dangerous and violent insanity and that the case is one of emergency, he may be sent, under these certificates, to any hospital for lunatics at once; but within the ensuing five days the usual steps for commitment must be taken.

The closing section of the law relating to commitments may have some interest for physicians:

"Section 56.—A physician who shall wilfully conspire with a person, unlawfully or improperly to commit to an insane hospital or asylum in this Commonwealth a person who is not insane, shall be punished by fine or imprisonment, at the discretion of the Court."

In Case Traumatism Occurred in the Course of Unlawful Acts.—Suppose it comes to the knowledge of a physician in some unexpected manner that a patient whom he is treating surgically received his injuries while in the act of committing a crime. Suppose it is a burglar who has broken his leg while attempting to escape from a house he has unlawfully entered. The author is not speaking of cases about which information is common property, in which the police wait for the convalescence of the patient in order to take him into custody, but of cases in which, through a hint dropped by the patient, the physician's *suspicions* are aroused that his patient is a man whom the police would like to capture. What does the law require of the doctor in *this* contingency? As a purely legal matter his only relation to any criminal should be such that he can escape the imputation of being an accessory to the crime. Judge Washburn says: "Accessories after the fact are such as, knowing a felony to have been committed by another, relieve or assist the felon, or voluntarily and intentionally suffer him to escape." Now, while the law does not require physicians to be either detectives or informers, it does punish, and punish severely those who are willingly accessory to crime by concealing crime or criminals. There are some kinds of knowledge that are exceedingly inconvenient, and a knowledge of a patient's felony, derived from him alone as a secret, shared between him and his doctor, is one of these. Legally, the physician is not *obliged* to impart it gratuitously to others—to give his patient into the hands of the police; but, legally also, the physician's silence makes him a participator in the crime and subject to the penalties which it merits. He may take his choice of the dilemma's horns. Moreover, any communication made to the attendant by his patient, any confession or statement is not privileged; he can not refuse to reveal it in court, as if there were some professional obligation to secrecy, some mysterious relation between doctor and patient which the law can not penetrate and uncover. Under these purely legal principles we may reach the following practical conclusions :

It is not always prudent to show too keen a curiosity about the manner in which our patients received their injuries. We

shall be wise if we do not dig too deeply for knowledge that will be embarrassing.

It is always imprudent secretly to relieve or assist a criminal, knowing him to be such, or voluntarily and intentionally to suffer him to escape.

Regarded, therefore, as a matter of simple duty under the law, a medical man should not withhold the word that would put the detectives on the track of crime. There is an ethical, as well as a legal, side to this question. This we cannot stop to discuss here; a single proposition may be made, however, on this side: Our duty to the State, to the common welfare and common order, in which we all share, transcends our purely confidential and professional relations to our patients; and the latter relations do not permit us to violate the former or justify us in so doing.

In a Case of Abortion Unlawfully Induced.—The case of a patient suffering from the results of a criminal abortion is a little different from that just considered. The woman in this case carries a double burden—she is at the same time the victim of a crime and its voluntary accomplice, because of her consent and direct application to the abortionist.

In response to the physician's importunities, born of his suspicions, she may tell him facts up to a certain point, but beyond that she is dumb, as a general rule. She will admit instrumental interference, *when* it was done and *how ;* but not where or by whom.

The law regards the physician's relation to the case in just the same light as in the case of wounding already considered. He may protect himself from any discreditable imputation by taking a medical friend with him to the patient's bedside. If the patient recovers, it can do no good to inform the police of her sickness and its nature, for all inquiry of her will be of no avail in convicting the abortionist; of course, no lies should be told. But if the patient dies, there should be entire candor and full investigation.

The writer thinks the best management of a case of abortion, if the reader is unfortunate enough to find himself drawn into its care, is to send the case to a hospital where its medicolegal as well as its therapeutic management can be undertaken without embarrassment. If that course is impracticable, take the precaution of securing a consultation with a medical friend in whose confidence and judgment you can rely.

Privileged Communications.—There is another class of cases in which confidential communications become a source of vexation to a physician. Suppose a person who has some-

time been under his medical care—with syphilis, for example
—brings a civil suit against another person whose interests as
a defendant would be greatly helped if the knowledge, which
he and the plaintiff share in confidence, was disclosed to the
jury. How do the courts regard such a matter? In some
States, like New York, laws have been enacted which forbid
the physician to disclose any matter which he has derived from
his patient in confidence, and which was necessary for the
proper treatment of the case. The law was passed to protect
the interests of the patient in any event when the patient is in
court as a litigant, and the prohibition upon the physician can
be removed only by the consent of the patient. In this respect,
the physician in New York stands in the same relation to such
confidences as the lawyer does to his client or the clergyman
to the secrets of the confessional. The law was never con-
sidered as a defense for the physician, but always to protect
the patient's interests.

The case is different in Massachusetts. Here, the common
law principle of England prevails and physicians have no priv-
ileges, as they are called, with reference to communications
given to them by their patients. If in the course of his treat-
ment of a case a physician becomes the repository of facts
which, if revealed, would seem to harm the reputation of the
patient, Massachusetts law will not protect him when he is a
witness in court. The emergency does not very often come,
but when it comes it is really distressing to a sensitive man.
To be compelled to disclose sick-room secrets is properly
abhorrent to a medical man's sense of honor. The babbler,
outside of court, who so far forgets himself as to tell clinical
confidences as good stories deserves the scorn and contempt
of all his fellows.

In such an emergency, however, until the law of the Com-
monwealth makes another way clear for us, a physician in court
as a witness has this resource: When the question comes, the
answer to which would be a revelation of professional secrets,
the witness appeals to the judge and states the reason for his
hesitancy in answering the question. Such an appeal will be
respected; or, if indeed, the judge rules that the question must
be answered, the physician's sense of honor has a sufficient
guard. It is for the judge to decide whether public interests
are, in such a case, greater than private privileges.

Euthanasia.—Suppose the patient, or the patient's kin-
dred, in a case of incurable disease, or through apprehension
of distress *in articulo mortis*, should ask the medical attendant
to put him out of his misery by a poisonous dose of some nar-

cotic, or by a lethal inhalation of chloroform. Is there any law that forbids? There certainly is, and the physician can not shield himself behind such a pleasant word as euthanasia. Any act, premeditated and intentional, which shortens life by the smallest period is a violation of the law forbidding homicide. Besides, the physician's function is to prolong and save life, not to destroy it. But, it is his duty to alleviate suffering while life lasts. Hence he may approach the line of unlawful conduct without crossing it. There is an obvious difference between a quarter of a grain and a full grain of morphine. Chloroform or ether anesthesia can readily be used within the line of safety. It is perfectly justifiable to annihilate suffering thus, while it is unjustifiable to transcend that limit and purposely to kill. Yet the author has heard clergymen of excellent reputation argue the other way.

Death Certificates.—We come now, in conclusion, to the question, What does the law require of physicians in the event of the death of their patients? There is a Massachusetts statute which is mandatory and explicit, covering all cases and leaving no room for discretionary conduct. It is in these words:[1]

"A physician shall forthwith, after the death of a person whom he has attended during his last illness, at the request of an undertaker or other authorized person, or of any member of the family of the deceased, furnish for registration a certificate stating, to the best of his knowledge and belief, the name of the deceased, his supposed age, the disease of which he died, the duration of his last illness, and the date of his death.

"A physician who neglects or refuses to make such certificate, or who makes a false statement therein, shall forfeit not more than fifty dollars."

The purpose of this law is to aid the registration of vital statistics, the foundation of sanitary administration, as well as a prevention of crime. The Statute forbids the burial of a dead body without a permit issued by the local board of health; and this permit is forbidden before certain facts relating to the death, including the medical certificate of the cause, are recorded.

A blank form for the purpose is always supplied, the undertaker usually presenting it to the attending physician soon after the death. Let the cause of death be plain, candid, and full, without ambiguity or evasion. It is better to write " unknown " opposite the cause of death than such meaningless expressions as " debility," " exhaustion," " inanition," " dropsy," " fits," and

[1] *Revised Laws*, chapter 29, section 10.

" heart failure." Let the cause be assigned so explicitly that there can be no excuse for sending the certificate back for further explanation.

How will it be, however, if the patient's death was in consequence of violence? The same rule holds. Let the certificate be explicit. If the death was by accident, the physician should be sure and state it so, and not in such terms as to leave a question. "A fall down stairs," "a pistol-shot wound," "poison," and "suffocation" may express the truth, but not the whole truth. If the case was one of *suicide*, the certificate should be candid about it. Coma has been used falsely to conceal the fact of poison, and injury of the brain and cerebral hemorrhage have been made to do duty for pistol-shot wounds. In the case of *homicide*, also, make the certificate tell the truth. In a case of abortion it is dishonest to use peritonitis as a cloak.

Such certificates indicating a death by violence will *not* go on record, but will be referred to the medical examiner or coroner for his investigation. The law requires that in case of death by *violence* the final certificate for record shall be supplied by a medical examiner or coroner. Hence, when such a death is brought to the notice of the Board of Health, the board transmits the case to the judicial authority of the district for his investigation. The attending physician's certificate, in other words, is his candid notification that, in his opinion, the case is one requiring such investigation. The law does not require the physician to give any other notice.

Suppose, however, a long interval has elapsed between the last medical visit to the patient and his death. The physician will then be justified in declining to sign a certificate, although he is the last attending physician in the case. Thus, phthisis, cancer, or heart disease—or other chronic diseases—may have a protracted course, and death may come after a long interval without medical attendance. In such a case, the refusal to write a certificate will be excusable, for much may happen in a month of which the physician may be presumed to be ignorant. Under such circumstances, the certificate will be supplied by the medical officer of the local Board of Health, the law providing for this in cases in which "there has been no physician in attendance."

There is another contingency in which the physician may decline to act: If he is called to a case in an emergency, and the person is dead on his arrival; or if he is called in when the person is dead or is supposed to be dead when the messenger leaves the house to summon medical help. In such a

case, the physician who is summoned is not the physician who attended the person in his last illness, and he is under no obligation to take any action whatever. His advice may be asked as to the proper steps to take. If the case is one clearly of death by natural causes, that advice may be: That an undertaker should be called at once, who may do anything except embalming; or, that the case should be reported to the nearest police station.

It is not necessary to direct that the body should be left undisturbed until a coroner or a medical examiner has inspected it, unless it is a case in which homicide is suspected. In any case short of homicide the body may be cared for in the usual way.

If the attending physician wishes an autopsy upon the body of his patient, common prudence dictates that he should first obtain the consent of the kindred, to avoid great scandal and a possible action at law. There is no specific statute governing this matter in Massachusetts. A case closely touching this question, however, was brought, in which the Children's Hospital of Boston was sued for making an unpermitted autopsy. The Superior Court judge decided that it was a case in which an action could not be maintained, there being no right of property in a dead body, and thus he let the hospital out of its difficulties (temporarily). However, the father of the child carried the case before the Supreme Court, and the following is this highest court's decision, rendered in June, 1897:

"The father, as the natural guardian of the child, was entitled to the possession of its body for burial. Being entitled to the possession of the body for the purposes of burial, is not his right against one who unlawfully interferes with it and mutilates it as great as it would be if the body was buried in his lot, and was thence unlawfully removed? That an action may be maintained in the latter case, we have already seen; and we are of opinion that it may be in the former.

"This was so held in a well-considered case in Minnesota, where in an action brought by a widow for the unlawful dissection of the body of her deceased husband, an order overruling a demurrer to the complaint was affirmed. . . . This was followed in a similar case in New York . . . where the right of possession was defined thus: 'The right is to the possession of the corpse in the same condition it was in when death supervened. It is the right to what remains when breath leaves the body, and not merely to such a hacked, hewed, and mutilated corpse as some stranger, an offender

against the criminal law, may choose to turn over to an afflicted relative.'

"The question has not been argued by the defendant whether the nature of the defendant hospital is such that an action against it can not be maintained for the alleged illegal acts of its officers and servants, and we express no opinion upon it. Nor do we inquire under what circumstances an autopsy is justifiable, as this question has also not been argued. These questions can better be determined when the facts are before us after a trial of the case."

There is a law which permits a physician or surgeon to have possession of the dead body of a pauper, under certain restrictions (bonds, etc.), for dissection purposes. Under this regulation medical schools obtain anatomical material. The ownership of a dead body, other than that of a pauper, is, by common law, vested in the executor of the will of the deceased (or if a minor, the father or guardian). A statute of Massachusetts (Chapter 24, Section 21) directed that the claim to the possession of a dead human body should be valid in the following order: 1. Husband or wife. 2. Next of kin. 3. Any friend of the deceased. So it would seem that our mortal remains are fairly protected.

The law [1] also carries this protection beyond the burial:

"Whoever not being authorized . . . wilfully digs up, disinters, removes, or conveys away a human body or the remains thereof, or knowingly aids in such disinterment, removal, or conveying away, or whoever is accessory thereto . . . shall be punished by imprisonment in the State prison or jail not exceeding three years, or by fine not exceeding $2000.

"Whoever buys or sells, or has in his possession for the purpose of buying, selling, or trafficking in the dead body of a human being, shall be punished by fine of not less than $50 nor more than $500, or by imprisonment in the jail for not less than three months nor more than three years."

Desecration of tombstones, graveyards, or memorials of the dead is prohibited under sharp penalties.

There are some other legal provisions of interest to physicians which the author will state without discussing them:

1. Physicians are by law exempt from military service in the militia.

2. Also from jury duty.

3. They may sue for their fees and their reasonable claims, established under oath, suffice to secure judgment.

4. If the person responsible to the physician for his fees for

[1] *Revised Laws*, Chapter 212, Sections 64 and 65.

medical attendance becomes insolvent, the physician's claim is third in the list of priority, debts for taxes and to operatives, clerks, and servants standing before his.

5. In some of the States the doctor's horse, harness, buggy, professional books, and instruments are exempt from attachment for debt. No such indulgence exists in this State.

6. Physicians are required to report to town or city clerks or to city registrars before the fifth of each month a correct list of all children at whose birth they were present during the preceding month. A fee of twenty cents is allowed.

In this review the writer has tried to confine himself to the purely legal relations of medical practice. Its ethical relations are also very important and very interesting, but we have no opportunity to discuss them here.

CHAPTER XXXIII.

A MEDICOLEGAL AUTOPSY.

THE subject of this closing chapter is the scope, purpose, and details of a medicolegal examination of the dead human body. We ask at the outset, How does a medicolegal autopsy differ from an ordinary *post-mortem* examination? It includes more. The ordinary pathological inspection has in view as its end, to verify a clinical diagnosis, to clear up clinical doubts and mysteries, to finish and complete clinical records. Generally a clue is at hand. Certain organs or regions are known to be diseased. The pathologist seeks to answer the question, Do the appearances at the autopsy table confirm and verify the observations at the bedside? Dr. Oliver Wendell Holmes once said: "Pathological anatomy teaches a great deal, but it is, after all, like inspecting what is left of the fireworks on the morning of the fifth of July."

The autopsy for judicial purposes, however, has a much broader scope than to observe diseased organs or exploded anatomical fireworks. It includes many details which are quite superfluous in an ordinary examination, because its object is to search for evidence to serve the needs of justice. Matters ordinarily trivial become, in this relation, of manifest importance. This is especially true of the external aspect and environment of the dead body. It thus follows that a medicolegal examination calls for greater exhaustiveness, precision, and thoroughness than is demanded in cases of simple death from disease; or at least it calls for the exercise of these in novel directions. For, besides determining the cause of the death, the medical examiner strives to ascertain its manner also, the fundamental purpose being either (1) to aid in convicting a person of a crime committed, or (2) to eliminate from the cause and manner of the death the element of an unlawful act.

Therefore, a medicolegal examination must be far-reaching and comprehensive. Its purpose is to trace, as far as can be done, the chain of connection, whether longer or shorter, between the injury received, the poison administered, or any other morbid agency and its ultimate consequences, carefully and

accurately distinguishing the effects of merely natural causes from such as are purely adventitious. The inspection is essentially a legal one with legal, rather than clinical, purposes underlying it.

Another feature characterizing judicial autopsies is the variety of material offered to the medicolegal inspector. The adult, stricken in full health; the fetus, mature or immature; the recently delivered woman; the body thrown up by the sea; half-consumed or mangled fragments; bodies exhumed after a longer or shorter burial; bodies decomposed above ground; persons dead after long decline following primary violence; subjects of the slow action of chronic poison—all these furnish the material for medicolegal investigation.

Medicolegal pathology differs in another respect from ordinary pathological anatomy. The latter is generally not subjected to critical supervision; the former is constantly being overhauled by more or less unfriendly criticism. The examiner in a medicolegal case has one thought constantly before him: "Have I covered the whole ground in this examination so that if called upon at any time to testify concerning it, I can sustain the questioning and cross-questioning in all its mazes, and give a truthful and convincing reason for every act relating to the autopsy, whether of commission or omission?" With this ever-present demand upon him for thoroughness, alertness, almost omniscient and clairvoyant powers of inspection, the medicolegal examiner has a task laid on him which the ordinary pathologist does not feel, and he never ceases to question himself whether, when the autopsy is all done and he has allowed the body to be buried, something has not been overlooked or forgotten. Re-examinations are always annoying.

The frame of mind and temper required on the part of a medicolegal pathologist involves alertness to observe and note, so that nothing shall escape attention; deliberateness in concluding; absolute freedom from bias; absolute fidelity and truthfulness; and consistent purpose to follow a well-matured plan. Casper says: "Coolness, impartiality, and zeal are the three requisites."

Each organ should be required to tell its own story; each region should declare its connection with the cause and manner of the death, without any preconceived theory on the part of the examiner. For him, the mind should be absolutely free from the purpose or notion of proving previously formed hypotheses. This freedom is essential to the truth.

A medicolegal investigation includes several distinct stages or parts:

I. Inspection of the body as it is found, with its surroundings and position undisturbed. This is the *view*, as it is called, and it supplies preliminary data.

Is there rigidity? Has warmth been dissipated?

Has the body been disturbed since death? Does it fit the surface?

Examine all its surroundings and make a sketch of it.

Are there any signs of the presence of a second party? How does the furniture appear?

Are there any indications of a struggle? Photography comes in here as a valuable aid.

Examine the dress. Are there stains, or tears and cuts? Is it unfastened? Save such parts as may be needed as evidence and protect them from meddling, and mark them for identification.

Are there signs of hemorrhage? If so, estimate the amount.

Is there any weapon? Note its relation to the body.

Are there any indications of poisoning, such as papers, powders, or bottles? Any food and utensils, or vomitus?

What, if anything, do the hands contain?

All this investigation is carried out before the body is disturbed. The tradition about moving the body before the coroner comes is especially valuable in homicidal cases, but it is not ordinarily called for in deaths other than homicidal.

Incidental to this primary stage of the examination is the matter of *identification*. It is usually not embarrassing; the kindred, acquaintances, papers in the pockets, dress, and ornaments generally supply the required information. But if this kind of evidence fails or is lacking, then certain data must be preserved, as follows: Sex; height; estimated weight; probable age; development as to nutrition; peculiarities of the features; contour of the face; type of the nose; color of the hair and eyes; length and thickness of the hairy growth; if a man, the growth and manner of wearing the beard; the state of the teeth, whether regular or irregular; what ones, if any, are missing? Do any show dental operations? Adventitious marks on the skin, such as warts, nevi, tattooing, scars; deformities; missing members, if any; vocation or trade.

The time appointed for the autopsy of the recently dead body should be before putrefactive changes have announced themselves. But it should not be precipitate—decency forbids section of a warm body—between twenty-four and forty-eight hours is the best interval. The Continental law requires that an autopsy shall not be made within twenty-four hours, although inspection, short of section, may be made earlier.

But the autopsy should not be refused because of the interval post mortem.

Casper[1] says: " Even at a very advanced stage of putrescence, abnormalities and injuries of the bones may be observed —foreign bodies discovered, pregnancy, etc., detected—and many kinds of poisoning may yet be proved. So also live birth may be settled."

The time of the day for making an autopsy should be limited to daylight and not include artificial light. The time of beginning should be noted as well as the time of ending.

Concerning witnesses, no one should be admitted for curiosity simply. Reporters for newspapers should be rigidly excluded. One medical man, at least, is desirable to assist, to make suggestions, to take notes, and to give confirmatory evidence. The notes made should be inspected before closing the examination.

In a case of suspected homicide, ought a representative of the accused to be present ? In certain contingencies it is advisable, but each case should be determined by itself.

In the somewhat celebrated case of the murder of Cook by Dr. Palmer, the latter was permitted to be present at the autopsy. As the stomach was being inspected, Palmer jogged against the medical man who held the organ and some of the contents were spilled. The material for chemical analysis was, after the autopsy, forwarded by post-chaise to the nearest railroad station to be sent to a city chemist, and it was proved that Palmer offered the post-boy five pounds sterling to upset the carriage. This case suggests the expediency of carefully considering the qualifications of the witnesses who are invited to a judicial autopsy, and of rejecting those who are not above suspicion.

The medical examiner may proceed now to gather data for a determination of the cause of death.

II. **The External Examination.**—He will note the presence or absence of post-mortem rigidity ; the nutrition and development of the muscular system ; the amount of adipose tissue ; the height and approximate weight (especially important in homicide cases), independently of the data for identification. He will observe any livid discolorations, their situation, extent, and color. If in doubt as to their nature, he will make an incision to differentiate the stains from ecchymoses. The color of the skin otherwise should not escape attention. The back should not be neglected. He will look out for marks and stains of mud, acids, or blood ; their situation and extent are

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[1] *Forensic Medicine,* i., p. 61.

important. If hemorrhage has occurred, and if there is pallor. If putrefaction has begun, he will take note of color changes, odor, the epidermis, gas in cellular tissues and veins, and tympanites.

He will examine with care all natural openings, the mouth, the nostrils, the ears, the anus, and the vagina.

The tongue is of particular interest in regard to its position, whether swollen, or injured, or stained on the surface.

The eyes will be looked at with reference to their conjunctivæ, corneæ, and pupils.

The hands will be studied as to whether they are open or shut into a fist; whether the thumb is in the palm; and whether there are any lesions.

The region of the neck is of special importance in the external inspection. Casper observes: " The most trifling yellowish-brown patch leads *a priori* to a suspicion of strangulation." Therefore, the examiner looks carefully for excoriations, bruises, and deeper injuries. Even severe spinal injuries may be found on external examination of the neck.

The external appearances of wounds have very great medicolegal value. Take note at the outset of the *class* to which they belong, whether incised, punctured, contused, lacerated, or gunshot. Accurately *locate* each wound with reference to adjacent anatomical landmarks, the nipples, navel, ears, eyes, and scapula. Do this by *measuring* instead of guessing; use compasses, a rule, or a tape. Note the shape and outline of each lesion, and measure its external length, width, and diameter. A photograph of the region is a great help.

The depth is determined by dissection, not by probing; but the *direction* may be ascertained by the finger, or catheter, or a large probe.

If a weapon is produced, compare it with the wound, so as to answer, *not*, Did *this* weapon produce the wound? *but*, Might such a weapon as this have caused these lesions?

Note the edges of the wound, as to vital action; if there is infiltration, ecchymoses, if everted, inflamed, or purulent.

The deeper parts should be inspected as to blood-stains. It should be ascertained if the skin adjacent to the wound is normal or bruised, smutched, burned, or tattooed with powder grains.

Fractures of bones, their situation and their gravity are to be determined in this part of the inspection. In this connection, too, it is to be remembered that it is the rule in all such injuries as are followed by instant or very sudden death, particularly in all cases of *rupture* of internal *organs*, proving

rapidly fatal from internal hemorrhage, that the body exhibits no external appearances of violence, presupposing, oi course, that the wound is not of a penetrating character.

Care is to be taken, also, to distinguish wounds during life from injuries made after death.

III. **Internal Examination.**—Having completed the external inspection and made careful memoranda of all important points, we are ready to proceed now to the internal examination or dissection of the body.

What instruments and implements are needed? A full assortment is very nice, but it is needless. It is remarkable how few the essential instruments really are, when one thinks of it.

The knife should have a blade three or four inches long, with an ample handle, a long edge, and a round, sweeping point.

Strong scissors will do for enterotomy and for costotomy, as well as for more obvious uses.

Dissecting forceps and small scissors for bronchi, vessels, and ducts are clearly desirable.

For the head, a saw, a chisel, and a hammer with a hook at the end of the handle comprise all the needful instruments. The clamp devised by the late Professor H. J. Bigelow for holding the head firm while the calvaria is removed is especially useful.

As accessory appliances, needles and twine, a graduated measure holding a pint, and a mallet will be needed.

Sponges and newspapers (or a rubber sheet), a basin, and, in special cases, glass jars constitute the balance of the essentials. Therefore, in a private autopsy, an old pail half full of water is all one needs to ask for.

What is the proper order of proceeding? What part should be examined first? This suggests as a question at the outset: How far shall we carry our examination altogether? What does the word "autopsy" imply? An autopsy, truly interpreted, means the systematic examination of all the contents of the three great cavities, the skull, the thorax, and the abdomen. One should not content himself with anything short of this.

The reasons for all three are obvious. They are: Scientific thoroughness in the abstract; the inclusion of all data relating to the cause of the death; and a clear ability to answer all questions in court.

The spine should be opened if, in any case, the cause of the death is not clearly apparent otherwise, or if the history of the case points toward the spine as the seat of the fatal lesion.

Concerning the question : What part of the body should be opened first? The usual medicolegal rule is to take first the injured part or the part presumably the seat of the fatal lesion. Thus, in wounds, the part wounded; in poisons, the abdominal organs. If, however, we have no hint of this sort to give direction to our work in a given case, we follow a regular order which experience and the teachings of the masters in pathology have set down as the best. In most respects, the technical methods do not differ from those of the ordinary pathological autopsy. But matters of *special* significance should be constantly kept in mind.

A preliminary inspection of the abdomen is of importance before any cut is made severing the natural anatomical connections and destroying normal relations; opportunity is offered to *measure* liquids, serous, purulent, or bloody, in the peritoneal cavity before leakage from the chest cavity interferes. There is opportunity, too, to demonstrate the presence of pancreatic hemorrhage.

It is a good point, moreover, to withdraw from the bladder by means of a catheter and to save it in a clean bottle for further examination any urine which the bladder contains. The importance of this analysis is sometimes very obvious.

The first stage in the internal examination is the removal

Fig. 28.—Heart, showing incisions (Mallory and Wright).

of the sternum and the adjacent costal cartilages, the preliminary incision extending from the top of the sternum to the symphysis pubis. The sternum is divided from its inner attachments to the tissues of the anterior mediastinum along its internal surface, and is best separated from the sternoclavicular union at its inner face, instead of above, where attempts to follow the curves of those unions are always difficult and tedious.

The exposure of the thorax enables one to examine the two pleural cavities for abnormal contents, the aspect of the anterior mediastinum, and to ascertain the presence or absence of the adhesions of former or recent pleurisy. The pericar-

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dium is opened by an incision like an inverted ʎ, and the
heart is exposed. The examiner notes the relative fullness
of the four cavities with blood before making any section ;
the size and general aspect of the organ ; the amount of fluid
in the pericardium ; its freedom from pericarditic adhesions ;
its smoothness, translucency, and freedom from injection.
When the cavities are opened the character of the contained
blood is observed ; its color, consistence, clots, and odor. The
competence of the valves is tested with a stream of water,
and with the fingers and eyes. The color, thickness, and
friability of the cardiac muscle are noted, with the presence
or absence of areas of fibromyocarditis. The coronary arte-
ries are explored for atheromatous constrictions or arterio-
sclerosis.

The lungs have medicolegal interest with reference to their
color, volume, density, edges, punctate or other ecchymoses,
presence of emphysema, relative amount of blood in their tis-
sue, edema, freedom of the pulmonary artery and its branches
from obstruction by blood-clots.

The bronchi are opened to observe the presence or absence
of hyperemia of their mucosa, and the character of any exu-
date which may have gathered.

The tissues of the neck are inspected and dissected, and
the tongue, pharynx, larynx, and trachea are removed and
examined in a group together. This care is sometimes
rewarded by the discovery of a plug of meat impacted above
the glottis.

Turning, now, for a fuller inspection of the abdominal
cavity, one observes the peritoneum before any of the viscera
are removed. Its color, translucency, thinness, and freedom
from adhesions are noted.

A ligature is passed around the colon at the sigmoid flexure
and the gut is divided and removed, taking care at the cecum
to glance, in passing, at the condition of the appendix. The
small intestine is cut away from the mesentery and divided
between two ligatures around the duodenum ; it is then
opened throughout its length and its mucosa is noted.

The left lateral ligament of the liver is divided, with the
adjacent diaphragm, and the lower reaches of the esophagus
are freed, tied, and divided at about the middle of the canal.
The spleen, stomach, pancreas, and upper part of the duode-
num are removed in a group with their anatomical relations
unimpaired, and thus they can be conveniently inspected.
The spleen and pancreas are submitted to section and their
tissue examined. The stomach is opened along the lesser

curvature and its contents observed as to color, consistence, amount, and odor.

A question has been raised relative to the propriety and expediency in cases of suspected poisoning of opening and examining the stomach and its contents at the autopsy, instead of sealing them unopened and transmitting them thus to the chemist. There are many, and, as it seems to the author, controlling reasons, for the inspection of the stomach when it is taken from the body primarily. It is thus practicable to observe the organ in its fresh state before putrefaction has disturbed its aspect; whereas, if this inspection is left to the chemist it may be days, possibly weeks, before that which, toxicologically, is of secondary importance receives attention.

One will not forget to note the color and condition of the gastric mucosa, after the contents have been measured.

The liver is of interest as to its size, weight, color, surface, density, edges, and blood-supply. The condition of the gall-bladder and of the gall-ducts is of obvious consequence.

The kidneys are next removed and inspected with reference to their size, color at the surface and after section, the condition of the capsules, their consistence, the relation of the cortical to the medullary portions, and the presence of cysts. Incidentally, one will observe the ureters in connection with the kidneys, and note their size and the freedom of the lumen from obstructions.

If the subject of the autopsy is a woman, the next step is to remove in their integrity the womb, vagina, bladder, ovaries, Fallopian tubes, and uterine ligaments together, the primary incision for this being through the peritoneum and subperitoneal connective tissue at the brim of the pelvis. The bladder is explored by means of a section through the urethra; the vagina is opened by a lateral section along its left side; the os uteri is uncovered by removing the vagina and bladder from the cervix; the depth of the womb is measured with a probe or catheter; the uterine cavity is opened along the front of the organ; the ovaries are examined with reference to their size, consistence, appearance on section, and the presence or absence of the remains of corpora lutea or other remnants of Graafian follicles, and the examination is concluded with an inspection of the tubes, ligaments, and rectum.

The Head.—Much aid will be given in the inspection of the head if the hair is shaved or otherwise removed from the scalp, although this is not essential. The primary incision for the removal of the scalp should be made well behind the crown from ear to ear, starting behind the right ear and end-

ing behind the left ear.   The saw, in section of the skull, after the scalp has been removed, passes in front through the frontal eminence, comes to an angle on each side an inch above the auditory meatus, and the two lateral cuts are joined posteriorly by an occipital section passing just above the occipital protuberance.   The dura declares its degree of injection.   The vascular meninges are chiefly of interest from the same point of view, as well as for the presence or absence of meningitis.   The convolutions, by their flatness and dryness, may give a hint of hemorrhage and the fatal compression resulting therefrom ; the cerebral lobes by their long, sweeping sections, may declare the blood-supply of their arteries; the lateral ventricles may disclose the amount of fluid which has accumulated there ; and the arteries at the base may express the more or less danger which sclerosis has insidiously wrought.   Finally, various traumatisms are defined and carefully traced and measured, if they have entered into the cause of death.   If care has been taken before cracking off the calvaria with the chisel and hammer, to leave half an inch of the bone above each ear at the lateral angles unsawed, it will be found that at these angles a mortise of bone is left which so fits into its place that the skull-cap remains firm when the scalp is brought into final adjustment with needle and twine.

This is the programme of an autopsy under ordinary circumstances when no clue is afforded as to the cause and manner of death, and the pathologist's mind is left unprejudiced, without any prepossessions to sway his observations from the path of absolute candor and truthfulness.   It is obvious, however, that much practical medicolegal work is not of this class ; the examiner is not obliged to grope for results.   He has the initial advantage of suggestions and indications to be followed out of the circumstances and surroundings, the facts and suspicions of the cases into which he is brought, in order that he may assist in unravelling them.   To a brief review of the inspector's duty in these cases, and, therefore, affording a summary of many points discussed in the preceding pages, these closing paragraphs will be devoted.

If a body is recovered from the water under circumstances which suggest drowning, the inspector will observe particularly if grass, mud, or other objects are clutched by the hands or contained under the nails ; if the tongue is protruded between the teeth ; if any fluid, froth, or foreign matters are in or about the mouth, nostrils, trachea, or bronchi ; if the stomach contains much water, and the physical or chemical characters of

it ; if the blood in the heart and great vessels is fluid and of dark color ; if punctate ecchymoses are found under the pleura, their number, size, and arrangement. When marks of injuries are found care should be taken to find some possible explanation of them in accidental injuries from foreign bodies floating in the water.

In cases of death supposed to be by hanging, strangling, or suffocation, one should attend particularly to the state of the face as to lividity ; the condition of the conjunctivæ as to hyperemia ; of the tongue as to position ; of the neck, chin, and lips as to nail-marks, ruffling of the cuticle, or the presence of small contusions ; the state of the blood as to color and consistence ; the heart as to its blood-supply ; the trunk and branches of the vena cava of the abdomen as to their injection ; and the state of the lungs with reference to hyperemia, rupture of the air-vesicles, and small ecchymoses under the pleuræ or pericardium. The mark of the ligature deserves special attention, and the possibility of large extravasations and other injuries in the tissues of the neck ought not to be overlooked.

In cases of suspected induced abortion, when the woman survives, the special points of inquiry include the proofs of recent delivery, the ascertaining of facts tending to show that she has been subjected to manipulations with instruments or has been infected by them, and the recognition of symptoms traceable to the effects of any of the drugs ordinarily reputed as abortifacient.

If the woman has died in consequence of an alleged abortion, the inquiry will be directed to the condition of the womb, its size, the state of its lining, the probable period of delivery, the site of the placenta ; close inspection of the vagina, os, cervix, and body of the womb for mechanical injuries, especially punctures, and any appearances indicating secondary inflammation or hemorrhage, or air embolism ; finally, the ovaries.

In cases of infanticide the investigation of the anatomical appearances will include the following : 1. The probable degree of maturity of the child. 2. How long since the death. 3. Whether death occurred before, during, or after delivery, and how long after. 4. Whether the death arose from natural causes, neglect, or violence. 5. Whether a suspected woman is the mother of the infant.

The points to be remembered with reference to the probable degree of maturity of the child are : The general aspect and development ; the state of the skin and its appendages, the hair and the nails ; the presence or absence of the pupillary membrane ; the length and weight of the whole body ; whether the

navel is at the middle of the length of the body; the amount and location of the meconium in the large intestine; the site of the testicles if the subject is a boy; and, in either sex, the size of the point of ossification in the lower epiphysis of the femur.

The indications that the death occurred before, during, or after parturition, and how long after, if the latter, are: The signs of putrefaction or maceration within the womb; the marks on the crown and elsewhere of the labor itself; the state of the lungs, heart, and great vessels, showing by the approved tests whether or not breathing had occurred; the nature of the contents of the stomach and intestines; the presence of foreign matters in the air-passages; the state of the umbilical cord and of the navel; if the funis is missing.

The writer concludes this abstract of the course of events in a medicolegal autopsy with a few words about the form in which the report should be rendered. In making this report, the judicial object of the inquiry should be kept in view. The investigation is not an exercise in pathological anatomy simply. Hence, the report, like the inquiry, should make prominent matters which shall aid the further legal investigation of the case, to the exclusion of anatomical matters only remotely related to the cause of the death. Every important change should have its due place; but there is no need to include full details of chronic abnormalities or old passive morbid processes of entirely foreign interest. For example, to burden a description of a bullet wound of the head with the details of an old and cicatrized tuberculous cavity at the apex of the lung, or a perfectly harmless and quiet hernia, would be superfluous.

It should be remembered that the language of the report is for non-medical persons; hence, it should be, like that of the medical witness in court, free from the objection of technicality. Its descriptions should be simple and readily intelligible. But as the report will generally be submitted to the scrutiny and criticism of a medical man (expert or other), it will be prudent to introduce parenthetically such technical terms as will make for clearness and will aid in a ready apprehension of the meaning desired. Thus, if the report uses the descriptive term "the investing membrane of the lungs," it will add to its intelligibility if the word " pleura " follows the clause in parenthesis; also " cavities of the brain " (lateral ventricles); " after-birth " (placenta), illustrate this intelligibility in a double sense to non-medical men and to medical men at the same time.

It is best not to use expressions which are comprehensively descriptive—" inflamed," " bruised," and " gangrenous." It is

preferable to use detailed and specific descriptions of the appearances, except when the lesion observed is not connected with the immediate cause of death and cannot aid in the investigation of that cause.

The medicolegal masters in France and Germany have taught us wisely that the best form in which to arrange the report is in a series of paragraphs, numbered consecutively, and permitting readily the use of cross-references.

The final word is an expression of the examiner's opinion of the cause and manner of the death, set forth in the fewest, simplest words consistent with clearness.

INDEX.

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