

On the value of certain signs observed in cases of death from suffocation and on death from hæmorrhage in the new-born : a thesis which was awarded the gold medal of the University of Edinburgh / by David Page, M.D.

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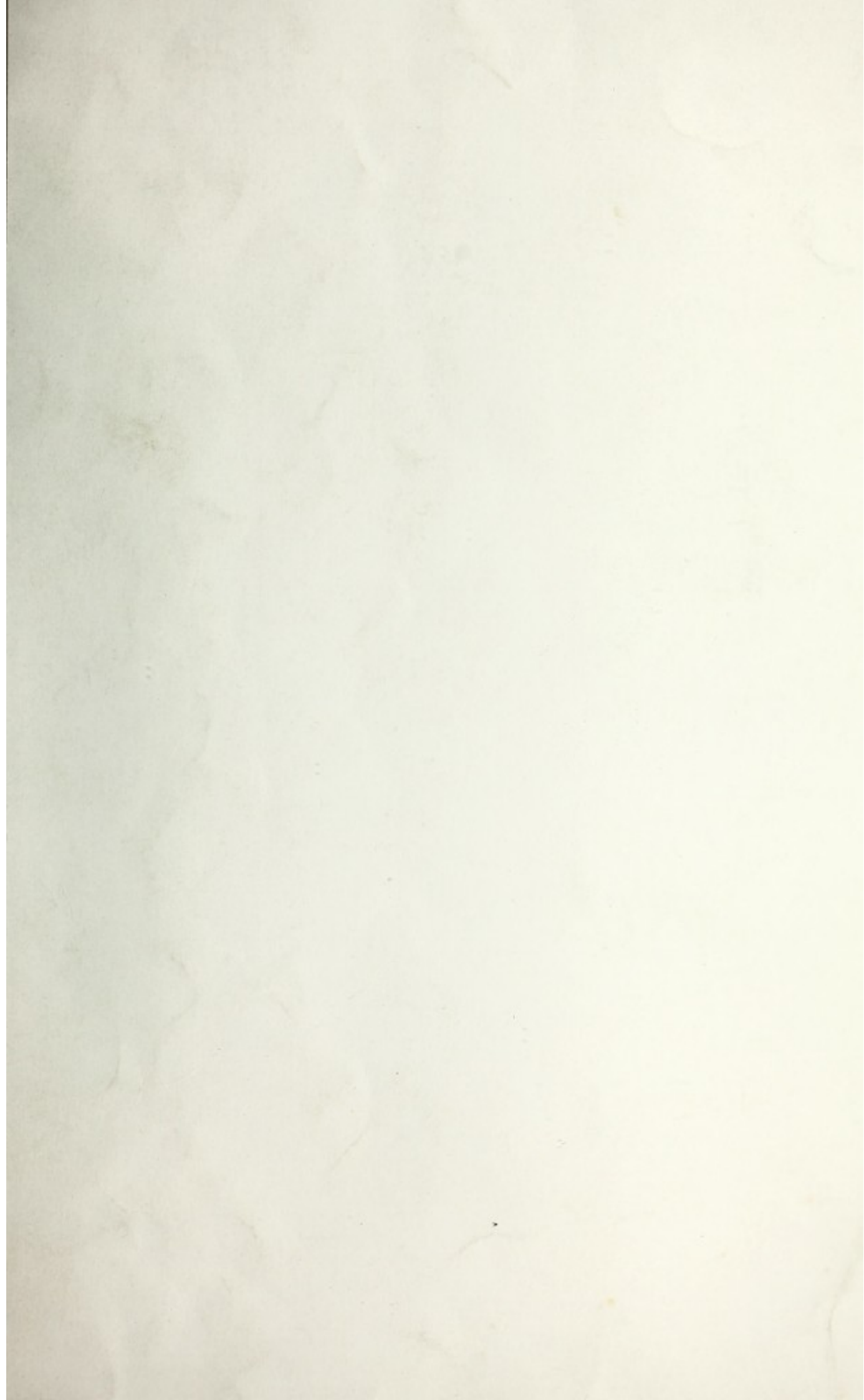
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ON THE VALUE OF CERTAIN SIGNS
OBSERVED IN CASES OF
DEATH FROM SUFFOCATION
AND ON
DEATH FROM HÆMORRHAGE
IN THE
NEW-BORN

A THESIS WHICH WAS AWARDED THE GOLD MEDAL
OF THE UNIVERSITY OF EDINBURGH

BY

DAVID PAGE, M.D. F.C.S.

ETTLER PRIZEMAN (1870), EMERITUS PRESIDENT OF THE ROYAL MEDICAL
SOCIETY OF EDINBURGH; AND MEDICAL OFFICER OF
HEALTH FOR THE COUNTY OF
WESTMORLAND

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THE HISTORY OF THE

REIGN OF

CHARLES THE FIRST

OF

ENGLAND

BY

JOHN BURNET

A NEW EDITION, WITH ADDITIONS, BY
JOHN BURNET

AND

DAVID HUME

WITH A HISTORY OF THE
REIGN OF CHARLES THE SECOND

BY JOHN BURNET

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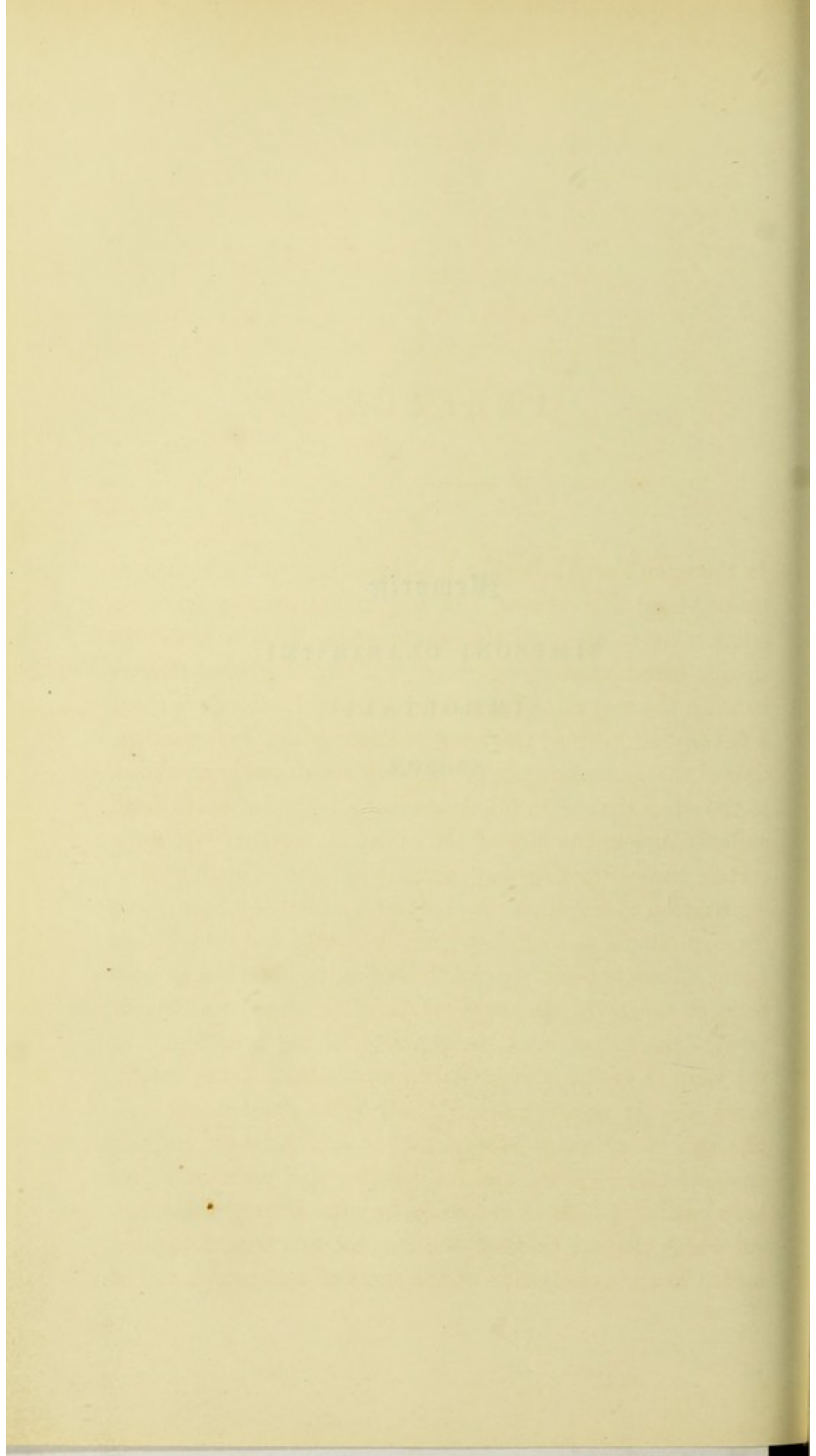
LONDON

Memoriæ

SIMPSONI CLARISSIMI

IMMORTALI

SACRUM



P R E F A C E.

IN the month of April 1872 I became engaged in a case of medico-legal importance, and was called upon to give an opinion as to the probable cause of death in a new-born infant, found in a dying state, half-buried among cinders beneath the seat of a common privy. At the coroner's court I felt myself justified in giving as the result of my examination of the various organs of the body a series of conclusions, to the effect that, from the absence of all signs of death from suffocation, and the fact of the infant having survived for a certain time after discovery, death could not be attributed to deprivation of air : that the cinders found in the mouth, nasal fossæ, pharynx, and windpipe, might have been drawn thither in the efforts to breathe ; and that from the blanched appearance of the body, the empty state of the heart and blood-vessels, the fact of blood in quantity having been found in the vicinity of the body, and the navel-string being untied, *death was the result of loss of blood by the navel-string, even although its extremity showed that it had not been cut, but torn asunder by force, and the remains still attached to the body measured eighteen inches in length.* During the interval which elapsed between the inquest and trial, I applied myself to an investigation of the signs of suffocation, and of

the conditions under which hæmorrhage from the navel-string is likely to occur ; for, owing to the peculiar features of the case, my conclusions had of necessity been guided by physiological inference rather than by precedent in medical jurisprudence. Besides, a merely theoretical exposition was neither desirable nor likely to be of weight in a court of law, where the evidence of circumstances and moral presumption are both more easy of comprehension, and, ostensibly at any rate, of less disputable value.

With regard to the question of death by apnœa,—preferring this term to asphyxia as being more exact,—and especially by that particular mode of apnœa, suffocation, I found that the leading works on legal medicine, and those accessible to the majority of practitioners, had repeated without further comment the statements of M. Tardieu concerning a means of diagnosis which that distinguished French medical jurist maintained to be furnished by certain effusions of blood occurring on the surfaces of the internal organs.*

I was induced to inquire by further experiment to what extent these signs were reliable, as alleged, in distinguishing suffocation from all other modes of death by deprivation of air.

This inquiry forms the first part of my thesis ; and if the results tend to deprive those pathological characters referred to of the specific value claimed for them, the gain is nevertheless on the part of medical jurisprudence in the removal of error, and the estimation of the true significance of the tests themselves.

The subject of bleeding from the navel-string is one which, I may say, has received no special consideration, and beyond the mention of its possibility, I am not aware of any number of observations having been adduced in testimony. My ex-

* Mémoire sur la mort par suffocation,—Annales d'hygiène ; 1855, tome iv. p. 371, &c.

periments on this question were conducted with due care and propriety on the new-born infant at the moment of birth, and they afford evidence, clear and incontestable, of the possibility of fatal hæmorrhage taking place from the navel-string even when of great length.

These researches, primarily undertaken for a special purpose,* have been carried out since and more fully, and they are now reported with the confidence that I may have contributed a short chapter of some interest to legal medicine.

The *first* part of this treatise is devoted to the consideration of those signs of death by suffocation, with remarks on the accidental entrance of foreign matters into the air-passages; the *second* part is occupied by researches on the loss of blood by the navel-string.

DAVID PAGE.

KIRKBY LONSDALE, WESTMORLAND,

April 1873.

* *Regina v. Hodgson.* Lancaster Summer Assizes, 1872.

ON THE VALUE OF CERTAIN SIGNS

OBSERVED IN CASES OF

DEATH FROM SUFFOCATION.

“ Il est bien peu d'affections qui puissent être caractérisées par un signe d'une telle valeur, qu'avec lui seul on puisse en établir une démonstration à l'abri de toute objection. Et cependant tous les jours au lit du malade, nous portons un diagnostic précis ou généralement exact ; c'est que, pour porter ce diagnostic nous ne nous basons pas sur un seul signe, mais sur un ensemble de signes qui, groupés, réunis, accolés les uns aux autres, ont une valeur d'ensemble qui équivaut à la certitude.”—DEVERGIE.

THE CHIEF PHENOMENA OF APNŒA—THE RELATION IN POINT OF TIME BETWEEN THE CHANGES TAKING PLACE IN THE CIRCULATION, RESPIRATORY SYSTEM, AND THESE PHENOMENA — THE LESIONS MAINTAINED BY M. TARDIEU AS DIAGNOSTIC OF SUFFOCATION—EXPERIMENTAL PROOF THAT THESE LESIONS ARE NOT PECULIAR TO SUFFOCATION—CONCLUSIONS.

WHEN an animal is killed by the simple deprivation of air by precise means which avoid any interference with the blood-vessels of the neck, whether by suffocation, that is, closure of the mouth and nostrils, or by a ligature directly applied to the windpipe, the phenomena manifested may be divided into four successive stages.

The *first* stage embraces a period of short duration, while the animal as yet makes no attempt to breathe, and the respiration thus arrested having been involuntary, as there was nothing present to arouse the sense of its necessity.

But very soon the arrest of respiration awakes that sen-

sation of the want of air, that *bésoin de respirer*, which compels the animal to make a succession of vigorous and violent efforts to overcome the obstacle to the entrance of air, and these voluntary but ineffectual struggles constitute the *second* stage.

These efforts at breathing become more and more powerful as apnœa advances, until suddenly, after a period of from three to four minutes,* they cease, and the unconsciousness which marks the *third* stage supervenes. Irregular and spasmodic movements now take place, indicating that the functions of the brain are disturbed, and in all probability corresponding to those symptoms of vertigo, loss of consciousness, and muscular power, experienced by those who have subsequently recovered from the effects of accidental apnœa.

At *last*, all movement ceases, and life appears to be extinct, but the heart still goes on pulsating, and fruitlessly contracting upon its cavities without propelling the blood-stream, which is already at a stand-still, throughout the vessels, until, after a period of four minutes after respiration had wholly ceased, it too stops, and organic death ensues.†

Generally, the stages of apnœa are considered to consist of three; but the fourth stage which I have added—the first in sequence—marks physiologically the change of involuntary or excito-motor to voluntary action.

If the body of an animal destroyed in this manner be examined soon after death, it will be seen that the lungs do not exhibit the congested and deeply-coloured aspect which might perhaps be expected, and as is usual in other and common modes of death by apnœa; but, on the contrary, they are pale, reddish in colour, and not much distended in volume. A few dilated air-cells may be seen towards their

* In nine experiments made by the committee appointed by the Royal Medical and Chirurgical Society to investigate the subject of suspended animation, the average duration of the respiratory movements, after deprivation of air, was found to be four minutes five seconds; the extremes being 3' 30" and 4' 40". In three experiments my results also fell within these extremes.

† The action of the heart continued after respiration had ceased for a mean duration of three minutes fifteen seconds, the extremes being 2' and 4'.—Op. cit. In the same three experiments before referred to, the results slightly exceeded the above maximum.

anterior borders, and notably there may be remarked certain little patches of effused blood, varying in number and size, and irregularly dispersed over the surface of the lungs.

The right chambers of the heart contain dark fluid blood, the left are empty. The pulmonary artery and the systemic veins are gorged with the same dark blood, even to their most minute ramifications ; and I have noticed that this condition of the vessels is more readily seen in the ranine veins on either side of the frænum of the tongue than elsewhere.

These are the general and constant signs in death from complete and uncomplicated apnœa. In those cases, however, which become subjects of judicial inquiry, there are other circumstances usually in operation which detract much from the clearness and precision of those phenomena, while in turn they involve the addition of phenomena of their own, and in nowise related to apnœa. I may say that, save in a case of suffocation by simple closure of the mouth and nostrils, those signs which properly belong to apnœa are found as a rule neither constant nor alone.

In proportion to the incompleteness with which access of air is prevented, and the duration of the violent and ineffectual efforts at respiration, the venosity of the blood and the engorgement of the viscera attain their most marked degree ; and when, in addition, there is an interference with the great blood-vessels of the neck, as in strangulation and hanging, the ultimate phenomena will show this disturbance of circulatory and respiratory functions by partaking of the mixed characters of death by coma, syncope, and even asthenia, or sudden failure of the heart's action from loss of contractile power.

For it can be readily conceived that a ligature placed around the neck will prevent breathing completely or not, apart from its degree of constriction, according to its position above or below the thyroid cartilage ; and this position, with the constricting force exercised, will, on the one hand, induce cerebral congestion, and comatose symptoms by venous obstruction ; and, on the other, by both venous and arterial obstruction, cerebral paralysis,—that is to say, syncope,—in a sense analogous to the effects produced by a sudden and profuse hæmorrhage.

Hence it is, that in those cases which commonly fall under medico-legal investigation, the lungs, heart, and blood-vessels exhibit in an apparently capricious manner appearances suggestive of no special mode of death beside others indicative of apnoea; and it becomes impossible to predict, so far as the means of apnoea employed are concerned, whether the right chambers of the heart will be gorged, and the brain and lungs bloodless, or the brain and lungs congested, and the four cavities of the heart empty, and its substance contracted upon them.

In hanging, the remarkable instantaneous loss of sensibility experienced by those who have accidentally suffered the partial effects of apnoea, is altogether a result of vascular disturbance, for it is not observed in cases of mere deprivation of air.

On the contrary, in those instances of death under conditions ostensibly of this nature, when no signs whatever point to such a cause, and very often the four chambers of the heart contain their normal amount of blood, the true source of death has undoubtedly been shock to the cerebro-spinal system, so violent and overwhelming, as to put immediate stop to the heart's action. These cases alone can with propriety be attributed to asphyxia or *pulselessness*.*

I am of opinion that these discrepancies in the *post-mortem* phenomena of suffocation, strangling, and hanging, would be capable of a more intelligible interpretation if attention was paid to the extent of the effects of the means of apnoea employed, both in due examination of the heart and lungs, and of such data as might afford a clue to the local disturbances to the air-passages and blood-vessels. As yet but scanty additions have been made to that one fact remarked long since by Bichat, that the accumulation of blood in the right side of the heart and vessels is greatest in cases of death from prolonged apnoea.

From the appearances presented by the heart and the lungs, various doctrines have been advanced from time to time by physiologists, explanatory of the changes which succeed the arrest of respiration, and referring the seat of ultimate causature to one or other of those viscera.

* Σφύξις, the pulse.

Towards the middle of last century Baron Haller propounded a theory, that the cause of death was arrest of the circulation in the lungs, on account of the impediment opposed to it by the absence of the respiratory movements. The engorgement of the pulmonary artery and its branches seemed to support this view. But some years later, Dr Goodwyn proved that the lungs offered no obstacle to the passage of the blood through them, and affirmed that the true seat of the hindrance to the circulation was in the left side of the heart, which failed to contract upon its contents by reason of them no longer arriving in an aerated state, and acting efficiently as a stimulus.*

Bichat, however, successfully demonstrated by experiment that venous blood may not only arrive at the left ventricle, but can circulate in the arteries, and flow from them in section.

Moreover, the injection of venous blood into the left auricle excited the pulseless left ventricle to immediate contraction. The doctrine of Goodwyn being thus disproved, Bichat in turn suggested that the real cause of stoppage of the circulation was the result of venous blood circulating through the coronary vessels of the heart.†

Many years afterwards, a graduate of this university (now Sir James Kay-Shuttleworth) undertook a series of experiments, which led him to believe that the arrest of the circulation must take place somewhere in the lungs, and certainly not in the heart, the movements of which continued long after it had ceased to receive blood from the pulmonary veins. Here is one of his experiments in proof of this: "A rabbit was asphyxiated by tying the trachea. The chest was opened. At the end of three minutes and a half no pulse could be discovered in the aorta. The left auricle was then opened, the blood contained escaped, and for a period of from one to three minutes blood occasionally collected in very minute quantities, as though it gradually drained from the larger vessels of the lungs, but never, as often as the experiment

* On the Connection of Life with Respiration (London, 1788), p. 82.

† Recherches physiologiques sur la vie et la mort, Paris, 1806.

was repeated, collected in quantity. The heart continued vigorous the usual period." *

The period of time, therefore, during which venous blood actually circulates is very short, and terminates before the heart's action has ceased.

These results refuted Bichat's theory.

Now, the actual cause of the stoppage of the circulation was first indicated, I am led to believe, by Allen Thomson in the article "Circulation" in Todd's *Cyclopædia*, wherein he states: "We have already stated reasons against regarding the stagnation of the blood in the lungs in asphyxia, as attributable to a loss of the supposed vital power of motion belonging to the blood in the capillary vessels; and we think it quite as just to regard the stagnation as the effect of overstimulation and constriction of the minute vessels of the lung by the dark blood, as to attribute it, as some have done, to the deficiency of that stimulation which arterial blood, without any good reasons, is presumed by them to give to the small vessels."

Lately, the nature of this constriction has received a probable explanation at the hands of Dr George Johnson. To use the words of Sir Thomas Watson: "When the conversion of venous into arterial blood in the pulmonary capillaries is suspended, the stream of dark blood is arrested by what he happily calls the stop-cock action of the ultimate pulmonary arteries." † Dr Johnson bases his conclusions on the appearances of the lungs, which he, in common with other experimenters, has observed to be pale and bloodless; while the pulmonary artery and its ramifications are gorged with blood, in cases of pure apnœa.

It had been especially remarked by Bichat, that the cerebral symptoms manifested by loss of sensibility and convulsive movements, were coincident with the appearance of venous blood in the arteries, and he ascribed those symptoms to the effects of venous blood upon the brain,—a view that has been generally adopted since. But I am led to doubt the

* *Edinburgh Medical and Surgical Journal*, vol. xxix. p. 42.

† *Lectures on the Principles and Practice of Physic*, fifth edition, vol. i. p. 73.

causative relation of these phenomena. In cases of apnœa, the length of time during which venous blood circulates is exceedingly short; and before any cerebral disturbance occurs, while the animal is quite sensible, and is making strenuous efforts to breathe, lividity of the surface and prominence of the veins plainly point to some cause of obstruction to the circulation already at work. Believing that the appearance of the lungs is most consistent with such an obstacle as constriction of the small arteries, I am inclined rather to say that the cerebral symptoms are contemporaneous, or nearly so, with the arrest of the circulation, and are really a consequence of defective blood supply. The contraction of the pulmonary arterioles, the engorgement of the pulmonary artery and its branches throughout the lungs by the action of the right ventricle, which, in its turn becoming gorged, leads to backward engorgement of the whole venous system, all combine to produce upon the arterial system very much the same effects as a complete hæmorrhage; so that, on the one side, we find signs of congestion and paralysed action, and, on the other, emptiness and contraction. In severe paroxysms of spasmodic asthma, I have seen phenomena which lend support to this view; and in a rarer form of disease,—thrombosis, or embolism of the pulmonary artery,—if the occlusion is imperfect and gradual, the patient may survive for hours, exhibiting all those symptoms which denote interference with the respiration and a defective supply of blood to the brain; whereas if the clot completely or suddenly blocks up the vessel, instantaneous death results from syncope. In the case of a puerperal patient under my care in the spring of 1872, death occurred in this instantaneous manner from thrombosis of the pulmonary artery. Disregarding my warning about rising, she had crept out of bed early in the morning of the third day after her confinement while the nurse was asleep in the same apartment; and when the latter awoke she found the poor woman dead, seated upon a chamber utensil by the bedside, against which her arm supporting her head in a gentle manner reclined.

It is in protracted cases of death from apnœa that the effect of the circulation of imperfectly arterialised blood in

the brain is perceived. This fact has often struck me in watching those hopeless cases of general or capillary bronchitis occurring in old and plethoric persons, where the patient suffering from orthopnoea, with livid and dusky countenance, rambles on in a state of semi-consciousness, somnolence, and delirium. Life may be prolonged in this state for days, hence there cannot obviously be that contraction of the minute pulmonary arteries assumed to exist in ordinary apnoea, and the circulation goes on, venous blood preponderating in the arteries, and the patient in a sense narcotised.

There is no doubt that carbonic acid, like carbonic oxide, is a narcotic poison, though in a less degree. An animal undergoes apnoea in an atmosphere of inert gases such as nitrogen, with the same symptoms as if it had been suffocated by mechanical means; whereas in the presence of a certain percentage of carbonic acid, the primary symptoms are those of narcotic poisoning,—loss of muscular power, giddiness, and stupor. In an atmosphere of undiluted carbonic acid, immediate loss of consciousness and death result. It is this rapid annihilation of consciousness that prevents the animal from making an effort to escape the danger, a sense of which is awakened at the very first in apnoea; but the respirations are little affected until, as the coma becomes more profound, and successive centres of the cerebro-spinal system become involved, they altogether cease; while the heart, *ultimum moriens*, pumps forward its contents, assisting to produce, as a final effect, engorgement of the veins. Death takes place in such a case not from apnoea, but from the action of carbonic acid on the nervous system, leading to an arrest of function throughout the body, although for a time the heart survives under the influence of its ganglia.

The mere presence of venous blood in the arteries is shown to be without rapidly deleterious effects, by the fact that recovery from conditions favourable to apnoea takes place after longer periods than it otherwise would, when syncope has consentaneously taken place. In such cases loss of consciousness in a manner antagonises apnoea. I do not seek to derive any arguments from the hybernation of animals, for here there is a physiological phenomenon produced under

changes in the economy of a gradual and preparatory character, not strictly comparable with the sudden and violent effects of apnœa. I have already noticed Dr George Johnson's theory as to the probable mode in which the circulation is arrested in the lungs by arterial contraction under vaso-motor nerve influence excited by the capillaries, which subsequently become empty, the impression being conveyed by incident fibres to the vaso-motor centre in the medulla oblongata, and thence the stimulus to contraction by excident fibres to the pulmonary arterioles. That the arrest of the blood-stream cannot be due, as Professor Alison supposed, to an absence of what he termed an "attraction of the venous blood towards the capillaries," is disproved, I think, by the consideration that the propelling force of the right ventricle alone would be sufficient to overcome a tendency to stagnation without any contraction of the vessels. Indeed the experiments of Spallanzani, Poiseuille, and Magendie, proved that in weakened states of the heart, when the tendency to stasis would be greatest, and the motive power least, the impulse communicated to the blood is the more clearly traceable through the capillaries into the veins.

No conclusive evidence has yet been adduced to prove the possession of contractile power by the capillaries,* but in the most minute arteries, and especially in them, as their muscular coat is purest, and the amount of elastic tissue least, contractility resides to a marked degree. Their contraction under the influence of a stimulus takes place slowly, is of long duration, and lasts while the source of irritation is present. Lately clinical evidence of contraction of the pulmonary arterioles has been afforded by the examination of the lungs after death in the collapse stage of epidemic cholera. They have been described as "anæmic, dry, and light in weight, their colour sometimes pale, sometimes dark : the dark hue

* "The capillary wall is contractile both in young and in adult animals. Stricker saw the capillaries not only of tadpoles, but of the nictitating membrane of frogs, contract to such an extent, that not even a single pile of blood-corpuscles could traverse them."—C. J. Eberth in Stricker's Manual of Histology.

in some cases being a result of passive engorgement of the bronchial veins and capillaries in common with the entire systemic venous system," * and the phenomena of this stage resemble those of apnœa.

The nervous supply of the arteries is derived from both the sympathetic and cerebro-spinal systems. Now, section, or paralysis of the nerves, derived from the latter, will have the same effect as stimulation of the sympathetic, for it has been shown that the cerebro-spinal nerves contain inhibitory fibres, by means of which the tonicity or balance between the extremes of dilatation and contraction is maintained. It is probable, therefore, that the contraction of the pulmonary arterioles is the result of irritation at the periphery, or else of direct stimulus of the vaso-motor centre. On the other hand, in cases of coma, the function of the pneumogastric nerve may be so interfered with that its inhibitory influence being annulled, the vaso-motor nerves set free from control produce arterial contraction, the nervous system of organic life presiding for a time over the tissues within its supply. Section of both vagi in the neck is followed by congestion of the lungs, and choking up of the air-cells and bronchi with serum ; hence it may be inferred that they include vaso-motor nerves within their sheaths, consequently section of those destroys the tonicity of the arteries, leaving their calibre dependent upon elasticity alone.

I now proceed to consider the actual appearances presented by the lungs after death by apnœa, and especially to investigate those signs to which attention was directed by M. Tardieu.†

In his memoir he asserts that, " It will be easy for me to prove that death by suffocation, which had scarcely been referred to by authors, presents quite distinct anatomical characters. Besides, the utility of these researches cannot be doubted if one thinks of the extreme frequency of crime

* British and Foreign Medico-Chirurgical Review, October 1872.

† Mémoire sur la mort par suffocation, par M. le Dr Ambroise Tardieu. Lu à l'académie impériale de médecine le 1^o Mai 1855.—Ann. d'hyg., tome iv. p. 372.

by suffocation, and of the difficulties which too frequently surround the appreciation of facts of such a nature. Let it suffice to bear in mind that in almost all cases of homicidal hanging the murderers have begun by suffocating or strangling their victims; and that if one has not the means of recognising with certainty the first mode of death, it is impossible to distinguish between suicide and homicide. Finally, there is a crime—infanticide—which derives from suffocation its usual means of accomplishment. Among 132 new-born infants, of which the law has required me to investigate the causes of death, I have been able to prove that 72 of those feeble creatures had perished from suffocation.”

In the works of Orfila, Devergie, and others, the signs presently to be explained are unnoticed, and must either have escaped observation altogether, or have been regarded of little moment by these authorities. But M. Bayard, in his ‘*Manual de Médecine légale*’ (Paris, 1843), in reporting a case of infanticide by suffocation, remarks the presence of certain subpleural ecchymoses (“*ecchymoses sous pleurales*”), without alluding to any diagnostic value that they might have possessed in his eyes; and again, in the course of some observations on infanticide, he mentions “the presence of dotted ecchymoses, disseminated under the pulmonary pleura, in infants which had succumbed, in consequence of the complete or incomplete occlusion of the air-passages.*

Tardieu was the first medical jurist who seems to have given special attention to those signs, and to have attached to them a diagnostic value in cases of suffocation.

Suffocation may be defined as that mode of death by deprivation of air otherwise than by means of strangulation, hanging, or drowning, and where no interference takes place with the blood-vessels of the neck. It therefore includes smothering by closure of the mouth and nostrils; compression of the chest or abdomen, hindering thereby the free action of

* “*La présence chez les enfants qui ont succombés par suite de l’occlusion incomplète ou complète des voies aériennes, d’ecchymoses ponctuées, disséminées sous la plèvre pulmonaire.*”—Ann. d’hygiène, 1847, t. xxxvii. p. 455.

the lungs; choking by foreign bodies obstructing the air-passages; and stifling in a space deficient in or deprived of air. But it excludes throttling, which is merely strangling, where the fingers are substituted for a ligature; and so-called suffocation resulting from the effects of sewer, carbonic acid, and other noxious gases.

I shall now proceed in detail with the observations and definitions of M. Tardieu.*

"The lungs do not generally present that aspect which has been assigned to asphyxia. They are, for the most part, but little distended, of a rose-colour, sometimes even pale, sometimes presenting a little engorgement towards the base and posterior border. But whatever be the colour and the degree of congestion, little spots ("petites taches"), of a very deep red, almost black, are found on the surface of the lungs, the dimensions of which in the new-born infant vary from the size of a pin's head to that of a small lentil, and present, though larger, the same proportions in the adult. Their number is extremely variable: sometimes as few as five or six; in others as many as thirty or forty; and in some cases so considerable that the lung presents exactly the appearance of granite.

"They are sometimes met with united together, so as to form patches, or a kind of marbling.

"In every instance they are exactly circumscribed, and their contour sharply defined from the neighbouring parts, trenching more or less abruptly on the general hue of the lung-tissues. Their seat is not less irregular than their number; but they are chiefly found at the root, base, and principally in the inferior border of the lungs.

"These spots are formed by little effusions of blood disseminated under the pleura, and are the result of rupture of the most superficial vessels of the lung. Rarely, limited infiltrations of blood, and even true apoplectic patches, are found in the tissues of the lung.

"These anatomical characters, moreover, have the advantage of remaining as long as the tissues are not destroyed. I

* Op. cit., p. 378, 379.

have found distinct subpleural ecchymoses upon the lungs of a foetus which had lain for ten months in a common privy. I ought to point out one peculiarity which is quite exceptional, but not the less worthy of attention. All the details I have given, so far as they relate to the lungs of newborn infants, refer only to those organs which have performed their function perfectly, and in which the penetration of air has been placed beyond doubt. But it has occurred to me on three occasions to meet characteristic subpleural ecchymoses upon lungs which did not float, and which were still in the most characteristic foetal condition.

"There is nothing in these instances, however, that ought to embarrass one. The three cases occurred in infants born before maturity, and under circumstances which opposed the establishment of life. One of these, born under my care, in the Hospital la Riboisière, uttered cries without air entering the lungs. But this feeble effort sufficed to produce the pulmonary lesions distinctive of suffocation; the obstacle to the entrance of air in all three was the extreme feebleness of the infants; and it is quite legitimate to reconcile those cases with the foregoing description, only in a medico-legal point of view the conclusions must differ between the two, so that whenever subpleural ecchymoses are found in the lungs of subjects born alive, but which have not breathed, one would guard against admitting criminal violence, whilst the lesions preserve all their significance in lungs which have manifestly been penetrated by air.

"It is pretty difficult to determine precisely the conditions which favour the development of these lesions, and give them a more or less striking character. The experiments made by me, with a view to verifying their constancy, have led me to think that the sanguineous extravasations are so much the more well developed that suffocation has been rapid. In cases, on the contrary, where the interruption of air has been less complete, and death has more slowly occurred, the pulmonary tissue is more strongly congested, and the subpleural ecchymoses very abundant, but less distinct, from the uniform violet tint of the lungs. But even where death has taken place slowly, provided that the air has been almost

completely cut off, the lesions are depicted in all their clearness and attain their greatest development."

Ecchymoses in every respect similar to those upon the lungs occur elsewhere, especially on the heart, beneath the pericardium at the origin of the great vessels, in the tissues of the pericranium, beneath the hairy scalp, and, in the case of infants, in and upon the surface of the thymus gland; but in these positions they are not nearly so constant, and generally depend upon the degree of development of those met with in the lungs.

I was much struck with the assertions of Tardieu, for, although not doubting the accuracy of his observations, I yet failed to find sufficient grounds for assigning this arbitrary pre-eminence to an apparently insignificant lesion. And yet he maintained that they were of all others the most important, and the most constant, of the signs of suffocation!

While he admits his inability to offer any explanation of their mode of production, he yet seeks to discriminate between them and similar lesions observed in certain diseases—cholera and hæmorrhagic affections, for instance; those belonging to suffocation, he says, being more circumscribed, defined, and composed of coagulated blood—the others being of a violet colour, livid, diffuse, and fluid. But I have found the blood forming these ecchymoses in suffocation also fluid; and when it is borne in mind that the blood elsewhere is generally in a fluid state, this condition is not likely to be exceptional. As to the colour, this varies with the duration of apnœa and the venosity of the blood. In many cases, therefore, it would be impracticable to distinguish between those two sets of lesions, and for medico-legal purposes this attempt at nicety of diagnosis ought to be laid aside.

The first series of experiments which I performed gave results which corresponded with those of Tardieu. They were upon suffocation, but I did not observe in any case, those ecchymoses upon the heart or pericranium which were entirely confined to the lungs. When apnœa was quickly effected by direct closure of the air-passages, the appearances presented by the lungs were paleness, absence of congestion,

subpleural ecchymoses scattered irregularly over their surfaces, darker in colour than the rest of the lung, and, in most instances, frothy mucus in the bronchi, but not tinged with blood.

In other cases, where apnœa was a gradual result of suffocation amongst cinders or in a confined space, the appearances varied greatly. The chambers of the heart were sometimes empty, sometimes gorged with blood; the lungs irregularly congested, their colour varying from a deep red to a purple or spleen colour, and the congestion confined to the bases, or occupying the greater extent of the lung. Patches of diluted air-cells were sometimes met with, especially in the upper lobes, and frothy mucus tinged with blood in the trachea and bronchi. The subpleural ecchymoses were less conspicuous, and when the congestion of the lung was extensive, I failed, as a rule, to detect them, although in many instances effused blood occurred in the substance of the lung.

Three kittens, a week old, were suffocated among cinders, and the bodies examined soon after death. They presented similar appearances. The venous system throughout the body was gorged with blood; the left side of the heart empty, but the right chambers filled with dark semi-coagulated blood. Both lungs were voluminous and deeply congested of a violet colour, and careful examination of their surfaces failed to detect any ecchymoses. Section of the lungs displayed numerous small extravasations of blood in a dark and fluid state throughout their substance. Frothy mucus tinged with blood lay in the trachea and bronchi, and the lining membrane of the latter was red and injected. The state of the abdominal viscera was normal, so also were the brain and its membranes; the vessels of the pia mater, although well defined by their dark contents, not being gorged to any extent.*

I next proceeded to investigate those appearances which were presented after death from the other modes of apnœa,

* The urinary bladder in one of the kittens was greatly distended with its contents.

as it was especially between them and suffocation that Tardieu claimed a diagnostic value for the ecchymoses of the viscera, and notably of the lungs.

STRANGULATION.

In the first set of experiments death was accomplished by throttling the animal—that is to say, by compression of the windpipe by the fingers.

In three of these experiments the *post-mortem* appearances were: The veins generally gorged with dark fluid blood; the right chambers of the heart in a similar state, but the left empty. The lungs were small and not distended, of a pale-red colour without any congestion; but numerous small irregularly shaped but circumscribed ecchymoses of a dark-red colour were scattered over the surfaces, without noticeable partiality for particular regions. They were equally distributed over the outer surfaces, posterior borders, and roots of the lungs. Brain and membranes normal. Minute injection of the venous radicles beneath the capsules of the kidneys, but no ecchymoses. The rest of the viscera were normal.

In the second series of experiments, strangulation was effected by means of a ligature tightly applied to the neck. Three experiments recorded. The appearances, *post-mortem*, were: Venous engorgement, including the right cavities of the heart, the left being empty; lungs of normal volume, of a light-red colour, and ecchymoses seated here and there on the surfaces, remarkably well developed. They were of a bright-red colour, and slightly exceeded in size a large pin's head: on the right lung two ecchymoses were counted on the posterior border, and four close to the root; on the left there were, in all, three at the root. There was no congestion of the lungs. The brain, its membranes, and the other viscera, were normal.

In his experiments, Tardieu found the lungs moderately congested, of a pretty uniform rose-colour, presenting not always, but in some cases only, some little points of effused blood on their surface, "not larger than a needle-point," and

very much scattered, though chiefly on the posterior border. He did not find them beneath the scalp or pericranium. The trachea and bronchi did not always contain frothy mucus. He concluded that there was *only an analogy* between these lesions of strangulation and those of suffocation, and nothing more. But as if embarrassed by such a close analogy, he recalls to mind the possibility of further aid being in most cases derived from external signs of violence.

Leaving these aside, I consider, from what I have seen, that the identity of the signs exhibited by the lungs is proved by the above experiments, and consequently that they have no value in distinguishing an act of suffocation from one of strangulation.

HANGING.

The appearances presented in cases of death by hanging were well marked in the two following cases:—

A young cat was hanged by means of a cord with a running noose.

The tongue protruded very slightly, but was decidedly swollen, and the sublingual veins were very much gorged. Engorgement of the venous system generally. The lungs uniformly congested of a dark-red colour; no ecchymoses could be distinguished on their surfaces. No frothy mucus in the bronchi.

A young dog was deprived of life in the same manner.

The tongue did not protrude, and was not swollen. The lungs considerably distended and overlapping the pericardium. Subpleural ecchymoses in their outer surfaces, of a bright-red colour, irregular in outline, and clearly defined from the surrounding lung-tissue. The patches were most numerous towards the roots and upon the lower lobes. The posterior borders of both lungs were mottled of a violet hue from congestion. Irregular points of emphysema existed here and there over the outer surfaces, from which they were raised a little. In the substance of the lung there were no apoplectic effusions. The right cavities of the heart contained blood, but not the left. Brain and membranes, and

other organs normal. The evidence of the possible occurrence of subpleural ecchymoses in cases of hanging is of importance, as it is here especially that Tardieu claims an absolute diagnostic value for them. In every instance of hanging, he states that the appearances noticed by himself are, a general engorgement of the lungs, with entire absence of ecchymoses or apoplectic effusions, and only sometimes a limited amount of emphysema, or frothy mucus, in the trachea. Hence he concludes that *the presence of subpleural ecchymoses constitutes clear proof of criminal violence; and if seen on the lungs of an individual found hanged, that murder has been accomplished in the first place by suffocation, and the body afterwards suspended in order to simulate suicide.**

This is a strong statement which I cannot endorse. I have already referred to the remarkably sudden loss of consciousness experienced in apnoea by hanging, and attributed it rather to the interruption of the cerebral circulation by the effect of the ligature on the vessels of the neck, aided by the weight of the body, than to an arrest of respiration.

I can therefore readily understand that in the majority of cases of hanging these ecchymoses may be absent, as well as such signs as frothy mucus in the bronchi and windpipe, inasmuch as both are proofs in themselves of voluntary and strenuous efforts at breathing, excited by that sensation of the want of air, which, of course, is annihilated on the super-vention of insensibility. But bearing also in mind the occurrence of numerous cases of suicidal hanging, where the suspension of the body has only been partial, the chances of a slower accession of loss of volition and of violent respiratory struggles taking place should be kept in view. *In such cases the occurrence of subpleural ecchymoses would be probable.*

* "Les signes de la suffocation diffèrent essentiellement de ceux de la pendaison, et que l'existence des premiers constituerait une preuve tout à fait positive de violence et de tentatives criminelles d'étouffement dans les cas de suspension où l'on aurait à distinguer le suicide de l'homicide."—Op. cit. p. 398.

DROWNING.

The signs of death by drowning are so characteristic and peculiar, that I should not have considered any additional experiments necessary in connection with the diagnosis of this from the other modes of apnœa, had not M. Tardieu affirmed that *these superficial lesions of the viscera are never met with in cases of death by drowning; and that if found in a body taken out of the water, submersion must have been preceded by suffocation, the dead body being afterwards placed in that position to simulate accident or suicide.**

Two kittens were drowned by complete submersion. On opening the thorax in one of them, the lungs did not collapse, but remained distended, and occupying the entire cavity.

The right lung was deeply congested of a uniform deep-red colour at the base and throughout the lower lobe, but the congested portions floated in water even after compression between the fingers. Four small patches of coagulated blood were seen on section of the left lung near the base, and similarly, but in greater numbers, in the right. I could not see any subpleural ecchymoses. The general aspect of the lungs was that of prolonged apnœa, judging from the emphysematous portions occurring in both lungs, as well as the extent of congestion, and in addition they exhibited the watery condition peculiar to death by drowning. The trachea and bronchi were filled with red-tinged frothy fluid, while the mucous membrane was remarkably pale. Engorgement of the veins and of the right side of the heart, notably of the right auricle. Stomach distended with water; spleen deeply congested; urinary bladder full; brain and membranes normal.

In the second instance, the internal parts exhibited the same appearances with the exception of the lungs. In these there were no apoplectic extravasations, but, on the other hand, subpleural ecchymoses so numerous as to give a red

* "On n'y remarque jamais les ecchymoses sous-pleurales pas plus qu'on ne trouve les épanchements péricraniens et sous-pericardiques. De sorte que si l'on trouvait ces lésions sur des corps retirés de l'eau, on serait autorisé à conclure avec assurance que la suffocation a précédé la submersion, et que l'on n'a noyé qu'un cadavre."—Op. cit. p. 397.

granitic aspect to the lungs. The congestion of the substance of the organs being more mottled than uniform, allowed these lesions to be recognised with ease.

In the next place, I examined the bodies of three kittens which had been drowned without any measures being adopted to prevent their access to the surface of the water and respiratory struggles.

The general appearance was indicative of great resistance, and attempts to breathe.

The tongues were swollen, and the sublingual veins very much gorged. The special features in each were confined to the lungs.

α. The lungs were distended, and did not collapse when the thorax was opened. Congestion almost complete throughout both, the whole of the outer surfaces, bases and posterior borders being of a uniform violet colour. No ecchymoses observed. Frothy liquid, tinged with blood, abundant in the air-passages.

β. The lungs less congested over the surfaces: in both, numerous subpleural ecchymoses were disseminated over the outer surfaces, and in the left lung several were seated at the base.

δ. The congestion of the lungs was as intense as in the first case, and it was impossible to distinguish any ecchymoses if such existed. The veins of the pia mater were exceptionally gorged with blood.

I did not seek to carry this series of experiments any further, for already the results obtained had proved the possible occurrence of subpleural ecchymoses; and I found, besides, that trustworthy observers on another occasion had noticed that the lungs after drowning presented the same appearances of "intense congestion, ecchymosed points on the surface, and in the substance of the lungs." *

Now, with regard to the way in which these small extravasations below the pleural investment of the lungs are developed, I satisfied myself by examination in every case, with

* Report of the Committee appointed by the Royal Medical and Chirurgical Society of London to investigate the subject of suspended animation.

the aid of a lens of some twenty diameters, that they were actual effusions of blood situated beneath the pleura. On slitting the latter, the blood escaped.

They seem to me to be the results of violent and repeated attempts at inspiration during the earliest stage of apnœa, even prior to the production of any of its characteristic symptoms.

The following experiment supports this view :—

A young cat was deprived of air by stoppage of the mouth and nostrils for a period only sufficient to excite very violent struggles at respiration.

It was then released and instantaneously killed by pithing—*i.e.*, severing the spinal cord near the medulla oblongata.

The lungs were examined and found to present their natural appearance, being of a pale-red colour, not congested, but ecchymosed at several points near the anterior borders, the patches of effused blood presenting all the characteristics of ordinary subpleural ecchymoses.

Indeed these lesions are less to be accepted as signs of apnœa from any mode than as evidences of impeded respiratory action.

During these laboured attempts at breathing, a change must be produced between the capacity of the thorax and the volume of the lungs.

The sudden inspiratory effort tends to enlarge the former ; but the lungs, not receiving their tide of air, and not adequately expanded, cannot occupy this increase of space, and the result is, that although any vacuum, however partial, is prevented by the resiliency of the thoracic parietes, the superficial pulmonary capillaries, and perhaps, too, the air-cells, give way here and there, producing points of ecchymosis and emphysema.

In suffocation by closure of the mouth and nostrils, greater play to the respiratory movements is afforded than in hanging or strangulation, by the space of the cavities of the mouth and nose, and non-interference with the circulation, and there is consequently more opportunity for the occurrence of subpleural ecchymoses.

I have now arrived at the close of the experimental part

of this subject. It would have been easy to have extended the series, but as the object of the research was not statistical, the results, as they are, become of no less value for medico-legal purposes. And I was dissuaded to some degree by the philosophical remarks of John Hunter upon the needless repetition of experiments in his reference to the investigations of Spallanzani.*

Although it has not fallen within my reach to observe the ecchymoses which occur on the surfaces of the heart and lungs in the collapse stage of cholera, and in purpura and scorbutus, yet I am convinced, from the descriptions of these lesions, that their differentiation from those of apnoea would be impracticable.

The following conclusions embrace the main points of the preceding analysis:—

1°, The ecchymoses, or patches of extravasated blood, found on the surfaces of certain of the internal organs, and notably of the lungs, are not peculiar to any one mode of death from apnoea, but are common to all.

2°, The ecchymoses are not diagnostic of suffocation, as has been maintained by M. Tardieu.

3°, These lesions probably occur with greater frequency in suffocation owing to the absence of interference with the cerebral circulation, and the opportunity which the means usually employed afford for respiratory struggles.

4°, The value of these lesions from a medico-legal point of view must be determined by the conjunction of other signs of apnoea, and the adduction of proof that they are not the spontaneous results of disease.

* “Spallanzani is also incorrect in his anatomical knowledge; but it must be owned that his experiments, as far as they go, are in themselves conclusive; but, like all mere makers of experiments, he is not satisfied with those which are clear and decisive, but multiplies them most unnecessarily, without varying them, to elucidate other and essential parts of the same subject. *I think we may set it down as an axiom* that experiments should not be often repeated which merely tend to establish a principle already known and admitted; but that the next step should be the application of that principle to useful purposes.”—(Some Observations on Digestion.) Observations on Certain Parts of the Animal Economy, by John Hunter: London, 1786.

It is not the isolated fact, the so-called pathognomonic sign which is to be always looked for, but that concurrence of facts or signs which, of no specific value if taken one by one, afford then incontestable proof by reason of their mathematical integrity.

Tardieu fell into a great error when on an occasion of medico-legal controversy he remarked: "Chacun de ces signes est donc un zéro. Vous aurez beau ajouter des zéros les uns au bout des autres, vous n'aurez pas une somme;" but to this Devergie philosophically replied: "Ces signes ne sont donc pas des zéros comme vous voulez bien le prétendre; ce sont des unités, qui, réunies entre elles, constituerait des nombres."

ON THE POSSIBLE ENTRANCE OF FOREIGN BODIES INTO THE MOUTH AND AIR-PASSAGES DURING RESPIRATION.

The finding of cinders in the mouth, pharynx, and wind-pipe of the new-born infant, was assumed to be certain proof of wilful attempt at suffocation. In the *post-mortem* examination I gave great attention to the condition of the parts in contact with the foreign matters, but I could not detect the slightest trace of abrasion or other injury to the mucous membrane; the only noticeable feature being a greater degree of redness of the anterior surface of the soft palate than of the posterior behind which the cinders lay, doubtless the result of passive congestion from pressure.

The quantity of the cinders was considerable. One of the witnesses at the assize trial, the woman who removed the body from the privy, stated that she picked out a large cinder which lay in the mouth. In addition to this, I found one or two cinders, the size of field-beans, at the root of the tongue in front of the epiglottis, particles of cinders mingled with similar fragments in the pharynx, extending upwards behind the soft palate to the nasal fossæ, which were blocked up, downwards into the larynx and trachea, at the lower end of which one cinder lay of the size of a small pea, but leav-

ing the aperture of the glottis clear, and not passing into the œsophagus.

I made some experiments upon young animals with the view to ascertain how far the force of the respiratory movements would effect the penetration of cinders into the passages. But although, so far as they went, the results showed that this force was considerable, I did not obtain conclusions of direct importance. In most instances the mouth indeed was filled with cinders, and their absence behind the fauces seemed attributable to the peculiar form of the isthmus in young animals; for the uvula, an appendage peculiar to man and the quadrumana, being absent, the free border of the velum palati forms a straight line, and the anterior pillars descending from it to the sides of the tongue further constrict the orifice by their projection as membranous-like bands with tense edges. I was enabled, however, to collect trustworthy evidence from the scanty sources of information existing on this subject.

Matthysen,* in his experiments on kittens and rabbits, found that cinders could pass beyond the mouth into the pharynx, trachea, and œsophagus.

Bévinguier made further experiments, on the occasion of an infant being found buried in cinders, and in four young dogs which were placed by him among cinders, three hours after birth, fifteen hours later, when death occurred, the mouth, pharynx, and nasal fossæ were crammed with them ("les fosses nasales et le pharynx en étaient farcis" †).

The researches which Tardieu undertook to distinguish the extent of penetration of foreign matters in the case of living and dead bodies when placed under similar conditions, also afford evidence of as conclusive nature.

The force of the inspiratory efforts when violently exerted is very great, and some idea may be gained from the experiments of the Committee of the Medical and Chirurgical Society.

In dogs with a tube fixed in the trachea, and bent at right

* Ann. d'hyg., 1843, t. xxx. p. 225.

† Mémoire sur l'infanticide par l'immersion de l'enfants dans les matières pulvérulentes.—Journal de Médecine de Toulouse, Août 1851.

angles, one end being immersed in mercury, respiratory the efforts were sufficient to raise a column four inches in height. A guinea-pig was held nose downwards under mercury ; " on examining the lungs they were found full of globules of mercury, which had thus been drawn up by this weak animal a distance of an inch or two, and that in spite of gravitation : " and in the case of a dog which was plunged head downwards into liquid plaster-of-Paris, " on examining the lungs the white plaster was found throughout the bronchial tubes."

The specific gravity at ordinary temperatures of mercury is 13·5, and my estimation of that of cinders gave 1·27, while after removal of air contained in their interstices by exhaustion in the receiver of an air-pump, it only rose to 1·75. There was therefore no difficulty in arriving at the conclusion I formed, that in the absence of any marks of violence, the introduction of the cinders found in the pharynx and air-passages through respiratory efforts alone was extremely probable.

But, in addition to this effort at breathing on the part of the infant, we must not lose sight of the fact that all young mammals exhibit very soon after birth an instinctive desire to suck, and in this desire, to seize with the lips whatever comes in contact, as a nipple. In this instinctive effort portions of the cinders may have been, and most likely were, taken into the mouth—the combined attempt at sucking and at breathing being sufficient to carry the smaller fragments into the regions where they were detected. The presence of such fragments, therefore, by no means proves that they were wilfully thrust in with the intention of producing suffocation.

ON DEATH FROM HÆMORRHAGE IN THE NEW-BORN.

Loss of blood by the vessels of the umbilical cord immediately after birth, to such an extent as to be fatal to the infant, is a subject upon which, so far as I have ascertained, very little is known, and perhaps no authentic instances are on record.*

In an article translated by M. Marc, from 'Henke's Zeitschrift,' "Researches and observations on death of the new-born by hæmorrhage from the placenta and umbilical vessels," one is disappointed to find only a hypothetical consideration of the mode in which loss of blood might occur; while, so far as loss of blood from the umbilical vessels is concerned, not an observation to the purpose, nor an instance of it, is recorded.

There is a form of hæmorrhage, also very rare, which takes place from the cord several days after birth, at the time of separation of the remains. I do not recollect Sir James Simpson referring to this form in his Lectures; but Mr Syme in his 'Principles of Surgery,' treating of hæmorrhage, at page 99 observes: "Bleeding from a leech-bite may be arrested by transfixing the wound with a sewing-needle, and tying a thread tightly round it. In the same way was subdued a hæmorrhage from the umbilicus of an infant two weeks old, which I saw with Dr Begbie, and where the

* Ann. d'hyg., 1831, t. vi. p. 128.

actual cautery had been used in vain, at the suggestion of the late Dr Hamilton, who said that the very few cases previously seen by him had proved fatal. I passed two sewing-needles crosswise, as deep as possible through the conical cavity from which the blood proceeded, and then tied a thread round them."

This was the treatment, too, of Paul Dubois. Within a period of twelve months I have met with two cases of this sort, in one of which bleeding occurred on the fourteenth day after birth, and was associated with jaundice—and in the other, a small and puny infant, on the seventh day. In both, I adopted the above method, which failed to arrest the hæmorrhage, and death took place within a few hours. For the future I intend to cut down at once upon the umbilical vessels, and to apply the catgut ligature.

My attention was directed to the consideration of loss of blood from the untied navel-string at birth by the appearances presented by the infant, and the collateral circumstances of the case mentioned in the preface to my thesis. The cord, which was still attached to the body, measured 18 inches in length, and its extremity showed that it had not been cut, but had been torn by force. The delivery of the placenta from the accused took place some time afterwards, and to it I found 7 inches of cord attached which showed corresponding proof of rupture.

Conclusive as the signs of death, from loss of blood, appeared to my mind, and that it had taken place by the cord, the absence of any precedent instance of such a nature, and the novelty of this one, induced me to carry out a series of observations on this subject, and the value of the results of these is the greater because they were obtained from clinical experiments. After birth, the ligature of the navel-string at the usual distance of three fingers' breadth from the point of insertion, is the general practice, as it is well known that if left untied, profuse hæmorrhage will most likely ensue. Still this does not always happen even then, and I have met with instances when the cord might safely have been left untouched. Instances, too, are known where the cord, having been by accident torn off close to its insertion, bleeding has

nevertheless not taken place. But in the majority of such cases, free and profuse hæmorrhage is more likely to occur.

It seems natural, therefore, to expect that, in proportion to the length of navel-string the chances of loss of blood will diminish, and my observations were made by way of a reply to the question, From what length of cord is it possible for hæmorrhage to a dangerous extent to take place? The cases that served for that purpose were taken in succession in ordinary practice, and in all of them the health of both mothers and children was satisfactory.

In the first set of experiments, embracing 10 cases, the navel-string was cut at distances varying from $2\frac{1}{2}$ to 18 inches. Breathing was perfectly established in each, and was not subsequently interrupted.

At $2\frac{1}{2}$, 6, 9, and 12 inches, division of the cord was only followed by the escape of a small quantity of blood, which immediately ceased, and then no more hæmorrhage took place. The blood which was lost appeared merely to drain from the cord. On dividing the cord at 18 inches the escape of blood did not spontaneously cease, but continued in two profuse jets from the umbilical arteries with such vigour, that in interrupting it by compression of the cord, it was immediately resumed on removing the pressure. Convinced that in this case true systemic arterial hæmorrhage was witnessed, I applied a ligature.

In the second set of experiments I had in view, a circumstance which had been cursorily mentioned by Sir James Simpson in his Lectures on Midwifery to this effect, that if the cord be not divided until the infant has breathed freely, and the pulmonary circulation established, hæmorrhage is not likely to take place; but if then the respiration be prevented by momentarily closing the mouth and nostrils with the hand, the foetal circulation is renewed, and blood flows from the cord. The same observations were made by Ploucquet towards the end of last century.

α. Four observations were made on cords of $2\frac{1}{2}$ inches in length. Profuse and continuous hæmorrhage occurred when the cords were divided, and interruption of the respiration neither augmented nor retarded the flow.

β. Four observations were made at $2\frac{1}{2}$ inches ; in these, after division, no hæmorrhage occurred, and the infants breathed freely. In each the respiration was interrupted in the manner stated, with the result of setting up profuse and apparently continuous hæmorrhage.

δ. In one case where I had intended making the same observation with regard to the breathing, division of the cord at 12 inches gave place to profuse and rapid arterial hæmorrhage.

ε. Five observations were made on cords of 18 inches in length. In two of these bleeding did not result on division, and as the infants breathed freely I interrupted the respiration. At once both umbilical arteries delivered strong jets of blood. The cords were next cut off at $2\frac{1}{2}$ inches with the same results.

In the third case, the hæmorrhage was equally copious from the arteries of the cord only on stopping the respiration; the additional experiment at a shorter length was not practised. In the fourth and fifth cases the loss of blood was produced under the same conditions ; but in both of these I noticed that a simultaneous flow of blood took place from the umbilical vein, and very considerably.

The effects of interruption to the breathing appears to lead to umbilical hæmorrhage, at the same time the many instances where it occurred independently of all interference with respiration, would indicate some more immediate cause, and this I consider to be disturbance of the pulmonary circulation.

It is impossible to state with much exactitude the quantity of blood which must be lost to produce fatal results, but it is certain that in the infant this quantity may be very small. Haller estimated the amount of blood in the body at $\frac{1}{5}$ th its weight, and from this to $\frac{1}{8}$ th has been generally accepted as sufficiently approximate : but of more importance than the absolute amount lost, is the manner in which it is lost ; for the same quantity that might escape by gradual oozing from minute vessels and vascular parts without causing syncope, might, if discharged, *in pleno rivo*, from an artery, lead to even fatal sinking, and the extremes of life and debility increase the peril.

The hæmorrhage from the divided navel-string is chiefly

arterial. It is easy to distinguish the streams as they issue from both arteries, although from the pulsations of the heart in the cases under observation, varying from 130 to 150 per minute, the flow has little intermittency, and is apparently continuous. There may be also loss of blood from the vein; and when it is borne in mind that neither the umbilical vein nor the great trunks with which it inosculates—the portal, hepatic, and inferior cava—are provided with valves, and that the direction of the blood-stream is in them in opposition to gravity, this fact can be readily understood.

In the body of the infant which I examined I was struck with the extreme depletion of the veins and abdominal organs—the four cavities of the heart, besides, being empty, and their muscular walls firmly contracted. I thought that venous hæmorrhage had probably, in a great measure, assisted to produce this anæmia.

There was another point in connection with the navel-string to which I gave attention, and that was the effects of laceration of the cord upon the vessels. Rupture of a blood-vessel usually causes tearing of the middle and inner coats, while the more tenacious outer coat twists and closes the orifice beyond; a fact of which Amussat took advantage, and introduced into operative surgery in 1829. I did not find the arteries of the cord, however, either twisted or occluded after tearing it in two by the hands, for the orifices either remained visibly patent, or allowed the immediate passage of a gentle stream of fluid sent through from the opposite extremity.

Once I have met with a cord which I failed to tear directly asunder by the utmost force. It was one wherein the jelly of Wharton was very scanty; and after repeated attempts, during which the tissues gave way by degrees in long shreds like the fibres of a frayed strand of hemp, the vessels were ultimately left completely denuded for several inches.

In fine, the conclusions from the foregoing observations are:—

1°, Hæmorrhage may take place from the navel-string, even when of a length of 18 inches, and to such an extent as to endanger life.

2°, Hæmorrhage from the cord may take place without any interference with the respiration, but the arrest of this may lead to hæmorrhage when it might not otherwise occur.

Certain reflections have naturally occurred to me in the course of these researches, which so intimately deal with one of the most ordinary means of infanticide. The law does not regard this as a crime in any way distinct from murder, nevertheless, surrounding it in its medico-legal aspects with requirements of evidence, which virtually imply the recognition of some specific character. The ordinary mortality of childbirth being great, and in cases of illegitimacy very much greater, there has arisen, necessarily, to meet the plea of still-birth, an equal necessity for the prosecution to adduce evidence of life.

But proofs of this nature are not always available; for as they are afforded by an inspection of the organs of respiration, they must at all times fail when the destruction of life has anticipated the performance of that function, and in those rare cases where life may exist for many hours after birth, and yet the lungs are afterwards found in a perfectly foetal state.*

The further proof required of live birth—*i.e.*, life after birth—throws greater difficulties still in the way; for there is no sign wherewith to distinguish the infant that has breathed and died before birth, from one which having been born and breathed, has died immediately afterwards. And yet this antiquated legal quibble is retained in the face of repeated medical demonstration of its absurdity.

The anomaly, therefore, obtains, partly traceable to this evil, of a capital felony, of which the very penalty is an additional bar to a verdict at the hands of a sensitive and common jury, and the result follows that the hampered and dubious aspect of the case in court is too often the frequent cause of an inadequate conviction on such a count as concealment of birth, when the moral circumstances, and everything else, apart from the confusion of medical and legal

* Dr Alfred Swaine Taylor in 'Guy's Hospital Reports,' No. V. p. 355; Orfila and others.

differences, point clearly to the commission of the graver offence.

Now there is a crime where murder is perpetrated as part of a cool and deliberate plan, which for malice prepense exceeds in its heinousness that of infanticide, but which is not a capital one.

In abortion, to which I refer, the attempted or effected destruction of the foetus constitutes the proofs of evidence, and no specialty is introduced whereby these can be warped and made unintelligible.

If the destruction of life *in utero* be a crime for which, on due finding of evidence, the provisions of the statute are equal, surely the destruction of life a few minutes, it may be, after birth is a crime so little removed from the former, that its gravity and legal rank as a major offence should not be so fettered with demands for proof of a nature which medical science has again and again declared impossible, as to place it more on the footing of a misdemeanour with special immunities?

The removal of the stumbling-block of live birth, and the definition of infanticide as *destruction of the infant within a period of birth when medical evidence is unable to prove a separate existence*, the abolition of the capital felony, and the assimilation of the penalties with those of abortion, would, in my opinion, prepare the way for a more rational treatment of this class of offences, while the greater certainty of conviction would lead to their diminution. But with a greater certainty of conviction *under existing enactments*, the impending danger would be that practices happily less known in England than in other countries might become equally familiar here; hence it must be that a timely provision of legislation will impart to morality better safeguards than either ignorance or evasion.

