Henry J. Bigelow

# SURGICAL ANÆSTHESIA

# ADDRESSES AND OTHER PAPERS

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THIS volume contains the Articles by Dr. Bigelow relative to the discovery of Surgical Anæsthesia. Valuable historically and in other respects, they are here reprinted in their chronological order.

It also includes his Addresses, and a few Papers heretofore unpublished.

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# SURGICAL ANÆSTHESIA.

# INSENSIBILITY DURING SURGICAL OPERATIONS PRODUCED BY INHALATION.[1]

## THE FIRST PUBLIC ANNOUNCEMENT OF THE DISCOVERY OF SURGICAL ANÆSTHESIA.

It has long been an important problem in medical science to devise some method of mitigating the pain of surgical operations. An efficient agent for this purpose has at length been discovered. A patient has been rendered completely insensible during an amputation of the thigh, regaining consciousness after a short interval. Other severe operations have been performed without the knowledge of the patients. So remarkable an occurrence will, it is believed, render the following details relating to the history and character of the process not uninteresting.

On the 16th of October, 1846, an operation was performed at the Hospital upon a patient who had inhaled a preparation administered by Dr. Morton, a dentist of this city, with the alleged intention of producing insensibility to pain. Dr. Morton was understood to have extracted teeth, under similar circumstances, without the knowledge of the patient. The present operation was performed by Dr. Warren, and, though comparatively slight, involved an incision near the lower jaw of some inches in extent. During the operation

[1] Read before the Boston Society for Medical Improvement, November 9, 1846, an abstract having been previously read before the American Academy of Arts and Sciences, November 3, 1846. Published in the Boston Medical and Surgical Journal, November 18, 1846.

the patient muttered, as in a semi-conscious state, and afterwards stated that the pain was considerable, though mitigated; in his own words, as though the skin had been scratched with a hoe. There was probably in this instance some defect in the process of inhalation, for on the following day the vapor was administered to another patient with complete success. A fatty tumor of considerable size was removed by Dr. Hayward from the arm of a woman, near the deltoid muscle. The operation lasted four or five minutes, during which time the patient betrayed occasional marks of uneasiness; but upon subsequently regaining her consciousness, professed not only to have felt no pain, but to have been insensible to surrounding objects, to have known nothing of the operation, being only uneasy about a child left at home. No doubt, I think, existed in the minds of those who saw this operation that the unconsciousness was real; nor could the imagination be accused of any share in the production of these remarkable phenomena.

I subsequently undertook a number of experiments, with the view of ascertaining the nature of this new agent, and shall briefly state them, and also give some notice of the previous knowledge which existed of the use of the substances I employed.

The first experiment was with sulphuric ether, the odor of which was readily recognized in the preparation employed by Dr. Morton. Ether inhaled in vapor is well known to produce symptoms similar to those produced by the nitrous oxide. In my own former experience the exhilaration has been quite as great, though perhaps less pleasurable, than that of this gas, or of the Egyptian *hashish*.[1] It seemed probable that the ether might be so long inhaled as to produce excessive inebriation and insensibility; but in several experiments the exhilaration was so considerable that the

[1] Extract of Indian hemp.

subject became uncontrollable, and refused to inspire through the apparatus. Experiments were next made with the oil of wine (ethereal oil). This is well known to be an ingredient in the preparation called "Hoffman's anodyne," which also contains alcohol, and this was accordingly employed. Its effects upon the three or four subjects who tried it were singularly opposite to those of the ether alone. The patient was tranquillized, and generally lost all inclination to speak or move. Sensation was partially paralyzed, though it was remarkable that consciousness was always clear, the patient desiring to be pricked or pinched, with a view to ascertain how far sensibility was lost. A much larger proportion of oil of wine, and also of chloric ether, with and without alcohol, were tried, with no better effect.

It may be interesting to indicate how far medical inhalation has been previously employed. Medicated inhalation has been often directed to the amelioration of various pulmonary affections, with indifferent success. Instruments called inhalers were employed long ago by Mudge, Gairdner, and Darwin, and the apparatus fitted up by Dr. Beddoes and Mr. James Watt for respiring various gases has given birth to some octavo volumes. More recently, Sir Charles Scudamore has advocated the inhalation of iodine and conium in phthisis, and the vapor of tar has been often inhaled in the same disease. The effects of stramonium, thus administered, have been noticed by Sigmond.

The inhalation of the ethers has been recommended in various maladies, among which may be mentioned phthisis and asthma. "On sait que la respiration de l'éther sulfurique calme souvent les accidents nerveux de certains croups," is from the "Dictionnaire des Sciences Médicales"; but I find that mention of the inhalation of this agent is usually coupled with a caution against its abuse, grounded apparently upon two or three cases, quoted and requoted. Of these the first is from Brande's "Journal of Science," where it is thus reported: "By imprudent respiration of sulphuric ether, a gentleman was thrown into a very lethargic state, which continued from one to three hours, with occasional intermissions and great depression of spirits, — the pulse being for many days so low that considerable fears were entertained for his life." Christison quotes the following from the "Midland Medical and Surgical Journal," to prove that nitric ether in vapor is a dangerous poison when too freely and too long inhaled: "A druggist's maid servant was found one morning dead in bed, and death had evidently arisen from the air of her apartment having been accidentally loaded with vapor of nitric ether, from the breaking of a three-gallon jar of the spiritus ætheris nitrici. She was found lying on her side, with her arms folded across her chest, the countenance and posture composed, and the whole appearance like a person in a deep sleep. The stomach was red internally, and the lungs were gorged." The editor of the journal in which this case is related says he is acquainted with a similar instance, where a young man was found completely insensible from breathing air loaded with sulphuric ether, who remained apoplectic for some hours, and would undoubtedly have perished had he not been discovered and removed in time. Ether is now very commonly administered internally as a diffusible stimulant and antispasmodic, in a dose of one or two drams. But here also we have the evidence of a few experiments that ether is capable of producing grave results under certain circumstances. Orfila killed a dog by confining a small quantity in the stomach by means of a ligature around the œsophagus. Jäger found that half an ounce acted as a fatal poison to a crane. It was for a long time supposed to be injurious to the animal economy. The old Edinburgh Dispensatory, republished here in 1816 (p. 566), explicitly states that it is to be inhaled by holding in the mouth a piece of sugar, containing a few drops, and also that regular practitioners give only a few drops for a dose; "though," it adds, "empirics have sometimes ventured upon much larger quantities, and with incredible benefit." Nevertheless, it was known to have been taken in correspondingly large doses with impunity. The chemist Bucquet, who died of scirrhus of the colon, with inflammation of the stomach and intestines, took before his death a pint of ether daily, to alleviate his excruciating pains (he also took one hundred grains of opium daily); and Christison mentions an old gentleman who consumed for many years sixteen ounces every eight or ten days. Such facts probably led Mérat and De Lens, in their "Matière Médicale," to question its grave effects when swallowed. Mentioning the case of Bucquet, they say, even of its inhalation, that it produces only "un sentiment de fraîcheur que suit bientôt une legère excitation."

This variety of evidence tends to show that the knowledge of its effects, especially those of its inhalation, was of uncertain character. Anthony Todd Thomson well sums up what I conceive to have been the state of knowledge at the time upon this subject in his London Dispensatory of 1818: "As an antispasmodic, it relieves the paroxysm of spasmodic asthma, whether it be taken into the stomach, or its vapor only be inhaled into the lungs. Much caution, however, is required in inhaling the vapor of ether, as the imprudent inspiration of it has produced lethargic and apoplectic symptoms." In his "Materia Medica and Therapeutics" of 1832, however, omitting all mention of inhalation, he uses the following words: "Like other diffusible excitants, its effects are rapidly propagated over the system, and soon dissipated. From its volatile nature, its exciting influence is probably augmented as it produces distension of the stomach and bowels, and is thus applied to every portion of their sensitive surface. It is also probable that it is absorbed in its state of vapor, and is therefore directly applied to the nervous centres. It is the diffusible nature of the stimulus of ether which renders it so well adapted for causing sudden excitement, and producing immediate results. Its effects, however, so soon disappear that the dose requires to be frequently repeated."

Nothing is here said of inhalation, and we may fairly infer that the process had so fallen into disrepute, or was deemed to be attended with such danger, as to render a notice of it superfluous in a work treating, in 1832, of therapeutics.

It remains briefly to describe the process of inhalation by the new method, and to state some of its effects. A small two-necked glass globe contains the prepared vapor, together with sponges to enlarge the evaporating surface. One aperture admits the air to the interior of the globe, whence, charged with vapor, it is drawn through the second into the lungs. The inspired air thus passes through the bottle, but the expiration is diverted by a valve in the mouthpiece, and, escaping into the apartment, is thus prevented from vitiating the medicated vapor. A few of the operations in dentistry, in which the preparation has as yet been chiefly applied, have come under my observation. The remarks of the patients will convey an idea of their sensations.

A boy of sixteen, of medium stature and strength, was seated in the chair. The first few inhalations occasioned a quick cough which afterwards subsided; at the end of eight minutes the head fell back and the arms dropped, but owing to some resistance in opening the mouth, the tooth could not be reached before he awoke. He again inhaled for two minutes, and slept three minutes, during which time the tooth, an inferior molar, was extracted. At the moment of extraction the features assumed an expression of pain, and the hand was raised. Upon coming to himself he said he had had a "first-rate dream, — very quiet, — had dreamed of Napoleon,—had not the slightest consciousness of pain,—the time had seemed long." He left the chair, feeling no uneasiness of any kind, and evidently in a high state of admiration. The pupils were dilated during the state of unconsciousness, and the pulse rose from 130 to 142.

A girl of sixteen immediately occupied the chair. After coughing a little, she inhaled during three minutes, and fell asleep, when a molar tooth was extracted, after which she continued to slumber tranquilly during three minutes more. At the moment when force was applied she flinched and frowned, raising her hand to her mouth, but said she had been dreaming a pleasant dream, and knew nothing of the operation.

A stout boy of twelve at the first inspiration coughed considerably, and required a good deal of encouragement to induce him to go on. At the end of three minutes from the first fair inhalation, the muscles were relaxed and the pupil dilated. During the attempt to force open the mouth he recovered his consciousness, and again inhaled during two minutes, and in the ensuing one minute two teeth were extracted, the patient seeming somewhat conscious; but upon actually awaking he declared "it was the best fun he ever saw," avowed his intention to come there again, and insisted upon having another tooth extracted upon the spot. A splinter which had been left afforded an opportunity of complying with his wish, but the pain proved to be considerable. Pulse at first 110, during sleep 96, afterwards 144; pupils dilated.

The next patient was a healthy-looking, middle-aged woman, who inhaled the vapor for four minutes; in the course of the next two minutes a back tooth was extracted, and the patient continued smiling in her sleep for three minutes more. Pulse 120, not affected at the moment of the operation, but smaller during sleep. Upon coming to herself she exclaimed that "it was beautiful, —she dreamed of being at home, — it seemed as if she had been gone a month." These cases, which occurred successively in about an hour, at the room of Dr. Morton, are fair examples of the average results produced by the inhalation of the vapor, and will convey an idea of the feelings and expressions of many of the patients subjected to the process. Dr. Morton states that in upwards of two hundred patients similar effects have been produced. The inhalation, after the first irritation has subsided, is easy, and produces a complete unconsciousness at the expiration of a period varying from two to five or six, sometimes eight minutes, its duration varying from two to five minutes, during which the patient is completely insensible to the ordinary tests of pain. The pupils in the cases I have observed have been generally dilated; but, with allowance for excitement and other disturbing influences, the pulse is not affected, at least in frequency; the patient remains in a calm and tranquil slumber, and wakes with a pleasurable feeling. The manifestation of consciousness or resistance I at first attributed to the reflex function, but I have since had cause to modify this view.

It is natural to inquire whether no accidents have attended the employment of a method so wide in its application, and so striking in its results. I have been unable to learn that any serious consequences have ensued. One or two robust patients have failed to be affected. I may mention, as an early and unsuccessful case, its administration in an operation performed by Dr. Hayward, where an elderly woman was made to inhale the vapor for at least half an hour without effect. Though I was unable at the time to detect any imperfection in the process, I am inclined to believe that such existed. One woman became much excited, and required to be confined to the chair. As this occurred to the same patient twice, and in no other case as far as I have been able to learn, it was evidently owing to a peculiar susceptibility. Very young subjects are affected with nausea and vomiting, and for this reason Dr. Morton has refused to administer it to children. Finally, in a few cases, the patient has continued to sleep tranquilly for eight or ten minutes, and once, after a protracted inhalation, for the period of an hour.

The following case, which occurred a few days since, will illustrate the probable character of future accidents. A young man was made to inhale the vapor, while an operation of limited extent, but somewhat protracted duration, was performed by Dr. Dix upon the tissues near the eye. After a good deal of coughing the patient succeeded in inhaling the vapor, and fell asleep at the end of about ten minutes. During the succeeding two minutes the first incision was made and the patient awoke, but unconscious of pain. Desiring to be again inebriated, the tube was placed in his mouth and retained there about twenty-five minutes, the patient being apparently half affected, but, as he subsequently stated, unconscious. Respiration was performed partly through the tube and partly with the mouth open. Thirty-five minutes had now elapsed, when I found the pulse suddenly diminishing in force, so much so that I suggested the propriety of desisting. The pulse continued decreasing in force, and from 120 had fallen to 96. The respiration was very slow, the hands cold, and the patient insensible. Attention was now of course directed to the return of respiration and circulation. Cold affusions, as directed for poisoning with alcohol, were applied to the head, the ears were syringed, and ammonia presented to the nostrils and administered internally. For fifteen minutes the symptoms remained stationary when it was proposed to use active exercise, as in a case of narcotism from opium. Being lifted to his feet, the patient soon made an effort to move his limbs, and the pulse became more full, but again decreased in the sitting posture, and it was only after being compelled to walk during half an hour that the patient was able to lift his head. Complete consciousness returned only at the expiration of an hour. In this case the blood was flowing from the head, and rendered additional loss of blood unnecessary. Indeed the probable hemorrhage was previously relied on as salutary in its tendency.

Two recent cases serve to confirm, and one I think to decide, the great utility of this process. On Saturday, November 7, 1846, at the Massachusetts General Hospital, the right leg of a young girl was amputated above the knee by Dr. Hayward, for disease of this joint. Being made to inhale the preparation, after protesting her inability to do so from the pungency of the vapor, she became insensible in about five minutes. The last circumstance she was able to recall was the adjustment of the mouthpiece of the apparatus, after which she was unconscious until she heard some remark at the time of securing the vessels, — one of the last steps of the operation. Of the incision she knew nothing, and was unable to say, upon my asking her, whether or not the limb had been removed. She refused to answer several questions during the operation, and was evidently completely insensible to pain or other external influences. This operation was followed by another, consisting of the removal of a part of the lower jaw by Dr. Warren. The patient was insensible to the pain of the first incision, though she recovered her consciousness in the course of a few minutes.

The character of the lethargic state which follows this inhalation is peculiar. The patient loses his individuality and awakes after a certain period, either entirely unconscious of what has taken place, or retaining only a faint recollection of it. Severe pain is sometimes remembered as being of a dull character; sometimes the operation is supposed by the patient to be performed upon somebody else. Certain patients, whose teeth have been extracted, remember the application of the extracting instruments; yet none have been conscious of any real pain.

As before remarked, the phenomena of the lethargic state are not such as to lead the observer to infer this insensibility. Almost all patients under the dentist's hands scowl or frown; some raise the hand. The patient whose leg was amputated uttered a cry when the sciatic nerve was divided. Many patients open the mouth, or raise themselves in the chair, upon being directed to do so. Others manifest the activity of certain intellectual faculties. An Irishman objected to the pain that he had been promised an exemption from. A young man after sitting in the chair and inhaling a short time rejected the globe, and taking from his pocket a pencil and card wrote and added figures. Dr. Morton supposing him to be affected, asked if he would now submit to the operation, to which the young man willingly assented. A tooth was accordingly extracted, and the patient soon after recovered his senses. In none of these cases had the patients any knowledge of what had been done during their sleep.

I am as yet unable to generalize certain other symptoms to which I have directed attention.[1] The pulse has been, as far as my observation extends, unaltered in frequency, though somewhat diminished in volume; but the excitement preceding an operation has, in almost every instance, so accelerated the pulse that it has continued rapid for a length of time. The pupils are in a majority of cases dilated; yet

[1] Since the above was written, I find this irregularity of symptoms mentioned in the case of poisoning by alcohol. Dr. Ogston, according to Christison, has in vain attempted to group together and to classify the states of respiration, pulse, and pupil.

they are in certain cases unaltered, as in the above case of amputation.

The duration of the insensibility is another important element in the process. When the apparatus is withdrawn at the moment of unconsciousness, this state continues, upon the average, two or three minutes, and then the patient recovers, completely or incompletely, without subsequent ill effects. In a sudden cessation of the symptoms, this vapor in the air tubes differs in effect from narcotics or stimulants in the stomach, and also, as far as the evidence of a few experiments of Dr. Morton goes, from ethereal solution of opium when breathed. Lassitude, headache, and other symptoms, lasted for several hours when this latter agent was employed.

But if the respiration of the vapor be prolonged much beyond the first period, the symptoms are more permanent in their character. In one of the early cases, that of a young boy, the inhalation was continued during the greater part of ten minutes, and the subsequent narcotism and drowsiness lasted over an hour. In a case already mentioned, the narcotism was complete during more than twenty minutes, the insensibility approaching to coma.

Such cases resemble those before quoted from Christison and other authors, and show that the cessation of the inhalation, after it has been prolonged for a length of time, does not produce a corresponding cessation of the symptoms, while, if the inhalation is brief, the insensibility ceases in a short time. Recovery in the latter case is not improbably due to the complete and rapid elimination of the vapor from the lungs; the more gradual return of consciousness in the former case, to the presence of a larger quantity of unexhaled particles. A fact mentioned by Christison bears upon this point. This author states that insensibility from the presence of a large quantity of alcohol in the stomach often gives place to a complete and sudden return of consciousness when the alcohol is removed by the stomach pump. It is probable that the vapor of the new preparation ceases early to act upon the system, from the facility with which it is exhaled.

The process is obviously adapted to operations which are brief in their duration, whatever be their severity. Of these the two most striking are, perhaps, amputation and the extraction of teeth. In protracted dissections the pain of the first incision is alone of sufficient importance to induce its use; and it may hereafter prove safe to administer it for a length of time, and to produce a narcotism of an hour's duration. It is not unlikely to be applicable in cases requiring a suspension of muscular action, such as the reduction of dislocations or of strangulated hernia; and finally it may be employed in the alleviation of functional pain, of muscular spasm, as in cramp and colic, and as a sedative or narcotic.

The application of the process to the performance of surgical operations is, it will be conceded, new. If it can be shown to have been occasionally resorted to before, it was only an ignorance of its universal application and immense practical utility that prevented such isolated facts from being generalized.

It is natural to inquire with whom this invention originated. Without entering into details, I learn that the patent bears the name of Dr. Charles T. Jackson, a distinguished chemist, and of Dr. Morton, a skilful dentist, of this city, as inventors, and has been issued to the latter gentleman as proprietor.

It has been considered desirable by the interested parties that the character of the agent employed by them should not be at this time announced; but it may be stated that it has been made known to those gentlemen who have had occasion to avail themselves of it.

I will add, in conclusion, a few remarks upon the actual position of this invention as regards the public.

No one will deny that he who benefits the world should receive from it an equivalent. The only question is, Of what nature shall the equivalent be? Shall it be voluntarily ceded by the world, or levied upon it? For various reasons, discoveries in high science have been usually rewarded indirectly by fame, honor, position, and occasionally, in other countries, by funds appropriated for the purpose. Discoveries in medical science, whose domain approaches so nearly that of philanthropy, have been generally ranked with them; and many will assent with reluctance to the propriety of restricting by letters patent the use of an agent capable of mitigating human suffering. There are various reasons, however, which apologize for the arrangement which I understand to have been made with regard to the application of the new agent.

1st. It is capable of abuse, and can readily be applied to nefarious ends.

2d. Its action is not yet thoroughly understood, and its use should be restricted to responsible persons.

3d. One of its greatest fields is the mechanical art of dentistry, many of whose processes are by convention secret, or protected by patent rights. It is especially with reference to this art that the patent has been secured. We understand already that the proprietor has ceded its use to the Massachusetts General Hospital, and that his intentions are extremely liberal with regard to the medical profession generally, and that, so soon as necessary arrangements can be made for publicity of the process, great facilities will be offered to those who are disposed to avail themselves of what now promises to be one of the important discoveries of the age.

## INSENSIBILITY DURING SURGICAL OPERATIONS PRODUCED BY INHALATION.[1]

To the Editor: —

Sir, — I observe in the last number of your Journal an article entitled "The Inhalation of an Ethereal Vapor to prevent Sensibility to Pain," etc., signed by J. F. Flagg, M.D., a considerable part of which is devoted to comments upon a paper of mine in the same Journal, of the date of November 18, 1846.

Any one who will trouble himself to examine that paper, will find there a narrative of physiological facts observed by myself, with a few concluding remarks connected with the patent right, intended chiefly to inform the medical profession, at the request of the inventors, that every practicable facility would be afforded to them in their use of the new process. It was far from my intention to take part in the differences likely to arise from an invasion of the patent, and I indulged the belief that I had avoided any issues of a controversial character.

It may be necessary, however, to notice one or two points in the communication of Dr. Flagg, but I do so with regret that they should have emanated from so respectable a quarter. I disclaim any interest of any kind whatever in the matter under discussion, except the heartfelt desire I have, in common, I believe, with almost every man in the community, that full justice should be done to the inventors of a method by which the whole human race is benefited; and

[1] Boston Medical and Surgical Journal, December 9, 1846.

I regret that an article embodying, as I assume this does, the views of those who would appropriate to their own advantage the discovery of others, should have first emanated from a gentleman for whose position in this community I entertain much respect.

I am free to say that I believe many persons besides myself would have been gratified if this invention could have been issued to the world unfettered by any restrictions of law or private right. But when your correspondent, in his anxiety to take possession of the invention, refuses to allow to Drs. Jackson and Morton any right to their discovery, or to admit any "apology" for the patent, I am ready to show what I consider their right to be; and shall also take the liberty to examine how far Dr. Flagg has sustained his position.

The history of inventions is well known. Some fortunate individual makes a discovery. This individual is frequently not he who has investigated the most deeply or theorized the longest upon the subject, though the discovery itself is all the evidence the public can require of his right to receive for it an equivalent. But no sooner is the discovery announced, than a multitude of individuals begin to recognize their own claims to a reward; and we hear that "there was nothing new in the discovery," "they were quite near it," "they had produced the same effect." It is rare, however, that a man who offers no evidence of any participation in a discovery, as in the present instance, openly avows his intention to share in the profits. This point deserves further consideration.

The inventors of a method of producing insensibility by inhalation have shown an almost infallible way of annihilating the pain of some of the most formidable surgical operations. If any plan were to have been devised for promoting the comfort of the race, it would have been difficult to suggest one so wide in its application as that which should obliterate sensibility at will, — which should mitigate the sufferings of those who are called upon to endure pain in its most atrocious forms. If any individuals have bestowed this inestimable boon upon the race, they have a right to look to the race for a substantial return in some shape or other. Who, then, are these individuals? I can find no evidence that the invention would not have slept for twenty years longer, had not Drs. Morton and Jackson demonstrated it to the public.

I have no prepossession in favor of the tribe of *ex post facto* inventors, who always settle like parasites upon every recent invention of any pecuniary value. Either the discovery was previously made, or it was not. If it was, we have only the alternative of supposing that the fortunate individual saw fit, for some inexplicable reason, to keep in his own bosom a secret which he knew to be of unparalleled value to the whole human family. I prefer to believe that it was not.

But what sort of claim is now made to previous knowledge upon the subject? Is the maid servant mentioned by Dr. Christison, who died in the cause, to be held as the discoverer? Or the gentleman who recovered from his lethargy? Or yet your correspondent, who "almost fell asleep"? Obviously not. These facts were mere suggestions, pointing to a hypothetic principle; and it was the business of those who received such hints to have pursued them till the single fact was generalized and the principle established. Drs. Morton and Jackson have done all this. They have struck out a new path; and even when future science shall have abridged and improved the present method, or substituted another for it, it will not detract in the slightest degree from the merit of the original discoverers of a great and novel principle.

It is fair to presuppose that your correspondent has ample grounds for availing himself of this discovery, without offering to the inventors a recompense. I shall examine these as far as I am able to understand them. And, first, let me separate the question of legal right from that of common right and justice. With the former I have nothing to do. It can only be decided by those who possess competent legal knowledge. Your correspondent exclaims, "What is patented? a power? a principle? a natural effect? the operation of a well known medicinal agent? I doubt the validity of such letters patent. It would seem to me like *patent sunlight* or *patent moonshine*." This figurative expression of Dr. Flagg's legal opinion may be of great value, but it may be mentioned that the inventors have, on the other hand, the opinions of several eminent authorities, and also that of the Commissioners at Washington, that the patent is perfectly valid and tenable. Leaving, then, for those who are competent to it, the discussion of the law of the question, I shall inquire on what grounds of professional right or of common justice your correspondent proposes to appropriate this discovery.

In the first place, he objects to the use of patent or secret medicines. "I shall not," he says, "obtain and use it as a secret medicine; I shall not purchase and use it as a patent medicine," apparently on the ground that "the enlightened and regular medical faculty of Massachusetts . . . are associated and have arrayed themselves against all secret remedies or patent medicines, and therefore cannot feel themselves at liberty," etc. "But," he says in another place, "I shall use it." The scruples of your correspondent lie, then, not against the use of the discovery, but against the purchase of it. I shall attempt to remove all hesitation he may have upon this point.

In so doing I may state that, as far as my humble influence was concerned, I urged the adoption of the new method in one at least of the early cases which occurred at the Hospital, without consulting the by-laws of the Massachusetts Medical Society, in full reliance upon the wisdom and liberality of the framers of that code. A subsequent examination of it has confirmed my position. I am unable to find any law bearing directly or indirectly upon the present case. The tenth by-law of the Massachusetts Medical Society is directed, as I understand it, against any one who shall publicly advertise or publicly offer to cure disease by medicine the composition of which he (the advertiser) makes a secret. It deals with the question of proclaimed secrecy; and in my view is directed against that prudish class of practitioners whose ostentatious solicitude to conceal their wares is their only chance of persuading people of their value. The same remarks apply to the fifty-eighth by-law. I leave others to judge of the propriety of applying such restrictions to a method which has been publicly registered, the nature of which has been voluntarily announced to every surgeon who has used it, and of which the immense utility is universally conceded. I am unable to discover that your correspondent has here any ground for his scruples about purchasing a right.

But, he says, "no one can restrict them [the medical faculty] from using what is used for the relief of suffering humanity." It is, then, "suffering humanity" which compels them to share in the equivalent which the public is returning to the inventors. But why not send "suffering humanity" to Dr. Morton, or call him to its aid? Dr. Morton has made ample arrangements for its reception at No. 19 Tremont Street, or for its relief at the houses of other dentists. When the papers coolly announce "the best method in use for narcotizing patients," or "the improved method," I for one enjoy the audacity of those who assert their intention to have a share in any profits to be made. But it is painful that any man should be compelled by his conscience to receive a part of the substantial gratitude of suffering humanity, when they to whom alone its gratitude is due have made ample arrangements for its relief.

I confess my inability to follow your correspondent in a large part of his argument, and shall therefore only allude to it. He says: "The free use of the article has been ceded to the surgeons of the Massachusetts General Hospital, and these gentlemen would receive it or adopt its use on no other condition, of course, than that of knowing what it was, and having full and free control of it for that institution. Hence I ask . . . why I must now purchase the right to use it."

Again, "If it is simple sulphuric ether, I shall use it; . . . if it is a compound" ("it is said to be ceded to the surgeons of the Hospital, . . . and if known to medical students who attend that institution . . . no one can rightly restrict them, and") "it will become free."

I can only interpret these logical sequences upon the ground that your correspondent confounds the question of secret and that of patent, and infers that what is no longer secret is no longer patent. It is understood that the matter was secret just so long as was necessary to secure patents here and elsewhere, and no longer. But the fact of its subsequent publicity does not change the question of property. The discovery and the patent right still belong to the inventors, and your correspondent, and whoever else of us wishes to avail himself of it, must accede to their very reasonable terms.

It remains to say a word with regard to three very inoffensive "apologies," "two of which" your correspondent considers to be "without force," while "the total incorrectness of the main part of the third must be apparent to all." I am unable to see that your correspondent has invalidated the force of the first two. With the intention of testing the correctness of my statement that certain secrets are conventional among dentists, I have applied to three of the most eminent dentists of this city, to whom I can refer your correspondent, who do not hesitate to state that such is the fact. But if Dr. Flagg still holds that he "does not know of anything which is practised in dentistry, even relating to the mechanical department, which is kept secret by duly educated dentists," I know no way in which, according to his own views, he could contribute more directly to the cause of "suffering humanity" than by volunteering to communicate to "duly educated dentists," for the mere equivalent of the time occupied in so doing, a concise account of his methods in some of the more recondite departments of his art; for example, in the composition and manufacture of mineral teeth. I am confident that the number of applicants, both in town and in the country, who would amply compensate him for his time, would testify at once to the demand for this sort of knowledge, and to the general appreciation of his skill.

I have been led to exceed my intended limits, because I was desirous of answering in some measure a class of objectors of whom I regret that your correspondent should be the representative. No one can doubt that an inestimable discovery has been made. Though it may be regretted that it has not been made free to all, yet the inventors have an undoubted legal right to pursue with regard to it whatever course may seem to them best. They have made arrangements which place it at the command of any who are disposed to avail themselves of it,[1] and I cannot but think

[1] I had occasion a few days since to tie the femoral artery of a patient who was unable to pay for the operation. I found no difficulty in obtaining the gratuitous use of the method; nor do I conceive that others would, in similar circumstances. It may be added, that the patient was wholly unconscious of the dissection.

that the community, if not the government, will be forward in recognizing the magnitude of their claims.

I have only to add, that I am not ambitious of controversy, and that I shall make no further communication upon this part of the subject, unless the position I have here assumed shall seem to me to be in any way invalidated.

Your obedient servant,

HENRY J. BIGELOW.

BOSTON, December 4, 1846.

# ETHER AND CHLOROFORM:

## THEIR HISTORY, SURGICAL USE, DANGERS, AND DISCOVERY.[1]

The astronomer Leverrier calculated the direction and rate of travel of a star, and pointed to its place in the heavens. A star appeared; yet astronomers tell us that this was not his star, that its rate of travel was other than had been predicted by Leverrier. No other appeared exactly to fulfil the astronomer's calculations. Yet Leverrier is great, and his name is familiar.

Professor Schönbein converted cotton into a new vehicle of sudden force. The belief that gun cotton might be cheaply used for purposes of offence or of defence, gave to the name of Schönbein a currency in all parts of the civilized world, and to gun cotton the position of one of the discoveries of the age.

The French experimenter has attached his name to the Daguerreotype, and this, too, is great, although a mere luxury when tested by its applicability to the necessities of man.

Few will deny to these inventions and discoveries the epithet *great*, when compared with others of the day; and yet their greatness is of very different kind. What, then, shall be considered a test of greatness in discovery?

[1] The author of these pages does not propose to dig up the well-worn hatchet of the ether controversy. It may, therefore, be proper to state that the following pages were originally published more than six months ago in the Boston Medical and Surgical Journal, April 19 and 26, 1848.

A writer upon patents has said that an invention is entitled to protection from the law, when it materially modifies the result produced, or the means by which it is produced; that a patent right is due to novelty in a machine producing an old fabric in a new way, or to the manufacture of a new and very different fabric, resulting from a slight change in the machine; in other words, to novelty in the combined result of means and end. This distinction, if not legal, is apparently just; and I should, in like manner, call an invention great in proportion to the combined amount of mind invested in its production, and of its intrinsic ability to minister to the supposed or real comfort and well-being of the race.

What, then, is the character of the discovery of etherization? And it is not idle nor superfluous to examine definitively the claims of this invention. I shall presently show that there are regions where the use of ether is still unknown, or its efficacy doubted; and that there have been those who maintained that a certain good fortune attended its discovery, which in a measure abated its claim to greatness.

The following position is, I believe, quite tenable.

Ether is capable of producing, with very rare exceptions, if there be any, complete insensibility to pain, with discomfort to the patient in only a part of the cases; this discomfort being trifling compared with the pain of an incision an inch in length.

What is pain, which the race has ceased to know in its more formidable phase, and which in another age will be remembered as a calamity of rude and early science? Pain is the unhappy lot of animal vitality. It respects neither condition nor external circumstances. In the countless generations which lead us step by step into the remote ages of antiquity, each individual has bowed before this mighty inquisitor. It has borne down the strongest intellect, and sapped and withered the affections. The metaphysician finds in it the secret spring of one half of human action; the moralist proclaims it as the impending retribution of terrestrial sin; the strongest figure of the Bible condemns man to eternal flames; and yet this "dreaded misery, the worst of evils," now lies prostrate at the feet of science. Pain is encountered at man's option, and the nerves fulfil their functions only with the connivance of the intellect.

One hundred years ago a lecturer proved that the discoverer who had subdued the lightning was not an impious man. The modern lecturer may proclaim that the greatest of discoveries has deprived terrestrial fire of its terrors; that man was not born to pain; and he may reply to those who argue that pain is immediately administered by a Divine agency, that physical suffering grows out of the imperfection of physical existence, and that it is not the mundane retribution of transgression.

The practical employment of etherization ensued upon the conference of two individuals. One of these, retreating to the privacy of his own apartment, placed his watch upon the table, and applied ether to his mouth. Eight minutes of complete obliviousness now elapsed, and he awoke excited with the purpose of testing the degree and quality of this new somnolency with reference to his peculiar art. For some hours the confirmation of certainty was delayed, and the future discovery hung upon a slender thread. Public wayfarers inclined no sympathetic ear to the necessities of a discoverer, and several diplomatists, sent out to bribe some chance foot-passenger to lose a tooth for an equivalent of five dollars, returned without being able to negotiate. Towards nine o'clock, the inmates of the establishment were aroused by the arrival of a patient. Yet he, recognizing in the dental art only the substitution of one pain for another, despairingly inquired if Mesmerism was not available in such ordeals. Here, then, was the long wished for opportunity, and complete unconsciousness crowned the experiment with success. It is quite probable that the world will not remember who this individual was, and yet it is true that the whole discovery of which we are now speaking exhibited its first authentic effort when it annulled the pain accompanying the lesion of the little nerve that animated his defective molar.

It is worth while here to ask, What was the position of the discovery at this time? A tooth had been painlessly drawn, and at a previous time an irritation of the pulmonary air tubes had been alleviated, with alleged insensibility, by the inhalation of a subtile vapor. Here were two facts, insufficient for the most hasty generalization, circumscribed in their purport, showing, not that every person could be affected in a similar manner, bearing not upon vitality at large, but only upon two specimens of it as modified in these two individuals, and proving, at the most, that animal vitality could be thus affected in two instances, and not that it could be so in all instances. Besides this, the wholly different question of danger was not yet touched by evidence. If these two cases showed that insensibility could be thus effected without danger, two or three previous cases showed, with equal clearness, that insensibility produced death. Knowledge, at this point, rested upon a few hypothetical facts. I confess, had I been then asked what inference I considered safe, I should have replied, "You have succeeded in two instances only; and, in view of the previous evidence upon this subject, it is quite likely that, in two more instances, either you will fail to produce insensibility, or, having produced it, your patients will die." This seems to me the necessary logical conclusion from previous evidence; and that this was the first conclusion of those who had knowledge in such matters will be well remembered by many. I cite only the opinion of a distinguished chemist in a neighboring city, who, after one or two facts of insensibility, counselled his son not to risk his health upon it. Also a letter from Sir Benjamin Brodie, one of the distinguished experimenters in physiology of twenty years ago, who, in full view of all the facts that were borne across the Atlantic at the first announcement of the discovery, and after reflection, still wrote to Dr. Chambers: "I had heard of this before. The narcotic properties of inhaled ether have been long known, and I have tried it on guinea pigs, whom it first set asleep and then killed. One question is, whether it can be used with safety."

This was indeed a great question to be decided. Another was, Can insensibility be produced in all cases? Let these inquiries be answered affirmatively, and the surgeon would be justified in multiplying his experiments, while the value of the discovery would be infinitely enhanced.

To settle these important questions many instances of insensibility were needed, which were not long in offering themselves to the tenant of a largely frequented dental establishment. Each new trial added evidence in geometrical proportion, while the absence of serious mishap encouraged hope.

I consider a second point in the discovery to have been now pretty well established. This was, not that ether *might* produce insensibility during the extraction of a tooth, and that the state of somnolence might be unattended with danger, but that it could always produce insensibility, and that the danger was comparatively slight.

Brief inhalation may be considered as fairly tested, and the discovery fairly demonstrated, in this rapid and multiplied experience.

Analogy, the degree of insensibility, and its superficial extent, rendered it quite probable that such insensibility would prove complete and universal An *experimentum crucis* could alone determine such a point, nor was it long delayed.

The gentleman who had conducted these experiments determined upon submitting the new phenomena to the test of a surgical operation; and there was a certain liberality of spirit which was instrumental in introducing the discovery into the Massachusetts General Hospital. Many such pretended discoveries had failed. To be a party to such public failure was to invite an imputation of lack of judgment; and although this novelty presented peculiar and unequivocal evidence, and possessed an intrinsic worth which need have regarded no opposition, yet a spirit of liberality and of discernment is to be recognized in the attitude of Dr. Warren, who assumed the responsibility of failure, and of the danger that might well seem possible to one who had not witnessed the previous experiments. Ether has not always met with equal consideration.

The operation of that day was incomplete in its results, for reasons to be hereafter indicated. A young man offered signs of sensibility during and after a dissection which was not particularly painful. Some powerful drug already known, or even the imagination, might well have been suspected of agency in the phenomena.

On the ensuing day, a woman offered herself with a tumor of considerable magnitude on the right shoulder. A few minutes of the most complete and passive insensibility served for its extirpation. No imagination was here to be accused. The drooping lid, the head fallen on the shoulder, the stolid relaxation of the mouth, suggested no overworking of the intellect, no rapt unconsciousness, no inspired ecstasy. The phenomena were real, familiar to daily experience; they belonged to the profoundest sleep. This operation of

Dr. Hayward first showed conclusively the power of the new agent in averting the terrors of the surgical art. The casual spectator would have remarked no expression of wonder nor unusual excitement in the bystanders at the working of this miracle. Nothing to awe or startle marred the tranquillity of the operating-room. Yet I think those present will not soon forget the conviction of those few moments, associated at this remote day with the breathless silence of the crowd, and the unwonted fumes of aromatics burned to mask the emanations from the yet mysterious agent. Cognizant of these facts, and having studied the phenomena of etherization in a number of successive experiments at the dental establishment before alluded to, I felt that there was no longer any hazard in vouching for the efficacy of ether; and on the 3d of November I read a memoir upon the subject before the American Academy of Arts and Sciences. The case of Alice Mohan, whose limb was successfully amputated by Dr. Hayward under the new influence, occurring soon after, I incorporated this confirmatory evidence into a second paper read before the Medical Improvement Society of this city. This paper, afterwards published in this Journal, was the first upon the subject, and was, I believe, that which carried the news to the South and across the Atlantic.

It has been well said that the first attitude of the world towards a great discovery is incredulity, and then hostility; and this was well exemplified in the reception of this announcement at the South. Three weeks elapsed before any notice of the subject appeared. Then came the doubts of those sagacious and experienced philosophers who were not easily to be deceived.

In January, 1847, a New York medical journal announced that "the last special wonder has already arrived at the natural term of its existence. It has descended to the bottom of that great abyss which has already engulfed so many of its predecessor novelties, but which continues, alas, to gape until a humbug yet more prime shall be thrown into it."

The New Orleans Medical Journal says, in the same month, "That the leading surgeons of Boston could be captivated by such an invention as this excites our amazement." "Why, *Mesmerism*, which is repudiated by the *savans* of Boston, has done a thousand times greater wonders."

A leading medical periodical in Philadelphia, says: "We should not consider it entitled to the least notice, but that we perceive, by a Boston journal, that prominent members of the profession have been caught in its meshes." It was "fully persuaded that the surgeons of Philadelphia would not be seduced from the high professional path of duty into the quagmire of quackery by this will o' the wisp." What the surgeons of Philadelphia have considered the "high professional path of duty," up to a very recent date, I shall soon show.

It is fair to state, that at the West, in Chicago, Buffalo, and St. Louis, the discovery received candid consideration.

The great show of dissatisfaction, emanating from those who were not contented to receive tranquilly this great discovery, and to recognize it as such, was directed against the patent right connected with its early history; but so soon as the discovery received the confirmation of European testimony, it was providentially discovered that the patent was probably invalid, and hesitation and opposition rapidly subsided, although for some weeks the enthusiasm of periodical medical literature was tempered by the character of the reports which reached us from the other side of the Atlantic.

The article before alluded to was, I believe, the first published in the European journals. The discovery, then, rested in Europe upon the identical evidence which introduced it to the medical community on this side of the water, and it is interesting to observe what was the attitude there assumed towards it.

Upon the arrival of the steamer of December 1, private notices were at once forwarded to many of the eminent surgeons in London, who zealously investigated the subject. Mr. Liston, who amputated a leg, was, on the whole, successful. Yet there, as elsewhere, doubtful cases occurred. A signal failure happened at Guy's Hospital. Other cases of incomplete success contributed to place the subject upon doubtful ground. Notwithstanding these failures, the mere chance of producing insensibility to pain, once demonstrated, aroused an inconceivable enthusiasm in the surgical world. The English journal which announced the discovery remarked, in an editorial article: "The discovery seems to have *a remarkable perfection about it*, even in its first promulgation. . . . We suppose we shall hear no more of Mesmerism and its absurdities as preparations for surgical operations." And of the paper alluded to, and of Liston's case, it says, "It is almost impossible to discredit the statements contained in the communication referred to." A similar tone was held by other leading journals, experiments were instituted in all the principal hospitals, and new evidence daily arrived from the provincial towns.

Information was conveyed to Paris, by a private letter, in the month of November, 1846. The incredulity of surgeons prevented its early adoption. Velpeau "politely declined" to experiment upon it. When, however, in January, the accumulation of evidence arrived from England and America, a new interest was at once excited. Experiments, the majority of which had previously been failures, were now instituted with a Boston inhaling apparatus, which soon arrived, and before the 1st of February the two great surgeons Velpeau and Roux averred, in the presence of the two Academies, that the discovery "was a glorious conquest for humanity." The news rapidly spread through European cities, and over the civilized world.

Once, and only once, out of the country of its birth, did a government discountenance the discovery.

In this country, where no legal form hinders any individual from purchasing a bottle of prussic acid for his own private consumption, such interference excites comment; but when we remember that a court adviser is quite likely to be some single philosopher who has become too wise for innovation, an error of judgment emanating from such a source is less remarkable.

In thus detailing the early narrative of the discovery I have endeavored to present the contemporaneous and accumulating evidence of experiment, in order to show how far, at each stage of its advancement, new experiments were justified, and also to exhibit in this relation the various attitudes of those who were to be the instruments of its progress. And this is important. At various points in its history those who stood between this agent of mercy and the world, those whose duty it was to deal out to mankind this inestimable blessing, have seen fit to refuse it to the unhappy victims of surgical art, and have condemned them to severe suffering which might easily have been avoided.

It would be illiberal to impugn the motives of those who occupy this position; nor do I conceive it would be attempted by those who know the variety and complication of the secret agencies of human action. Yet a wide influence is diffused by many such, and it is impossible to calculate how far the mass of human misery may be augmented by such opinions joined to authority.

However easy it may be for an individual, or body of individuals, to promulgate what they conceive to be their convictions, yet if there is a chance of error in these convictions, and if that error tends considerably to increase the aggregate of human suffering, it will be readily conceded that the world has a right to question how far such convictions may be reasonable. Fortunately for this purpose, human reason is identical in all. To determine how far etherization ought to be adopted by the world, let us re-examine the evidence in relation to its more obvious conclusions.

Ether was said, in one instance, to have produced insensibility. In another experiment it made an individual unconscious of the drawing of a tooth. Twenty or more experiments were immediately instituted with nearly the same effects and no accidents.

These were certainly novel and striking circumstances. They were calculated to arrest attention. They presented credentials which had a right to be examined. Ether had a right to be tried, candidly and fairly, unless it could be shown that its previous bad character forfeited all claim to further consideration. What, then, was its previous character? What is the *a priori* evidence respecting the danger of ether on the one hand, or its narcotic power on the other? And, first, the danger rests mainly upon the evidence of a few cases, — the gentleman in Brande's journal, the druggist's maid servant, and the young man of the "Midland Medical and Surgical Journal"; to which may be added the experiments of Orfila upon dogs, and of Brodie upon guinea-pigs.

I put against these cases the hundreds of young men who had been for years harmlessly exhilarated by ether; I add to these well known facts the half-hundred cases which occurred in a few weeks after the discovery; and reaffirm that, as far as danger goes, ether, before the end of 1846, had a right to be tested anew. Analogy fortifies this ground. It points to a state of dead drunkenness effected through the air tubes, as corresponding to a similar state effected through the stomach. Patients dead drunk had lost their legs without pain; others had instantaneously revived when alcohol was pumped out of their stomachs. Why should not the lungs become the recipient of the inebriating agent, and respiration be the resuscitating stomach pump? This analogy, which still holds good, was distinctly alluded to in the original article upon the subject of ether inhalation.

Many people had died when alcohol was not thus pumped out of their stomach; and might they not well die when the atmosphere of a room was surcharged with ether, and they asleep in it? If the argument from analogy proves anything, it proves that it is no more dangerous to be narcotized by inhaling ether, than to be dead drunk with alcohol. I hold, then, that at the time alluded to, the middle of November, 1846, neither analogy nor fact forbade the use of ether.

At this date, too, certain doubters shook their heads and talked of *Mesmerism*. Now there was something in the previous knowledge of ether which widely separated it from such pretended agencies, whose phenomena are opposed to our experience of the order of nature. Ether is very different from Mesmerism; and I think it must have occurred to any one who fairly investigated the subject, that it was quite possible, and even probable, that what was now affirmed of twenty cases was, unlike Mesmerism, likely to be true from all previous evidence. A gentleman well known in the professional and scientific world, hearing, on the day of the first experiments, that inhalation had produced insensibility to pain, exclaimed, as conviction flashed upon him, "I believe it! It can be done! Ether will do it!" Such discrimination is not to be generally looked for; but such a fact tends to show that previous evidence led towards ether, and not from it.

Mesmerism, in spite of the bad odor of repeated failure and deception, has not unfrequently obtained a candid hearing; and this circumstance singularly contrasts with the philosophy that refused to give ether an impartial hearing, even after it was invested with the accumulated evidence of experience.

A hundred promiscuous cases rapidly occurred, — often in the face of hundreds of spectators, not one of whom attributed the results to deception or imagination. Many of these cases were detailed in papers published by Doctors Warren, Hayward, Peirson, Townsend, J. M. Warren, Parkman, and others, of equal credibility. The mass of evidence swelled as it rolled onward, month after month, to every part of this country and of the civilized world; and yet in November, 1847, more than a year after the discovery, we find it stated that in one of the largest hospitals in North America ether "had not been tried at all."

For the sake of humanity, if not of science, it is to be hoped that no hospital gates are barred against ether at this late day.

How different was the attitude of the London surgeons, who, only eight weeks after the first discovery, and with far less evidence than lay at the disposal of any one on this side of the water, hailed the American discovery with generous enthusiasm. The gentleman to whom the communication above alluded to was sent was kind enough to return to me the replies received from some of the leading medical men. Thomas Bell writes, "I fully intend to try it the first opportunity. The cases are very satisfactory, and the whole affair most important." Liston says, December 21, "I tried the ether inhalation to-day, with perfect and satisfactory results"; and at once writes, "It is a very great matter to be able thus to destroy sensibility to such an extent without apparently a bad result. It is a fine thing for operating surgeons, and I beg to thank you most sincerely for the early information you were so kind as to give me of it." Of Liston's case of amputation, which is usually supposed to have carried with it extraordinary conviction, Sir James Clarke says, "The man said that he felt something was doing with his leg, but it was not pain." Yet he does not hesitate to avow that "it is really a marvellous thing." December 17, Richard Bright, in spite of information from Guy's Hospital that they had completely failed to produce the desired state of intoxication, apologetically writes, "However, there must have been some want of skill in this first attempt, and I can scarcely doubt that future experience will lead to better success." Lastly, Dr. Forbes adds to the American communications Liston's case, and writes, "I have sent copies of the enclosed to all the newspapers, so that I hope all the world will soon have the great news."

Here was the effect of evidence upon the scientific mind of Europe. Now it is unquestionably very respectable to doubt. The world may not question the judgment of those who suspend their judgment. Yet there are times when doubt is sophistry, and indecision culpable. Richard Bright did not delay to forward the news to Guy's Hospital, "that no time might be lost in affording so great a relief to any who might be in the unfortunate condition of being obliged to undergo a serious operation."

Ought not the motive of relieving human pain to induce the appointed officers of public charities to ask what is the nature of this anodyne, in whose behalf united nations rise to testify? Is it supposed that one of these gentlemen would lose his own arm without invoking ether? Shall none remonstrate, when those who are appointed to alleviate human suffering in administering the accumulated charities of years virtually avow that, having tried no experiments, and comparatively ignorant of the subject, they consider that the decision of mankind is wrong, — and, acting upon this avowal, condemn, not themselves, nor yet the reasoning community who resist their influence, but their helpless hospital patients, to the horrors of the knife?

If these consequences were limited to the sphere of a few institutions, the public would have a proportionally limited interest in the subject; but the wide-spread influence which such institutions exercise upon their own section of the country, and upon the large community of which they are the scientific centre, as well as the indirect influence they may have exercised upon governments, render it imperative at least to exhibit the actual value of the influence they choose to exert.

Equally futile were the objections to the new and patent method upon the ground of quackery and professional etiquette. Such considerations should fall before a question of this magnitude; and as to the fact, professional custom does not sanction such objections.

A few words upon the patent may not be here inappropriate. Discoverers in art tax the world for a pecuniary equivalent. In the higher atmosphere of science, which deals with abstract truth, it is not easy, nor is it usual, thus to extort a value for any application growing out of discovery. It is well that a line should be drawn between discoveries in pure science, which enlarge the sphere of the intellect or the boundaries of permanent knowledge, and the transitory and less disinterested labors directed to the amelioration of a narrower circle and a briefer term.

It does not harmonize with our better impulses, that a great invention in the art of relieving human suffering should be in any way conditional. I believe that nations would have emulated each other in meeting any liability generously abandoned to them as a debt of honor. Yet it should be remembered that the question of patent is very insignificant compared with the discovery itself, or the gratitude due to it. Besides, secrets are common, and perhaps justly so, in the profession with which this discovery had an intimate connection in its early history, and where a patent is not a subject of comment.

Some of the journals seem to have been indignant at the announcement of this patent by a regular physician. I investigated and published some of the first experiments, by the permission of those concerned in making them, and, at their stipulation, announced the patent, with its extenuating circumstances. That the patent was an error of judgment, as well as a violation of custom, I had no doubt, and I vainly endeavored, as far as my influence might weigh, to prevent taking the final steps for procuring it. I even urged an appeal to interest, the force of which has been fully verified in this case; namely, that when the burden of sustaining his position falls on the patentee, and not upon the violator of the patent, nor upon the government who grants it, an invention may be so valuable as to be worthless to the patentee in a pecuniary point of view. In other words, the encroachment of the multitude may become too formidable for the resistance of an individual. Finding such expostulation of no avail, and as an humble instrument in the announcement of a great discovery, I did what I should be most ready to do every week, if by so doing I were able to accelerate, even by a few days only, the ability of the world to relieve human suffering. Those who were most indignant at the patent seem to have been slowest to grant ether to their patients. A fear of "quackery" was instrumental in persuading Congress to withhold the agency of ether, when it might have assuaged the agony of the wounded soldier. Let us hope that such nice discriminators have no more to lay to their consciences than a violation of professional etiquette, like that of announcing and using a patent right by which a man is lulled to slumber while his leg is amputated.

A want of ability has been displayed in confounding the questions of ether patent and ether inhalation. Those who have declaimed against the ether patent, upon this side of the Atlantic, have found it very difficult to give a candid hearing to the separate question of ether insensibility. But it was not so abroad. In England, scientific discrimination far outweighed any discreditable feeling of prejudice or jealousy. The very unimportant question of patent was soon at rest. This error of custom or of taste was forgotten; and the united scientific world abandoned themselves to a determination of the real value of the discovery. No opportunity for experiment was lost, no evidence rejected. The whole medical community gave themselves to the work, and in a short time most honorably avowed that the discovery of etherization was not second to the discovery by their own Jenner. Let us believe that in the country of its birth prejudice against ether inhalation will now yield to a recognition of its value.

An impartial consideration of the question, "Who was the discoverer of ether insensibility to the pain of surgical operations?" will be best attained by a previous consideration of the abstract question of discovery, reserving for its conclusion a special application of the principles illustrated by it to this special subject.

Why was the discovery not made before? Why did no one discern the value of the exhilarating agent which had attracted the attention of so many?

Because the human mind is fettered by long custom. It runs in the channels of routine. First diverted from its course by some little obstacle its current swells and deepens, bearing down solid opposition that it may roll tranquilly in its distorted bed. Watch the tide of human footsteps, guided by the mind of successive generations. The pathway turns here and there to avoid some little inequality, and the old man and the child follow the winding track. Mind follows where mind has been. Few turn aside to analyze the difficulties which discouraged others. That a thing has not been is to most men, perhaps justly, a reason why it will not be; and here is the office of philosophic incredulity which doubts the track of custom.

It is quite obvious that such incredulity may emanate from widely differing sources. It often grows out of depth and originality of intellect, — of capacity which takes a wide and general view, discovering imperfection in mode or in material.

On the other hand, as he who is ignorant of a path may make the shortest route from point to point, so one who is not familiar with the erroneous conclusions of previous knowledge may first trace a true result. In such a case ignorance of error is an accidental vantage ground, which places its man considerably nearer truth than that occupied by prejudice based upon error.

I hold that such incredulity, whether of knowledge or of ignorance, is likely to indicate a philosophic mind. It proposes to think for itself. Its experience of the world has shown it that the world may be wrong. Its experience of its own abilities has taught it to respect itself. For example, Whitney was said to form his decisions, not after the model of common opinion, but by his own nicely balanced judgment. Perhaps in some details, humble though they be, such a mind has seen the defect of others' judgment, and has had cause to prefer its own results, and, thus instructed, turns to a new subject determined to win its own experience, to make its own investigation.

Such incredulity, brought to bear upon an extended system, especially in the inexact sciences, is justly viewed with suspicion; and the reformer in politics, in social organization, or in medical science, meets no enthusiastic greeting. A little zeal, with a little error of premises or of reasoning, may then make the reformer dangerous. Here, the *experimentum crucis* cannot easily be tried, either from the number of elements in the problem, from the length of time required, or from the magnitude of the interests at stake; and the world therefore very justly maintains a degree of conservatism and immobility in its moral, social, and political relations.

In the exact physical sciences the tenets of a reformer may be easily tested. Here the logician easily supplies himself with facts. The result of single and brief experiments made at will can admit of little doubt. Even in the obscurer parts of medicine, where the material and immaterial influences are numerous, and sometimes inappreciable, every honest and logical mind must, upon points of importance, arrive at one and the same result. No danger can result from incredulity in medical science. On the contrary, in view of the errors of fact which grow out of want of time or qualification on the part of observers, or the intrinsic difficulties of the science, a healthy and vigilant scepticism of recorded facts, whether in diagnosis or in therapeutics, is one of the essential methods of its advancement.

It is quite obvious that such incredulity, such distrust of recognized authority, occupies a merely negative position. It is a quality which adapts its possessor for the reception of new light, from which the act of invention may emanate. But that such act should in reality occur, certain active faculties are requisite. Positive inventive talent is required, the nature of which I shall attempt to show. But let it be remembered that there is a partial substitute for talent. It has been said that the difference between men lies more in their power of application than in this quality. Great application, resulting from strong stimulus, will be readily allowed to bring about results much like those of talent. At any rate, it is more nearly allied to the untiring zeal and stern energy which recognizes no obstruction to its march. It is well known that this unyielding perseverance has characterized a large proportion of inventors; it has animated them in failure, and nerved them through adversity. Of Whitney, whose cotton gin, even fifteen years ago, was said to be demonstrably worth $100,000,000 to the United States, it was said, "In all my experience in the thorny profession of the law, I never saw a case of such perseverance, under such persecution. Even now, after thirty years, my head aches to recollect his narratives of new trials, fresh disappointments, and accumulated wrongs." Fulton's energy was marvellous. His experimental boat was completed after inconceivable difficulties in the spring of 1803, when a messenger announced that it had broken in pieces and gone to the bottom. After a momentary despondency, which he had never felt till then, without returning to his lodging, and without rest or refreshment, he labored with his own hands to raise her during twenty-four hours incessantly. To this imprudence he attributed much of his subsequent bad health. The boat was almost entirely rebuilt, and was again completed in July. I take Fulton, Whitney, and Arkwright as types of the mechanical inventor. They possessed in an eminent degree the inventive talent, but this did not predominate over determination and perseverance, as not unfrequently happens when such talent is exaggerated. Of Whitney's power of invention it was said, "It never ran wild; it accomplished, without exception, all that he ever asked of it, and no more. I emphasize this last expression, from having in mind the case of a man whose inventive power appeared to be more fertile even than Whitney's, but he had it under no control. When he had imagined and half executed one fine thing, he darted off to another; and he perfected nothing. Whitney perfected all he attempted."

Such energy, vital to the existence of most discoveries, may grow out of either the inventor's sense of the necessity, or his conviction of the possibility of reaching his object. The latter is another qualification, mysterious to many, and allied to the incredulity before mentioned, which eminently characterizes the inventor. It may be defined as a belief in the possibility, or certainty, of producing a result attainable through the more active perception and reflection of his mind by a series of processes which he may be, and often is, totally unable to impart. He is often, in consequence, considered as unsound or unwise; for as far as the subject in hand is concerned the inventor is actually ahead of the world. His faculties may not be recognized as stronger, his character as more forcible, his intellectual range as broader, nor his knowledge of experience as greater, than those of other men. Yet for the narrow point at issue he is more competent than any other. His perceptions are stimulated and brought to a focus, and his energy is hot. He may actually become a better instrument for a special purpose than another whose intellectual mechanism is far more complicated. Franklin, in an essay before the American Philosophical Society, gave a drawing of a water-wheel, accompanied by a demonstration, conclusive as he supposed, that such wheels could not be used to advantage in propelling steamboats. He proposed a jet from the stern. Fulton proved that, among all methods proposed, the jet was the worst and the wheel the best. Fulton was right, and not Franklin.

The power of remodelling old forms, of abbreviating method, of devising and economizing force for the passage of trodden or untrodden paths, appears to me essentially the same in most of the vocations of the human mind. Superadded to it may be a taste or a talent for the combinations of mechanical or other agencies, or for the complicated details of number and of space, or for any other of the fields of science. But how often is a mind simultaneously given to various inventive fields, and exhibiting its powers in various directions, intuitively recognized and stigmatized by the world as having a genius which incapacitates it for the daily routine of life! And how many, like Newton or Franklin, who added the element of perseverance to this genius, have been distinguished for a versatility of talent, manifesting itself each year in a new field, and exhibiting in each its peculiar trait! Franklin was a reformer; Fulton a warm advocate of the principles of free trade; while Whitney, in his college compositions, according to the words of his biographer, "with a spirit somewhat prophetical, anticipated the decline and overthrow of all arbitrary governments, and the substitution in their place of a purely representative system like our own."

The inventor invents or devises the means to attain his ends. He is therefore most likely, other things being equal, to be a discoverer, because he will best devise the instruments, material or abstract, with which to cross-examine nature and discover abstract truth. Yet it often happens that an inventive talent confines itself to the exposition of mechanical truths of limited application; not demonstrating large and suggestive laws in science, but settling limited questions of expediency in art; or making combinations, as Newton did with a watch, for mere intellectual pleasure.

Such mechanical talent as that of Fulton and Whitney, and hosts of others whose names are or are not attached to great inventions and discoveries, is not the less because it remained circumscribed by the field of mechanics to which it first addressed itself. The modifications of mechanical force do in fact afford an ample field to intellect. But give opportunity to such men as Fulton, or to a thousand nameless artisans, whose talent is valued at more than gold by those who convert such knowledge into money, — find some way of detecting humble genius, and give to it the opportunity for education in science and unmerchantable truth which may take the place of a natural strong taste for them, — and the combination of the inventive talent with the scientific knowledge would yield the true philosopher. Newton built a watch, and, having a rare genius for arithmetical computation, discovered the law of gravitation.

It is difficult to overestimate this talent for expedients and resources. What is American ingenuity? It is this great talent seeking a field in mechanical combinations in a country where opportunities for scientific knowledge have been hitherto comparatively rare. The elements of American ingenuity constitute the perception, the discrimination, and the resources of the American people.

The true power of originating, wherever manifested, is the result of a power of analysis and a power of combination; the former enabling the inventor to discover the differences between the elements of existing combinations, to detect the influence of each, and to reject the useless, while the latter perceives the relations of new elements to the problem, and invokes their agency in new combinations. The intellectual philosopher may justly recognize in these faculties the agency both of powerful judgment and of the imaginative quality, both brought to bear upon a range of subjects with which their possessor is familiar.

It has been conceded that this talent is peculiar, — often an uncultivated gift, brought to bear upon some narrow range of material by those whose general knowledge does not testify to their industry or opportunities, or whose intellectual calibre and general range does not at all comport with this local development of talent in the direction to which taste has guided it.

On the other hand, many discoveries important to the world owe little to this peculiar talent. They depend upon a fortunate or accidental succession of events, encircling a comparatively moderate ability; and then the magnitude of the invention may be much out of proportion to the degree of the inventive faculty. The invention of printing, perhaps the greatest in the scale of social importance, was but a division of the Roman printing block. Gunpowder, which happens to abbreviate warfare, was an unpremeditated invention. The discovery of Jenner has been attributed (1) to his talents; (2) to his education under Hunter; (3) to his situation in the vale of Gloucestershire.

I would not abate a leaf of the laurel to which the discoverer has an undisputed right; and I shall presently indicate another quality, different from the inventive talent, which ranks high in intellect, and often compensates a discoverer for this talent. I wish here to show that a discovery of great value may result in part from good fortune, from the first occupation of a ground, from perseverance in a particular direction, or from some other adventitious circumstance; that its magnitude and usefulness may be out of proportion to the character of the intellectual processes invested in it; and that it has happened that a discovery of immense practical importance to the human race, with good fortune to aid it, has involved but an inconsiderable intellectual pang in its creation; and in consequence, that any *a priori* reasoning upon the mode of its creation has very little connection with what may well be a question of pure fact.

Having thus considered the intellectual qualities concerned in invention, I pass to the progress of the invention itself, and to a consideration of its successive steps. These consist, first, of the suggestion, and, secondly, of the generalization.

Perhaps the most fertile source of error in the history of invention grows out of a misappreciation of these two stages of discovery. Yet they can be shown to differ widely, both in their character and in the credit they deserve.

There can be no doubt that unless invention be a result of pure accident, suggestion always precedes it. It has been often distinctly recorded, in connection with the greater inventions and discoveries. Thus the vertical spindles of an overturned spinning wheel suggested the jenny to Hargreaves. Iron rolling suggested the drawing of cotton by rollers to Arkwright, who thus reinvented the spinning frame (ignorant of Wyatt's previous invention). The valves of Fabricius suggested the circulation of the blood to Harvey.

In such cases the inventor or discoverer abstracted from the individual instance some inherent element, the applicability of which to other instances he alone saw. Hargreaves saw the value of a vertical position to spindles; Newton, of a force which attracted the apple; Harvey, of the idea that venous blood could run in only one direction; and they generalized this element in reapplying it.

It does not modify the truth of this proposition, that the first suggestion or experiment should yield a new result; that, instead of a falling apple, it should be the contraction of a frog's leg, or an unpremeditated pustule on the hand of a Gloucestershire milkmaid. Such facts were still suggestions, not discoveries, and were new only in the aspect they received from the mind whose key-note they struck,—new because attention was then first drawn to them in a new relation, and not new in their actual occurrence.

And the suggestion varies in its suggestive power, both from its own character and from that of the mind it works upon. The apple fell, but Newton alone abstracted a principle in behalf of the moon. Horace Wells says: "Reasoning from analogy, I was led to believe that surgical operations might be performed without pain by the fact that an individual, when much excited from ordinary causes, may receive severe wounds without manifesting the least pain; as, for instance, the man who is engaged in combat may have a limb severed from his body, after which he testifies that it was attended with no pain at the time. And so the man who is intoxicated with spirituous liquor may be treated severely without his manifesting pain. . . . By these facts I was led to inquire if the same result would not follow by the inhalation of some exhilarating gas." It is well known that he tried the experiment with various results, upon himself and others, in November, 1844. The philosopher Seneca makes the remarkable observation: "That which presses hard upon you, and is very urgent, if you begin to withdraw yourself, will certainly pursue you and fall heavier. If, on the contrary, you stand your ground and seem resolved upon opposition, you will drive it from you. How many strokes do boxers receive on the face and whole body! Yet a thirst of glory makes them regardless of pain."

To Seneca it suggested nothing; but to Wells, a principle. A suggestion derived from one or two instances becomes an invention only when its important element is abstracted and actually reapplied; and it will be soon seen that the abstraction itself, the supposition, the theory, without this actual reapplication, amounts to nothing; and that for every actual and successful reapplication of a newly appreciated phenomenon, there have been innumerable claims from those who suspected that such reapplication might be made, but did not actually make it, — who mistook a single truth for a universal truth, suspicion for certainty, theory for fact.

It will be found, by reference to the histories of discoveries, that the suggestion and generalization have occurred almost invariably in the experience of one and the same individual. Though it is quite possible to conceive that, while the suggestion occurred to one individual, he might transfer it for generalization to another individual, yet I am unable to find any instance in which this has occurred. On the contrary, the suspicion, the groundwork of the hypothesis, has generally stimulated and goaded the possessor until he was able to convert it into fact. The suspicion has been then established; or, much more frequently, has not been established; it has proved erroneous. Hope has not been realized, and the discovery has turned out to be no discovery. Watt, whose name is identified with the history of steam, and the soundness of whose practical views no one will dispute, speaks of "the cast of a die. For in that light," he says, "I look upon every project that has not received the sanction of repeated success."

This transfer of a suggestion, a theory, unconfirmed by fact, or relying upon one or two facts alone, is, as I have said, quite possible. It would then have the character of a transferred ticket in a lottery, with which the recipient may draw a prize, but which is far more likely to turn up a blank.

But especially in great discoveries the theory has not been thus made over to a second party. The perceptions of the inventor, keen upon this point, have enabled him to discern its value, and he has allowed himself no rest, no interval, in the steady prosecution of his task.

I have alluded to a second quality which contributes to discovery. The inventive talent lies at one end of the intellectual vibrations. At the other extreme is a high quality which elaborates another element, while the invention itself is the electric flash which results from the contact of the two.

Here let me do ample justice to the mind of Jenner, which I do not find to have been especially characterized, in his biography, by the inventive genius. It did possess, as an equivalent, the power of appreciating the importance of a discovery; and it was in this power, and in the perseverance that resulted from it and indicated it, that I recognize his chief merit. Jenner comprehended that vaccination would considerably prolong the average of human existence. A breadth of view, a simultaneous consideration of many circumstances with ability to reason justly upon them, — in short, a very clear conception of the whole subject, — could alone afford the notion of importance or necessity which was to become the stimulus and proximate cause of the discovery. Few minds are capable of becoming so imbued with the importance of a merely possible result as to permit it to divert the current of daily life. Such men are pointed at as having one idea; their wisdom is questioned; they are the butt of ridicule. And when the result demonstrates the accuracy of their convictions, we may fairly bow at once to their discernment and understanding, whether it detected a possibility, or comprehended a necessity, which others overlooked.

At this point let us pause to make a distinction of cardinal importance. We have hitherto considered the qualities of the inventor's mind, and the sucessive steps of the process by which it accomplishes its end. Another element now complicates the problem. The invention is to go forth to the world, and to establish certain relations between the world and the discoverer.

Up to this point it is quite obvious that an invention may be made, that it may grow from an original hint into a theory, which again may be confirmed beyond a doubt by the test of repeated experiment, and yet that the whole process may be confined to the inventor's mind, to his own cognizance. So long as he thus retains it for his own benefit or for that of a few friends, does the world stand in his debt? Clearly not. The demonstration of the world to an inventor is a demonstration of gratitude and honor, — gratitude for the donation of a great invention, honor to intellectual ability. To the latter it is conceded in the case of certain astronomical discoveries, for example, not immediately concerned in the direct welfare of mankind, but the product of vast and recognized intellectual power.

But when a discovery becomes great, not from the character of the intellect invested in it, but from its immediate applicability to the amelioration of the condition of humanity, then the gratitude and honor conceded by the world is a mere equivalent for value received. The world will not concede this gratitude until they have received the value. They will only concede it to the source through which they receive it, and they will examine very closely the claims of those who assume to have acted as agents in the matter.

To investigate this last position further. The world is to bestow a large reward in honor and in gratitude, but requires indisputable evidence of merit on the part of the recipient. It is prejudiced against *ex post facto* claims; because it naturally argues, first, that one who had made the invention and appreciated it, would in anticipation of this honor, grateful to all men, have published his invention when he made it; and secondly, that although such *ex post facto* claimant be a real inventor, yet he is so only in relation to himself or those with whom he has communicated; and as he either could not or did not make the world at large feel the full value of it, so they owe him nothing. Such is ample reason for the world's prejudice against such claims.

This suspicion of inventors who do not appear until after the world has been made to recognize a discovery is also justified by the remarkable fact that hardly an invention of importance was ever made known that it was not at once claimed, often simultaneously, from a variety of sources. It is perfectly natural that it should be thus contended for. The world, whether in science or in art, is built, up to a certain point, by the easy and wide transmission of knowledge, and upon this elevation stand a multitude of philosophers, engaged often in identical researches, and therefore possessed of much information upon the subject to which a discoverer first gives utterance. The world is then liable for a short time to confound their claims, to confuse the perfect with the imperfect knowledge, the incomplete result of few facts with the complete demonstration from many, the unproved with the indisputable, theory with fact. But the law of the land has left no doubt upon this point. Before ceding a patent it first identifies a discoverer. Here is an opinion from the clear head of Judge Story: "He is the first inventor in the sense of the act, and entitled to a patent for his invention, who has first perfected and adapted the same to use; and until it is so perfected and adapted to use, it is not patentable. An imperfect and incomplete invention, resting in mere theory or in intellectual notion, or in uncertain experiments, and not actually reduced to practice, is not and cannot be patentable under our patent acts. In a race of diligence between two independent inventors, he who first reduces his invention to a fixed, positive, and practical form, would seem to be entitled to a priority of right to a patent therefor."

And the actual history of discovery and invention is conclusive upon these points. The world, if it has doubted awhile, has always been right in the end. The man who has first generalized the proposition, and first made the world allow that it was thus generalized, has been the inventor.

About 1750 one Sultzer published an account of the peculiar taste arising from the contact of bits of silver and of lead with the tongue. Forty years after, Galvani brought metals in contact with a frog's leg. In each case a hint was received. Sultzer published his, but the world was not impressed with its importance. Galvani followed up his hint with numerous experiments, demonstrated that the phenomena resulted from a new modification of abstract force, compelled the world to recognize it, and was the discoverer.

The young countrywoman at Sodbury said of small-pox, I cannot take that disease, for I have had cow-pox! The Duchess of Cleveland said she had no fear about her beauty, for she had had a disorder which would prevent her from ever catching the small-pox. Were these discoverers? No. They furnished the isolated hint, and made no further experiments. Jenner, with infinite energy and perseverance, through many successive years, in spite of ridicule, at last proved, not that cow-pox might protect the system, but that it always would thus protect it, and that it was safe. He generalized the single fact, and was a discoverer.

Many experimenters raised their voice to say that they too had wiped acids up with a towel which had then burned like powder; but Schönbein was the first to make the world allow that cotton treated by a certain process would always thus burn.

The Abbé Nollet suspected the identity of the electric fluid and of lightning, and experiments were made in France. Franklin, braving the ridicule of failure, flew his kite, and by this and subsequent experiments with a lightning rod proved that the electric fluid was thus identical.

Adams made a calculation with regard to the existence of a new planet, but, although Astronomer Royal, he could not or did not compel the world to listen to him. Leverrier calculated a result, compelled the world to recognize its intrinsic greatness and the magnitude of his own mathematical power, and was the discoverer.

Jonathan Hull, the Abbé Arnal, the Earl of Stanhope, Franklin, and others, proposed to propel boats by steam. They tried it, and failed to persuade the world of the expediency or value of the method. Long afterward, Fulton, impressed with the immense importance of the subject, made a series of experiments and calculations, discerned the cause of previous failures, persevered through inconceivable difficulties, and, in the face of ridicule he felt but did not yield to, demonstrated a proposition; not that steam, a long recognized power, might be made to move a boat, but that it could do so efficiently and profitably. He first compelled the world to recognize this great fact, and was the discoverer of this abstract truth, and the inventor of a profitable steamboat.

A hundred other instances might be cited to show that the man to whom the original hint occurs is not the inventor; nor yet he who forms a theory upon this hint; nor even he who publishes this theory, if he does not convince other people of its truth. This last may readily occur. A man may happen upon a fortunate theory, and yet not appreciate its value; so he gives himself no trouble to proclaim it; or perhaps his proofs are not conclusive, and the world will not believe. Goethe knew this when he said, "Many things may be discovered and made known for a long time without producing any effect on the world, or the effect may be wrought without its being observed, — wrought, and yet not take hold of the multitude. This is the reason why the history of inventions is so surrounded with strange riddles."

He is the inventor who generalizes the single instance, and who makes the world concede that it is thus generalized.

Now if there is any one point which has identified the true inventor's mind, it has been an invincible determination to compel the world to recognize the reality and value of its invention. The inventor saw it himself when other men could not, and he determined that other men should see it, and he accomplished his determination. Sydney Smith says, in the Edinburgh Review, "He is not the inventor who first *says* the thing, but he who says it so long, loud, and clear that he compels mankind to hear him."

Recognize this point, and the question of invention is comparatively simple. Yet it is not recognized. There is no abatement of claims to previous invention. The writer of a Life of Fulton well says, "Those who question Mr. Fulton's claim are precisely those who have been utterly unsuccessful in their own attempts; and it would seem that exactly in proportion as their efforts were abortive, and as they had thrown away money in fruitless experiments, their claims rose in their own estimation and that of their partisans." And the witness, I believe before the House of Commons, probably did not overstate the matter when he gave it as his opinion that, if a man were to show he had found a road to the moon, his neighbors would testify that, if they had not been there themselves, they knew several individuals who were familiar with the road in question.

The above considerations have been presented with the intention and desire of impartially exposing the authority of precedent. I have wished that the reader should not lean to one or the other side of the ether controversy until all these considerations were presented. It remains to show their bearing upon the gist of the evidence contained in the statements which have been made in behalf of Dr. Jackson and of Dr. Morton. The considerations alluded to bear upon four principal points.

The character of the mind and education required for discovery.

The suggestion of the discovery.

The generalization of this suggestion.

Its presentation to the world.

1. This community is familiar with the great scientific talent and attainment of Dr. Jackson. Dr. Morton has acuteness, ingenuity, zeal, and perseverance. The discovery is not of a character to have demanded extensive scientific acquirement, and it is probable that either Dr. Jackson or Dr. Morton might have made it.

2. The suggestion occurred to Davy, Jackson, Wells, Morton, and many others. Horace Wells seems to have conceived this hypothesis more distinctly than any other individual. So persuaded was he of its probability, that he made several experiments; and even made a journey to the medical class at Boston, before whom, however, he entirely failed to verify his theory. He then abandoned it until it was confirmed by Dr. Morton. Dr. Jackson fails to prove that Dr. Morton was ignorant of the hypothesis until he suggested it to him, because Dr. Morton shows by the evidence that he was considering the properties of ether at intervals both of three months and of three days before his interview with Dr. Jackson.

3. I have shown that he who verifies the suggestion is the real discoverer. Dr. Morton, according to the evidence, generalized this discovery. He verified the suggestion, from whatever source it emanated; he made and modified the experiments at his own discretion; he assumed the responsibility of danger; he first conclusively demonstrated of ether, that it would always produce insensibility to pain, — that it was safe. These two points constitute the discovery. Dr. Morton demonstrated these points, and no one else did.

To show that Dr. Morton was only a "nurse," — an instrument of pre-established knowledge, — such knowledge must be proved to be pre-established. It is impossible for human reason to infer, upon the experiments put in evidence by Dr. Jackson, either that ether was universal in its effects, or that it was safe. It must, therefore, be argued that this knowledge was not pre-established; that Dr. Morton was not a mere administrator, but that he was an originator.

4. Lastly, many may have been the real discoverers of ether insensibility to pain, and at a remote period. But if so, they have kept it to themselves; and they will be known as discoverers only to themselves. The world has always honored that individual among such discoverers who presented his discovery to them. Dr. Morton was, according to the evidence in print, both the prime mover and the immediate agent in the introduction of this discovery to the world.

# ANÆSTHETIC AGENTS:

## THEIR MODE OF EXHIBITION AND PHYSIOLOGICAL EFFECTS.[1]

THERE is no difference of importance in the general character of the insensibility or other symptoms resulting from the inhalation of ether and chloroform. The latter, whose discovery in this relation the world owes to Professor Simpson, is much more potent than ether, more palatable, and less irritating to the lungs.

Chloric ether was extensively employed by Mr. Lawrence, and has been since used by other experimenters. Its effects are apparently identical with those of common ether, than which it is if anything less powerful, while its vapor may be a little less irritating. Its odor is certainly more agreeable.

Nitrous oxide was employed by Horace Wells in his experiments. It was then found to produce exhilaration out of proportion to its inebriating properties. In order to place this gas in circumstances favorable for its complete effect, it should be furnished to the lungs as freely and as pure as ether vapor from the evaporating surface of liquid ether. It should be supplied from a large gas-holder, and not from a small gas bag; and that portion of the gas which has been deprived by the lungs of its inebriating principle should be exhaled as waste. Thirty quarts thus inhaled by myself produced complete but brief insensibility; and on April 26 I removed a breast by the aid of about twice that quantity, consumed during six minutes, and producing a most tranquil and complete insensibility. Though bulky,

[1] Transactions of the American Medical Association, vol. i., 1848.

nitrous oxide, administered in the above manner, which I have not seen mentioned, is quite likely to prove a certain, as well as safe and agreeable anæsthetic agent. In the case mentioned, the pulse, which Dr. Townsend was good enough to note for me, rose from 90 to 120, and continued at that point during the operation.

Aldehyde, used by Monsieur Poggiale, although it is said to be stronger than chloroform, is also conceded to be more suffocating than ether, the odor of which it has. It is probable, therefore, that ether is the less objectionable of the two agents. It produces, says Professor Simpson, much bronchial constriction and coughing.

Nitrate of ethyl, upon the same authority, is also rapid and powerful in its effects, and produces excessive noise and fulness in the head, with subsequent headache and dizziness.

The bisulphuret of carbon, a rapid and powerful anæsthetic, has "a peculiarly offensive smell of putrid cabbage."

The vapor of benzoin, which has a rather pleasant aromatic odor, is said to be less powerful than that of chloroform. In the hands of Mr. Snow it produced in the patient certain convulsive tremors. The foregoing agents are "not comparable," says Professor Simpson, "with chloroform or sulphuric ether, either in their manageableness or in their effects."

By a rough estimate of the quantity consumed in operations, chloroform is eight times as strong as ether; and a dram of the one or an ounce of the other is a fair allowance for inhalation at the commencement of the process. As it evaporates, the fluid may be replaced if necessary.

The absolute necessity of interposing something between the lips and the inebriating agent when, like chloroform, it irritates the skin, was quite overestimated in the case of common ether; and the public attached as false a value to the inhaling apparatus as to the stethoscope in a kindred science. In administering ether, an inhaling apparatus is occasionally convenient. The more complicated form, in all its modifications, contains as its chief element the double valve originally suggested by Dr. Gould; and a tube furnished with it may be dilated or constricted so as to represent almost all the principal inhalers in use.

For brief and repeated inhalation, and to avoid the odor of sulphuric ether, as well as to retard its evaporation, an inhaler is convenient; but for common purposes, a bell-shaped sponge is quite efficient, and is to be turned from time to time, during an expiration, to bring the gravitating ether to the top.

With the introduction of chloroform the invention of apparatus received new impetus. Its stimulant and even vesicating properties contraindicate the direct application of this fluid to the skin. The simplest contrivance is the best, and Simpson's folded handkerchief rolled into a cone answers well for a brief inhalation. Channing's pasteboard cone, so cheap that each patient may have a new one, lasts through an average midwifery case. A lamp chimney, stethoscope, or other tube containing a sponge, answers equally the purpose, while for the rapid and complete insensibility required for surgical purposes, and for hospital use, some more durable form of apparatus is requisite. It should comprise a mouthpiece, a receptacle for the sponge, and a diaphragm to prevent the flow of the fluid towards the mouth.

It is optional whether the vapor enter the system simultaneously through the mouth and nasal orifices, or by the mouth alone, the nostrils being closed. It has been said that the effect is more immediate when the nasal cavities are filled with vapor; but the difference in the time of inhalation, if any, is inconsiderable.

It is a striking fact that in many of the first experiments, both in this country and abroad, vapor was inhaled from a shut cavity or sac, in which the contained oxygen must have been rapidly exhausted. If there is one condition vital to the safety of inhalation, it is that an adequate supply of oxygen should be insured to the patient.

Inhalation should be of atmospheric air impregnated with vapor, and not of vapor alone. Air should be conducted through the medium containing the inebriating agent, and not merely to and from a closed cavity.

The production of the brief insensibility which suffices for the extraction of a tooth is rarely accompanied with danger, or with embarrassing circumstances; but the administration of ether for a length of time in a surgical operation demands much attention. Now it is difficult for the surgeon to attend at once to a dissection, perhaps remote from the head, and at the same time to satisfy himself of the adequacy and safety of the anæsthetic state; and it is therefore not improbable that the part of etherizing, especially for a length of time and to a considerable extent, will be soon recognized as involving an entirely distinct responsibility from that of the surgeon who performs the operation.

Let us now suppose a patient subjected to any of the ordinary modes of inhalation, with a view of inducing for examination some of the ordinary phenomena of etherization. It is unnecessary either to extenuate or to dissemble the symptoms which occasionally occur during the approach or continuance of the anæsthetic state. Though alarming in connection with the causes which previous experience had assigned to them, many of them are of comparatively trifling import as a sequence of an anæsthetic agent; while, on the other hand, a few comparatively quiet indications stand at the limit of vital endurance, and give notice of real danger. The order of experience, in a few typical or model cases as they occur, will perhaps afford the readiest method of exposing these phenomena.

A patient courageously inhales the ether, — a term intended to include the chloroform. Soon the respiration becomes more rapid; the chest heaves; the lips are blown out with the expiration, and while the patient is manifesting unequivocal signs of enjoyment, the head suddenly falls to one side, and the individual during the next two or five minutes is insensible to pain in any form. He awakes suddenly, smiles, is surprised to find the operation over, if one has been performed; has had a pleasurable dream, and experiences no ill effects. This is etherization in its most favorable form, less frequent than the next.

A second patient averts his head to cough, inhales again, and again coughs; declares his inability to take the ether, yet perseveres. The trachea now becomes less irritable; respiration is tranquil, and insensibility rapid in access. Such cases are quite common in the practice of the dentist.

A third subject makes grimaces, and, getting exhilarated, rejects the apparatus; but, still amenable to peremptory discipline, being directed to keep quiet and to close his eyes, is soon narcotized.

Yet not always at once. A large and muscular man, perhaps habituated to stimulus, sometimes modifies grimace into a demonstration of resistance; closes his lips and jaw firmly, and refuses to inhale; objects to verbal and other interference; at last becomes violent, and, if athletic, requires the united force of several assistants to confine him.

Here is a sufficient reason for not attempting the etherization of athletic subjects when aid is not at hand. I believe that the best practice in such a case is to confine the patient, and to apply the ether steadily to the mouth and nose. For some seconds, perhaps many, the patient may refuse to breathe, and bystanders unaccustomed to the phenomena exchange significant glances. But if the pulse is good there is no real danger, and at last exhausted nature takes a deep and full inspiration, which, while it aerates the blood, is laden with the intoxicating vapor; color returns, and the patient falls back narcotized. Violent resistance is not common.

It is, however, less unfrequent for the patient to vomit soon after the appearance of the signs of etherization; and partly from the exertion, and partly from the inspiration of fresh air, he may then recover sensibility.

Lastly, the signs of insensibility having been manifested, the operation is begun. In a few moments the patient partially regains his consciousness, and exhibits the unequivocal appearance of suffering, which may or may not be subsequently remembered; or, without being violent, is wild and uncontrollable.

It will be observed that in all these cases ether was administered for a comparatively short time. The result of such brief inhalation is brief narcotism, either complete or incomplete. If inhalation be arrested at this time, the period of subsequent insensibility to pain varies from one to three minutes. This short or partial insensibility is adapted to the operation of the dentist, which is usually rapid. The instrument is applied, and whatever be the demonstrations of the patient, it accomplishes its purpose. Here are no important nerves to be severed, nor vessels to be wounded. But in a dissection such as occurs in many surgical operations, especially in one of a formidable character, it is important that the subject of the operation should not hazard his safety by being liable to sudden and convulsive movements while the knife is dealing with the tissues. If the patient thus partially revives, assistance is not unfrequently required to confine him, and it is necessary to readminister the ether, the whole interfering materially with the tranquillity of the operation and the comfort of those concerned, perhaps endangering the welfare of the patient.

Although many operations were performed abroad, both in England and upon the Continent, and at no remote date, upon patients yet capable of movement and resistance, there is an obvious want of safety in operating under these circumstances. Decided preference should be bestowed upon a condition of complete and passive narcotism, provided it can be produced with equal certainty, and is equally free from serious results.

Such a condition is quite possible, and a short time suffices to induce a train of symptoms indicative of it. Let the inhalation be continued beyond the period during which the patient exhibits the earlier signs of narcotism. The muscles will be found gradually and completely to relax under its influence, and at a later period the inspiration becomes a snore. The patient exhibits no sign of consciousness, and is, in short, profoundly narcotized.

In the symptoms hitherto detailed, two stages of the anæsthetic state will readily be recognized, the first embracing the phenomena of partial consciousness, while the second presents the indication of total insensibility. These two stages of anæsthesia demand separate consideration.

The first stage is characterized either by the incomplete or partial character of the narcotism, or by its brief duration. These phenomena suggest the notion that the blood is insufficiently impregnated with ether, or that the vapor has affected a portion only of the circulating fluid, the influence of which upon the brain is soon counteracted by the arrival in the cerebral vessels of fresh and unadulterated blood. Such a theory illustrates the degree and the duration of the phenomena attending inebriation.

The first stage requires for its induction a comparatively small proportion of the ether vapor. Insensibility, if complete, is brief, and the patient revives in a period varying from one to three minutes, commonly without nausea, headache, vertigo, or other sensations of discomfort. But in certain cases, and especially when, either from pulmonary irritability or want of determination on the part of the patient, the dose has been insufficient and its inhalation by consequence protracted through a period of six or eight minutes, a different range of symptoms is presented. The patient may be bewildered, like a man waking from a deep sleep, or uncontrollable except by moderate coercion. At this time the pulse is natural, or yet more frequently accelerated, either from exertion, or because it has not regained its normal standard after the unavoidable excitement of anticipation. Though in the first stage of anæsthesia we might expect the pulse to be accelerated, yet it often deviates but little from its natural standard. Nor is the pupil especially affected in this stage. The muscular fibre is yet animated by the nervous influence, and is generally somewhat rigid, the arm resisting flexion or extension. Occasionally it exhibits the phenomena of catalepsy, retaining any position given to the limb. In rare cases I have noticed the access of clonic spasm, local or general in its invasion. When the spasm affects the glottis, it gives rise to a peculiar symptom, to be further noticed hereafter.

To the first stage of anæsthesia belong those remarkable and unanticipated physiological phenomena which seem to unlink the intimate connection between sensation and an intellectual recognition of it, between cognizance and memory, between will and action. A patient thus partially etherized quietly criticises the amputation of his own leg, or resists the dentist's instruments, or to appearance suffers, and yet remembers nothing of it; or he remembers, but has not felt; or, which is unpleasant and fortunately rare, has felt, but could not move. Such occurrences, familiar in the early history of etherization, have been somewhat less frequent since the subject has been better comprehended. Yet at a comparatively recent date partial consciousness of the patient, during an amputation for example, has been regarded as a circumstance of unlooked for occurrence, and not always amenable to ready influences.

The inconveniences of partial consciousness have been alluded to; and I am now especially desirous of exposing the advantages of a state of inebriation, during which the patient lies passive and motionless, exhibiting only the phenomena of deep sleep.

Such is the second stage of anæsthesia, essentially characterized and identified by muscular relaxation. Let the subjects of the last mentioned experiments continue inhalation. The arm from time to time, when raised from the side, resists. Soon, however, it becomes flexible, and at last falls passive and motionless. The voluntary muscles are now relaxed, and it is impossible at this moment to rouse the patient. This stage requires for its induction a considerable quantity of ether vapor, which may either be presented to the pulmonary surfaces rapidly in the course of two or four minutes, or by a more diluted vapor administered during a protracted inhalation of many minutes. In the former case, anæsthesia ensues quickly, and in its most favorable form. But in the latter, the dilute and protracted inhalation is often accompanied with the annoyances of partial anæsthesia, and, as will be stated in another part of this paper, other symptoms, especially that of vomiting, are quite apt to interfere with inhalation before the inebriation has reached its second stage. The commencement of this state of narcotism, characterized by passive flexibility of the arm, suffices for any brief surgical operation which is not likely to be impeded by the movements of returning sensibility. Yet this insensibility, though complete, is brief, and the revival of the patient often sudden.

A few additional inhalations so impregnate the system with the vapor that revival is deferred for some minutes after the inhalation of pure air. Ether in this way is cumulative in its effects. Besides this, recovery is then generally not instantaneous, but gradual, and preceded by the signs of returning consciousness, which indicate a readministration of the anæsthetic agent, and thus enable the surgeon to anticipate interruption. Protract the inhalation yet a little longer, and the inspiration becomes a snore; the pulse, which may or may not have been previously accelerated, beats slowly, while the pupil is frequently, though not invariably, dilated.

Some little familiarity with these phenomena is required to qualify the surgeon so to graduate inhalation as to continue the patient in this state of tranquil and deep sleep with safety.

There is no doubt that it can be done if necessary. I have frequently myself maintained insensibility nearly or quite complete for thirty minutes, and even for a longer period. While the snore is heard, the patient does not revive; yet the snore is an unnecessary symptom, and is an indication for the temporary suspension of inhalation, when a few inspirations of unadulterated air soon re-establish quiet respiration, and the patient is liable at any moment to swallow, or give other indication of approaching consciousness. The cumulative effect of ether, as already described, is at this time to be borne in mind. Young subjects, too, require less than adults; so that after eight or ten minutes of insensibility in the adult, or a considerably shorter period in the young subject, the system will have become impregnated with ether, and inhalation may be discontinued, even before the snore is heard, without apprehension that the subject will rapidly recover. The evidences of returning consciousness are the limit, on one side, of that degree of anæsthesia which it is important to maintain during most surgical operations, and are indications for the reapplication of the inebriating agent, when it is desired to protract insensibility.

At the other limit of the second stage of anæsthesia is a far more important indication of over narcotized vitality; and therein is the protection against danger. Without some safeguard, I conceive that it might well be hazardous to overshadow animal existence by this mysterious and powerful agency. The indication is a diminution of the force and frequency of the pulse.

In a case of the early administration of ether at which I was present, and which has been reported, the danger from over narcotism was quite as imminent as in any case not fatal I have since seen mentioned. As a bystander on that occasion I casually felt the pulse, and found it barely distinguishable; and though it subsequently still decreased, the means at once adopted for the restoration of the patient proved ultimately successful. This occurrence pointed to the pulse as an indication of the stage of narcotism; a few subsequent experiments confirmed my opinion; and I have not since hesitated to push etherization to complete insensibility, and to continue it, if necessary, during a length of time, provided the pulse remained full and strong. If it be retarded, it is curious to observe with what certainty it recovers force and frequency after a few inspirations of pure air. It will be inferred from these remarks that the pulse is to be carefully examined during the whole anæsthetic process, and that inhalation is to be temporarily discontinued or not according to its indication.

Briefly to recapitulate, the first insensibility, partial though it be, suffices for the dentist. It exhibits the intellect and sensibility in novel and singular relations, while muscular force may or may not be impaired. Nothing is here infallible in pulse or pupil.

The second stage is of great value, and often essential to the surgeon. It lies between the signs of returning consciousness on the one hand, and the decreasing pulse on the other. It is ultimately accompanied by snoring inspiration and the partially dilated pupil, which, together with the period of time necessary for the cumulative effect of ether, may be considered each as an additional indication for the temporary suspension of inhalation.

The eyes are usually closed during inhalation. Let the patient be directed to open them. If etherized, he takes no notice of the voice. Perhaps the head droops, or the hand supporting the inhaling apparatus falls. These alone are signs of narcotism, which may be incomplete, or, if complete, temporary in its duration. If in such a case the arm of the patient be raised from his side, it is quite likely to resist the effort, or, when raised, to remain extended; phenomena indicative of partial narcotism. If inhalation be now suspended, the patient soon regains his consciousness, either manifesting unequivocal signs of pain, or resisting interference during the half conscious state which often precedes recovery.

It should be added, that if the patient has inspired a good dose, and for a length of time, the dentist may consider any unusual manifestation as an indication of but partial sensibility to sudden pain. Protracted inhalation may be even taken as *a priori* evidence.

One of the early and occasional consequences of inhalation is a passive cessation of the respiration, while the pulse continues good. At this moment a tooth may be painlessly extracted; but as the vapor has now temporarily ceased to gain access to the lungs, the patient may revive before the next inspiration.

Muscular relaxation, the temporary loss of muscular contractility, the passive flexibility of the arm, is the most certain sign of complete narcotism. It is succeeded by snoring inspiration and slow pulse.

Signs of returning consciousness are swallowing, coughing, moaning, an effort to articulate, and muscular movement.

Somewhat modified by the strength and temperament of the individual, the rapidity with which the system yields is generally in direct relation with the dose administered. The maximum dose will be again discussed under the head of dangers; but it may be here stated that many of the unfavorable symptoms owe their existence to the protracted inhalation of an inadequate dose; whereas, after the first irritation of a large volume of vapor introduced rapidly into the air tubes has subsided, the patient yields tranquilly and is much less liable to disagreeable and annoying symptoms.

Vomiting is especially connected with the long duration of the inhalation, and also with its inadequacy. So also is general excitement and resistance, and probably spasm, whether of the vocal chords or of the muscular system generally.

The common imperfections of the inhaling process are the use of too large a sponge for ether, and of too small a sponge for chloroform. The former distributes and evaporates the ether rapidly, while its interstices admit a good deal of air. The latter will not detain an adequate amount of chloroform without endangering the patient's skin. If the sponge be previously wrung out in water, its capillary attraction is increased.

## ANÆSTHETIC SYMPTOMS CONSIDERED SEPARATELY.

It is said that a patient may take cognizance of the amputation of his own leg. This occurrence I have never seen, though it is far from improbable. It implies a distinct recognition of surrounding objects through special sense at a moment of complete insensibility to pain in its severer forms. Such complete insensibility is more frequently attended with entire disability of special sense; yet sensation may be partially annulled, and the patient continue quite cognizant of the external world.

The manifestation of acute suffering, and even of well directed resistance, may occur without the patient's subsequent remembrance of it. Here the faculty of memory is extinct.

Or memory may recall the manifestations of an operation of which it has forgotten the sensations. And it is said that cognizance and memory may be distinct, while the machinery of muscular action is deranged.

Mental excitement, hilarious or hostile, is not uncommon in an early stage of narcotism, and is materially influenced by its rapidity.

Pulmonary irritability varies with the individual.

Chloroform is less irritating to the lungs than ether, and so, perhaps, is chloric ether.

Violent cough is occasionally excited by a small quantity of vapor, while a much larger quantity may occasion none; but by a little careful graduation of the first few inspirations the patient may be saved much unnecessary irritation. Soon pulmonary sensibility is narcotized, and the patient breathes quietly. Even habitual dyspnœa, or the paroxysm of asthma, is temporarily solaced by this agent. As the process is continued, the trachea becomes insensible to the presence of fluid, whether blood from operations near the mouth, or the increased natural secretions of the pulmonary surface.

Nausea and vomiting are not uncommon sequences or concomitants either of partial or complete anæsthesia; nor, beyond their interference with the progress of the inhalation, and with the mere comfort of the patient and of the operator, are they objectionable. They are allied to the nausea induced by other narcotic and inebriating agents, and have especial relation with the duration of the anæsthetic process.

The snoring inspiration indicates profound sleep. Varying a little in the facility of its production in different individuals, it is a constant phenomenon of a certain stage of narcotism. While it is often desirable to induce this symptom, its exhibition renders further inebriation unnecessary for the moment. It is always accompanied with muscular relaxation, and soon succeeds it. It results from the relaxation of the muscles of the palate; and in this connection it is desirable to distinguish it from another symptom of somewhat different signification, viz.: —

Stertorous respiration, due to spasmodic action of the vocal chords, and allied to the spasmodic action of other muscles. It is somewhat rare in its occurrence, but, once heard, it will be readily recognized, and it indicates a brief suspension of the inebriating process. Though of itself quite unimportant, yet, as the immediate cause of another symptom, it deserves further consideration. The closure of the laryngeal aperture shuts off the supply of atmospheric air from the pulmonary tubes. The same condition results from the voluntary closure of the mouth and lips; but the last soon yields, while the spasm of the glottis gives rise, in rare cases, to a partial asphyxia, indicated by the then livid color of the cutaneous surface. Similar lividity is often exhibited during a spasm of whooping-cough, or in a hysteric fit, and is of comparatively slight importance, from the fact that when the system feels peremptorily the necessity for air, the spasm resulting from the anæsthesia relaxes, the patient breathes freely, and the blood is aerated. Two or three inspirations suffice to restore to the cheek its natural color.

The ordinary affections of the voluntary muscles have been already mentioned, viz. organized resistance resulting from nervous excitement and tonic or clonic spasm. A cataleptic state is not unfrequent; while in one case I have observed a convulsive effort of the whole system of voluntary muscles. The sphincters very rarely lose their contractility. It is well known that the uterus contracts during partial and even complete unconsciousness, a diminution or cessation of its contractile action being the rare exception, and not the rule. The respiratory muscles play tranquilly during narcotism, while the heart, losing the force and frequency of its pulsations, slowly ceases to beat in its latest and profoundest stage.

Incidental excitement usually accelerates the pulse, the relative frequency of which, during the earlier stage, it is difficult from this circumstance to estimate. It does not lose either in force or frequency until the whole system is profoundly narcotized. It is then, as at other stages of the process, a most reliable indication of the condition of the nervous system, and ultimately of the limits of vital endurance.

The pupil, though commonly at first contracted, and subsequently dilated, is less to be relied on as an indication.

Prolonged insensibility is quite exceptional and rare. In the case of a young woman, of the details of which I am cognizant, such insensibility ensued after a brief recovery of the ordinary character and interval. The patient then again became insensible, apparently without cause, and slept heavily during an hour, in spite of efforts to arouse her. The symptom which excited apprehension was the weakness of the pulse, which at times was barely perceptible at the wrist. This patient ultimately recovered, as I believe all others similarly affected have. The phenomena suggested those occasionally presented after an amputation, when the patient awakes in acute suffering, and again spontaneously sleeps while stitches are inserted.

A few phenomena only remain to be noticed.

Convulsions have been reported, occurring at an interval of many hours after inebriation.

A gentleman of Providence informs me that he has suffered for many months from vertigo, headache, and disability for labor, following upon a dose of ether vapor.

Such cases, with others which have been detailed, must be considered as exceptional, due to peculiar and individual susceptibility, and of exceedingly rare occurrence.

It may be convenient to arrange etherization under several distinct heads, adapting its degree to the character of the surgical operation for which ether is to be administered.

*In Amputations and other brief Surgical Operations, and in the Extraction of Teeth.* — In this latter case inhalation may be discontinued a few moments after insensibility. In the former, it is better to continue it two or three minutes longer, and till muscular relaxation. For the extraction of teeth, the patient may himself hold the sponge. When the hand wavers or falls the mouth is carefully, or, if need be, forcibly opened, without loss of time, and the forceps at once applied. In this way one or more teeth may be removed while the patient is in an unconscious or half conscious state, but free from pain.

*Protracted Dissections* may be commenced a short time after insensibility, the sponge being continued to the mouth, with an occasional interval to insure the patient ample supply of oxygen. When there is snoring respiration the sponge should be removed during the interval required to re-establish quiet inhalation. The pulse is kept in hand, and any diminution of its frequency or force, especially the former, is an indication for the admission of unadulterated atmospheric air. Forty-five minutes is a somewhat unusual duration of insensibility, and is not to be attempted by those not conversant with the process. It is important to the operator, in these cases, that the patient should be fairly narcotized. With a little experience, and with a rigid attention to the above precautions, accident need not be apprehended.

It may be added, that much of the pain of a dissection is not of an acute character likely to arouse the patient, so that after some time has elapsed a state of semi-consciousness often suffices; the vapor being then applied, either during the intervals of the operation, or as manifestations of pain or resistance may present themselves.

*Hare Lip.* — With this operation may be included others upon the nose, mouth, fauces, and trachea. It has been presented as the type of these operations, because it embraces several particulars of interest. An operation in this region is often a dissection, and of the parts concerned in inhalation. It is, therefore, impossible to continue etherization during manipulation. If, then, in such a case, the patient is to remain insensible, the surgeon has only the alternative either of profoundly narcotizing the patient in the first instance, or of readministering the ether, often at an inconvenient moment, and when the operation is materially interfered with. Of these courses, the former seems to me the least objectionable. Another important feature in these operations is the liability of the blood to accumulate in the trachea when it is no longer irritable or conscious of its presence. If a tracheal râle gives indication of the collection of a considerable quantity of blood or other fluid in this region, the patient should be made to lean forward, in order to facilitate the natural expulsive efforts of the expiration or of the cough, as consciousness returns. In general, during operations upon the face and jaw under the influence of ether, the patient should be sustained in a position inclining somewhat forwards, and care should be taken to prevent, as far as possible, by sponges or otherwise, the recession of blood into the buccal cavity. Protracted operations upon the fauces are difficult, if not impracticable, with the use of ether. On the other hand, the admission of instruments to the trachea, especially from the outside, is, without doubt, thus facilitated.

In *Dislocation*, it is obvious that ether inhaled can be of no avail unless continued to the relaxation of the muscles.

It is well known with what facility dislocation is reduced upon the dead subject; and it is quite probable that all recent and favorable cases in the living subject may be reduced with almost equal facility, when muscular relaxation is completely effected. This is confirmed by one or two cases of dislocated shoulder, which have fallen under my notice. I have met with no case of recent dislocated hip since the introduction of anæsthetic agents. It would be desirable, in such a case, that an attempt should be made completely to annul muscular resistance before efforts are directed to the replacement of the bone.

It is equally evident that the reduction of hernia can be facilitated only by muscular relaxation, and that anything approaching to spasm would aggravate the difficulty of reduction during its access.

Lastly, ether has proved of service in abating the spasm of stricture, in facilitating the operation of lithotrity, and in breaking up adhesions resulting from fracture near the joints. In the last case pain has always offered a sure indication of the advisable extent of operation, and in its absence considerable discrimination is to be exercised. I have myself seen an arm refractured by an attempt to overcome the resistance of a mass of callus after the adhesion of the articulating surfaces had yielded.

Experience shows that no especial ill effects result from the administration of ether to patients of average physical force at almost any age. Though I have operated on a child of three months, who was so far inebriated that its cries were modified into a sort of moan, yet I know of no case in which a young infant has been completely narcotized after its birth. Indeed, the facility of controlling a child of this age, together with the fact that it has neither the anticipation nor remembrance of suffering, however severe, seems to render this stage of narcotism unnecesary.

*Antidotes.* — It has been well said that fresh air, and in an extreme case artificial respiration, is the best antidote to ether inebriation.

The symptoms of spasm, vomiting, etc. generally subside when the patient is left to himself. When the pulse is weak and slow this state of *narcotism* must not be identified with that of *syncope.* Brandy and other diffusible stimulants, appropriate remedies for syncope, belong to the class of agents which induce the anæsthetic symptoms; and it is quite probable, though evidence is yet incomplete upon this point, that the difficulty would only be aggravated by their use. Besides, the patient cannot always swallow. Cold water dashed upon the face, or injected into the ears, undoubtedly aids in arousing the patient from the common ether narcotism. Galvanism to the precordial region has been suggested as a remedy in an extreme case; and it may be a question whether rest in the recumbent posture, or active exercise, as adopted for the restoration of subjects affected with narcotism from opium, is not best adapted for these cases. If any fluid is to be administered internally, analogy would suggest strong tea or coffee.

The nature of the anæsthetic state is a question of considerable interest. Perhaps the most satisfactory evidence upon this point is that afforded by the analogy between the symptoms resulting from ether vapor in the lungs, and those of alcohol in the stomach. Both, in small quantities, produce exhilaration. Both, in a large dose, produce the phenomena of dead drunkenness, and also of insensibility to pain. With alcohol, the state persists while the fluid remains in the stomach; and patients have been at once aroused by the use of the stomach pump. In like manner, anæsthesia continues while ether vapor fills the lungs. Respiration pumps the ether vapor from that receptacle, and, gradually aerating the blood, terminates the anæsthetic state. Alcohol is found in the blood by chemical analysis; ether is equally detected in it by its peculiar odor.

Convulsions have been noticed in rare connection both with ether and with alcohol. Finally, there is in ordinary cases no great solicitude for the safety of a patient who is dead drunk, and experience has shown that ether narcotism is very rarely accompanied with danger.

Time does not serve for an analysis of the evidence relating to the effect of ether upon the different portions of the nervous system, nor is this evidence of a conclusive character. There may be some connection between the spasm occasionally produced by alcohol and ether and that induced by opium, alluded to by Todd and Bowman, resulting from polarity of the spinal cord in cold-blooded, and even in warm-blooded animals.

Upon the same authority, spasm of the glottis is among the results of irritation of the medulla oblongata. On the other hand, the medulla oblongata has been considered by Flourens, who claims this point as his discovery, to be the last stronghold from which life is driven by the anæsthetic agent. The animal then dies. Yet spasm of the glottis is not a formidable symptom.

The details of experiments in this obscure branch of physiology may be found in the papers of Flourens and of Longet, and may be compared with the intellectual phenomena elsewhere alluded to in this paper.

*Dangers.* — It remains only to speak of the dangers of the anæsthetic state. From this category the symptom of asphyxia may be rejected, this being an evil easily anticipated when due to an imperfection in the process, — to the non-admission of oxygen to the lungs. Gradual and overwhelming narcotism may also be anticipated and arrested. The danger arising from the specific effects of an inebriating vapor in the pulmonary tubes may be considered, (1) as a question of experience and fact, and (2) of analogy and probability. As to the fact, I have been unable to find any fatal case clearly resulting from the inhalation of ether, until the very recent one at Auxerre, apparently resulting in part from convulsions improperly treated, and in part from a neglect of the indications which the pulse affords. Of this case the details are imperfect. Deaths, like those reported by Nunn and Robb, occurring at an interval of twenty-four hours or more after the operation, may or may not have been accelerated by ether. Ether does not prevent, and is not to be considered responsible for, the ordinary collapse resulting in certain states of the system after certain injuries and certain operations. The strong argument in behalf of ether is, that so few opportunities have occurred in which it can even be suspected of agency in fatal results.

With chloroform the evidence is a little different. Two somewhat remarkable cases of death, occurring during the brief administration of this agent for surgical purposes at once present themselves, — the Cincinnati case and that of Mr. Meggison at Winlaton. In these cases death occurred in about five minutes from the beginning of the inhalation. In the Cincinnati case the quantity inhaled from a saturated sponge in a four-inch glass globe must have been considerable. Yet in Meggison's case a dram only was applied upon a handkerchief. It is quite possible that death resulted in the latter case, as Mr. Simpson avers, from asphyxia produced by the administration of brandy and other liquids before the patient was able to swallow. Such error may be easily avoided. Yet these instances suggest a specific cause of danger. This is the sudden impression upon the system of a powerful inebriating agent. Abundant alcoholic stimulus has often produced immediate death; and analogy would suggest that inebriating vapor in the lungs may be the equivalent of similar fluid in the stomach, and that in one or both of these cases chloroform may have produced a sudden and overwhelming shock upon the system.

Apart from the somewhat obscure case before alluded to, there is no authentic evidence that sulphuric ether has been a cause of sudden death; and there is little doubt that this immunity from danger in its use is due in part to the comparatively moderate degree of its inebriating property, and in part to its volatility. Chloroform is much stronger than ether, while it is less volatile; so that although the vapor of a few drops may only give rise to moderate symptoms, and then escape by exhalation, that of a large quantity, whose volume the lungs might easily contain, would powerfully impress the system, and the delay of its evaporation materially enhance its cumulative effects. Such theory suggests a consideration of practical importance, — that in the use of chloroform a moderate dose should be inhaled gradually, and not at once.

It is obvious, too, that the agency of heat to promote its evaporation must increase the chance of danger. I think it may be laid down as a rule that a dram of chloroform, at ordinary temperatures, suffices for a gradual inhalation of three minutes in the average adult. In recognizing a possible danger from an instantaneous and powerful dose, on the other hand, it must not be forgotten that many of the unpleasant symptoms of the anæsthetic state are undoubtedly induced and aggravated by protracted and futile attempts to produce insensibility with an insufficient dose. Experience shows that after the first few minutes, and with due regard to the condition of the pulse, it is safe to increase the quantity of ether or of chloroform until the inspired air is fully saturated and the patient fairly narcotized.

If there is any one consideration calculated to arrest attention in the history of etherization, it is that, although the anæsthetic agents have been open to liberal use in every part of the civilized world, whether experimentally, ignorantly, or carelessly,— although thousands have experienced their good effects,— and although the physiologist, the ether opponent, and the coroner have been equally ready to seize upon and to exaggerate any case of accident that might seem to fall within their range, — yet it is probable that the number of cases thus publicly suspected to have been fatal is less than ten, while the only conclusive instances of direct relation between an anæsthetic agent and death are two in number. Can antimony or opium show as clean a bill of health for the same period ?

# THE DISCOVERY OF MODERN ETHER ANÆSTHESIA.[1]

THE date of the announcement of modern ether anæsthesia is October 1, 1846. The medical profession, whether here or elsewhere, were then believing as little in the possibility of escaping the pain of amputation as they do at this moment in the existence of a cure for cancer. Up to that time mankind in general was in fact as profoundly asleep in regard to this subject as if it were itself under the influence of ether vapor. Suddenly the light of the American discovery was blazing all over the civilized world. The new method was everywhere received and practised as the greatest gift that medicine had ever conferred upon mankind. There can be no doubt that the discovery of modern anæsthesia would have been so received at any previous time.

There can be but one inference as to whether the discovery of 1846 was already in their possession. In order to settle this question understandingly, however, we should be fully agreed as to what constitutes a discovery, and also as to what this particular discovery was. To discover is to uncover, to bring to light, to show, to make known, as well as to find out something hidden or not known before.

The world pays handsomely, but not for what is doubtful or uncertain. It exacts clear evidence of the value of what it pays for. If Dr. X. last year thought that he had discovered a cure for cancer, but for some reason was unable to persuade the world of its value because it did not always

[1] Now first published.

succeed, or because there was some other doubt about it, or, in short, if he did not "compel the world to hear him," and if next year Dr. Y., working in parallel lines, makes a similar discovery, so clearly and undisputably that the civilized world recognizes it, Dr. Y. will receive the honor and gratitude of the world, and Dr. X. will have to be content with his own approbation and that of the friends who were benefited at his hands. Such is the theory, and such the practice, of discovery.

Thousands of people had been made insensible, many by inhalation, some by ether. But until 1846 neither ether nor gas was known to produce at will an anæsthesia that was complete, sure to occur in every individual, and safe. On the contrary, all previous insensibility was either uncertain to occur when wanted; or it was incomplete, as against the severer forms of pain; or it was considered to be of doubtful safety.

Morton's discovery consisted in his proof that ether insensibility was possible to everybody, that it could always be made complete when the operator desired it, and that it was safe. It detracts nothing from his discovery, that, like every discoverer that ever lived, he availed himself of all previously existing knowledge, written or oral. In September, 1846, nobody knew that ether inhalation was sure, complete, and safe. Indeed, without Morton there is no reason to believe that this property of ether would have been known for years after. It was still generally believed by the scientific world that great danger attended the experiments. In the view of the best contemporaneous science, Morton was recklessly, culpably, and indiscriminately subjecting every patient he could procure to this danger. But he proved that the scientifically ignorant Morton was right, and the scientifically learned world was wrong.

A man may discover or make known new things to himself, or to a few friends, or to the world. The last is what we are now talking about. There never was a discovery of importance made which was not claimed by others who had come near to it. In fact, there never was a discovery of a principle, or an invention of a method of much pecuniary value, which was not contested in the courts. It should be fully conceded that many an *ex post facto* claimant is honest, and believes himself in the right. It may be also conceded that he made ingenious experiments in the right direction, producing results that were not wholly conclusive to the world, but fell short of persuading it.

# THE DISCOVERER OF SURGICAL ANÆSTHESIA.

## A LETTER.[1]

MY DEAR SIR, — In reply to your note requesting "an opinion of the relative merits of two rival claimants" in the ether discovery, I must say that it is so many years since I have indulged in that controversy that I approach it with reluctance, not to say awe, in respect of its duration and magnitude.

I have advocated the claim of Morton on two grounds, that his alone was the first perfect knowledge as to the three points of certainty, safety, and completeness. These three points constituted the discovery.

Experiments previous to his (no matter by whom, and they had been instituted by several persons) were inconclusive, because desultory and of varying and uncertain import, one resulting in one way and the next in another. They brought about no conviction, and were virtually abandoned, while the great question of danger from this extraordinary trance was wholly unsettled. Morton, by close and consecutive experiments, which he had firmly determined to make with something or other to produce insensibility, proved the infallibility and the safety of ether on his own responsibility, and made the world concede the demonstrated fact. Inasmuch as, if he had killed his subjects, he, and he alone, would have been indicted for manslaughter, without benefit of clergy or a particle of sympathy from any doctor whatever,

[1] Now first published.

I hold that his perseverance and discernment, or rashness and luck, should now entitle him to the emoluments of a discoverer.

Would surgeons have given a surgical dose of ether vapor, on all the then existing evidence, five minutes before Morton's first successful experiment? (it was assuredly difficult enough to persuade them to do so afterwards;) and these experiments he made at his own discretion or indiscretion, and at his own risk, and after they were made the discovery had been made.

I am, very truly, yours,

HENRY J. BIGELOW.

## A NEW ANÆSTHETIC.—KEROSOLENE.[1]

Messrs. Editors, — In reply to your request for information concerning the "kerosolene," and although the evidence is incomplete, I see no impropriety in my furnishing you with such observations as I have been able to make since its introduction to the Medical Society last evening, by Mr. Merrill, Dr. Dickinson, and Dr. Bowditch, as an untried agent of suspected anæsthetic properties, which had accidentally affected a man sent in to clean a cistern at the kerosene works, and which had been afterwards tried on flies and mice.

This fluid presents remarkable properties. It is tasteless as water, volatile and inflammable as ether, though burning with a dense white light. It has a faint chloroform odor, which as it evaporates changes to that of coal tar, and then disappears absolutely and altogether; so that a handkerchief saturated with the fluid when dry at the end of a few minutes has no odor at all, and the room or atmosphere where it has been used shows no trace of its presence. Both ether and chloroform leave, in different degrees, a persistent, *fade*, and stale aroma after evaporation, as is well known. They are also far less agreeable to inhale than this new agent, which has thus an obvious advantage over either of them.

A few whiffs were sufficient assurance of its efficacy as an anæsthetic, which, with its other qualities, as I ventured to remark, would place the kerosolene beyond any known anæsthetic, provided its use was not followed by headache,

[1] Boston Medical and Surgical Journal, July 11, 1861.

vertigo, or other unpleasant symptoms, and it should prove as free from danger as ether.

Subsequently I inhaled the new vapor, which Dr. Hodges administered at my request. Complete insensibility supervened, lasting several minutes, with some diminution of the volume of the pulse. Its effect was wholly agreeable, leaving neither headache, nausea, nor bad taste.

I have this morning administered it to three surgical patients. The first, a girl of nineteen, presenting some hysteric tendencies, had thrust some twenty needles into her leg, and was wholly insensible during the extraction of four of those which remained. Yet there was more cough than I had expected from the wholly unirritating odor of the vapor, more muscular rigor than usual in favorable anæsthesia, and more intermittence of the pulse.

In a second patient, to whom it was given preparatory to an operation upon the face, insensibility was equally complete. But this woman did not take it kindly, and its complete effect was attended by so feeble and intermittent a pulse as to lead me to desist until she had recovered. A second attempt reproduced, with the anæsthesia, a feeble and intermittent pulse, and I again desisted. Upon her recovery, I gave her common ether vapor, which she afterwards said was less agreeable, but which was followed by complete insensibility, the pulse beating steadily and full at seventy-six. Though this patient perhaps succumbed more readily to the third anæsthesia, there seemed to be in the first two trials a certain degree of purple color and asphyxia, with its attendant spasm, which I have elsewhere described as an occasional and disagreeable symptom of attempted anæsthesia. To guard against this asphyxia, which might possibly have resulted from the folded towel with which I habitually administer ether, I tried in the next case an open sponge. The subject required a considerable incision for a mammary abscess, and was a patient of Dr. H. G. Clark, with whose assent I tried the kerosolene. In spite of the open sponge, the symptoms of asphyxia again appeared, suggesting to Dr. Clark a resemblance to those resulting from charcoal gas. The color was livid, and the rigidity marked. In each of these cases the quantity used was from one to two ounces.

In conclusion, it may be remarked of these three cases, that they are insufficient for satisfactory demonstration, and that their common and unfavorable symptoms may have been but a coincidence; yet they suggest some caution in the use of the kerosolene vapor. It is probably more potent than that of ether, requires a freer admixture of air, and may produce upon the system some impression or influence other than that of the mere intoxication attendant upon the use of ether. In awaiting further evidence, it can be considered established that kerosolene is an anæsthetic of undoubted efficiency, and that it possesses certain remarkable and attractive properties peculiar to itself.

Henry J. Bigelow.

Boston, July 9, 1861.

# RHIGOLENE,[1]

## A PETROLEUM NAPHTHA FOR PRODUCING ANÆSTHESIA BY FREEZING.[2]

THE above name is proposed as convenient to designate a petroleum naphtha boiling at 70° F., one of the most volatile liquids obtained by the distillation of petroleum, and which has been applied to the production of cold by evaporation. It is a hydrocarbon, wholly destitute of oxygen, and is the lightest of all known liquids, having a specific gravity of 0.625. It has been shown that petroleum, vaporized and carefully condensed at different temperatures, offers a regular series of products which present more material differences than that of mere degree of volatility.[3] The present product is probably a combination of some of the known derivatives of petroleum with those volatile and gaseous ones not yet fully examined, and to which this fluid owes its great volatility. A few of these combinations are already known in trade as benzolene, kerosene, kerosolene, gasolene, etc., all of them naphthas, but varying with different manufacturers.

1 Boston Medical and Surgical Journal, April 19, 1866.

2 Rhigolene, from ῥῖγος, *extreme cold*, to which is added the euphonious termination of most of the other petroleum naphthas. About three weeks after my first experiments with rhigolene, I first learned that Professor Simpson, of Edinburgh, had lately employed "kerosolene" for this purpose.

3 See "Researches on the Volatile Hydrocarbons, with References to Authorities," by C. M. Warren. American Journal of Science and Arts, July, September, and November, 1865.

I procured, in 1861, a quantity of kerosolene[1] of four different densities, and found the lightest of them, the boiling point of which was about 90°, to be an efficient anæsthetic by inhalation.[2] When it was learned here that Mr. Richardson, of London, had produced a useful anæsthesia by freezing, through the agency of ether vapor, and had reduced the temperature to 6° F. below zero, it occurred to me that a very volatile product of petroleum might be more sure to congeal the tissues, besides being far less expensive than ether. Mr. Merrill having, at my request, manufactured a liquid of which the boiling point was 70° F., it proved that the mercury was easily depressed by this agent to 19° below zero, and that the skin could be with certainty frozen hard in five or ten seconds. A lower temperature might doubtless be produced, were it not for the ice which surrounds the bulb of the thermometer. This result may be approximately effected by the common and familiar "spray producer," the concentric tubes of Mr. Richardson not being absolutely necessary to congeal the tissues with the rhigolene, as in his experiments with common ether. I have for convenience used a glass vial, through the cork of which passes a metal tube for the fluid, the air tube being outside, and bent at its extremity so as to meet the fluid tube at right angles, at some distance from the neck of the bottle. Air is not

[1] The kerosolene was furnished by Mr. Merrill, Superintendent of the Downer Kerosene Oil Company, South Boston.

[2] An account of these experiments may be found in this Journal, July 11, 1861. Reference is made to them in a paper "On the most Volatile Constituents of American Petroleum," by Edmund Ronalds, Ph. D., in the Journal of the Chemical Society, London, February, 1865. Mr. Ronalds there states that "the most volatile liquid obtained by collecting the first runnings from the stills employed in the process of refining petroleum has a specific gravity of 0.666." He had also received a specimen of "kerosolene" from Professor Simpson, of Edinburgh, at 0.633. It will be observed that the rhigolene has a specific gravity of 0.625.

admitted to the bottle, as in Mr. Richardson's apparatus, the vapor of the rhigolene generated by the warmth of the hand applied externally being sufficient to prevent a vacuum and to insure its free delivery. By this apparatus 15° below zero is easily produced. The bottle, when not in use, should be kept tightly corked, a precaution by no means superfluous, as the liquid readily loses its more volatile parts by evaporation, leaving a denser and consequently less efficient residue. In this, and in several more expensive forms of apparatus in metal, both with and without the concentric tubes, I have found the sizes of 72 and 78 of Stubs's steel wire gauge to work well for the air and fluid orifices respectively; and it may be added, that metal points reduced to sharp edges are preferable to glass, which, by its non-conducting properties, allows the orifices to become obstructed by frozen aqueous vapor.

Freezing by rhigolene is far more sure than by ether, as suggested by Mr. Richardson, inasmuch as common ether, boiling only at about 96° instead of 70°, often fails to produce an adequate degree of cold. The rhigolene is more convenient, and more easily controlled, than the freezing mixtures hitherto employed. Being quick in its action, inexpensive, and comparatively odorless, it will supersede general or local anæsthesia by ether or chloroform for small operations and in private houses. The opening of felons and other abscesses, the removal of small tumors, small incisions, excisions, and evulsions, and perhaps the extraction of teeth, may be thus effected with ease and certainty; and for these purposes surgeons will use it, as also perhaps for the relief of neuralgia, chronic rheumatism, etc., or as a styptic, and for the destruction by freezing of erectile or other growths. But for large operations it is obviously less convenient than general anæsthesia, which it will never supersede. Applied to the skin, a first degree of congelation is evanescent. A long application is followed by redness and desquamation, which may be possibly averted by the local bleeding of an incision. If used on a large scale, the dangers of frost-bite and mortification must be imminent.

It may be superfluous to add that both the liquid and the vapor of rhigolene are highly inflammable.

# NITROUS OXIDE GAS FOR SURGICAL PURPOSES, IN 1848.[1]

A RECENT number of this Journal contained an account of the removal of a cancerous breast by Dr. Sims, in Paris. I take the liberty of referring to the following extract from the records of the Massachusetts General Hospital, in April, 1848. In the operation therein described, which precedes that of Dr. Sims by twenty years, the inhalation of nitrous oxide was conclusively shown to be capable of producing a complete insensibility for surgical purposes. It was performed only eighteen months after the original discovery of practical anæsthesia by ether in November, 1846, and at that time possessed the interest, which it no longer has, of a novel experiment connected with the development of a recent and great discovery. Anæsthesia by nitrous oxide was then abandoned, not only in view of the livid surface and muscular rigidity, both doubtless due to asphyxia, but also on account of the inconvenience of the preparation of the gas on a large scale, and especially from the bulk of the apparatus required for its administration. This will continue to prevent the extensive employment of the nitrous oxide in surgical operations while agents so much more portable are at command. For the extraction of teeth, dental practitioners may prefer to keep upon their premises a reservoir of nitrous oxide rather than a permanent odor of ether; but the amount consumed in surgical operations alters the question. Again, pure nitrous oxide

[1] Boston Medical and Surgical Journal, February 13, 1868.

gas will not support animal life, the discoloration of the surface noticed in the following operation illustrating this fact. And, lastly, while a patient may be so narcotized with ether vapor that fresh air can be let into the lungs without restoring him to consciousness during a long surgical operation, it is not so with the administration of nitrous oxide, where the admission of a little air is apt to arouse the patient, so that it is comparatively difficult to maintain a protracted and equable anæsthesia.

The following report of the case was made by Dr. John C. Dalton, the present distinguished Professor of Physiology, then house surgeon at the Hospital.

April 25, 1848. — M. H., æt. 45, married. Reports that eleven months ago she felt a peculiar sensation in the left breast. Since then, the breast has gradually become indurated and painful. The latter symptom has been much aggravated during the last three weeks, and an opening which took place near the nipple about a month ago has continued to discharge moderately since. Her general health has suffered somewhat. Now, the left breast is very hard and knobbed, with a brawny appearance of the skin, excepting over the most prominent protuberance, where it is smooth, red, and shining. Breast perfectly movable. No enlargement or induration in axilla.

27. — The patient, having been placed on the operating table, was made to respire nitrous oxide gas through a valved mouthpiece and a flexible tube leading through a bladder to two large copper reservoirs filled with the gas. After several inspirations, the patient's lips and the most vascular part of the tumor began to assume a purple color. She remained quiet, however, and in a short time was evidently insensible, though the muscles were not perfectly relaxed. The tumor was then encircled by a double incision through healthy skin, down to the fibres of the great pectoral muscle.

The dissection was continued in the usual manner, until the whole mass was separated. Three vessels were tied, and the wound covered with a wet compress.

The patient made no outcry or other sign of suffering until some time during the ligation of the arteries, when she expressed a little uneasiness. She recovered perfect consciousness soon after, without unpleasant symptoms.

During the above operation, the patient inhaled about sixty quarts of the gas, which was delivered under a moderate pressure from two large gasometers. By means of the double valvular mouthpiece, the inspired gas was exhaled into the apartment, and a constant supply of fresh gas insured; a provision which is not sufficiently attended to by some of the dental practitioners of the present day.

The following extract from the last edition of the Chemistry of Brande and Taylor,[1] a high authority, corroborates the observations made upon the patient operated on in this instance: —

"This gas is a narcotic poison, and, when breathed, rapidly destroys the life of an animal. It may, however, be taken by a human being in limited quantity. . . . When breathed it is rapidly absorbed into the blood, and produces a great change in that fluid, manifested by a dark purple color of the lips, and by a livid or pallid appearance of the face. . . . It is not to be regarded as an anæsthetic, like chloroform or ether vapor. It is a powerful excitant and stimulant to the nervous system."

If it be asked why a double proportion of oxygen should, in protracted doses, produce lividity of the surface, the

[1] Chemistry. By William Thomas Brande, D. C. L., F. R. S. L. & E., of Her Majesty's Mint, etc., etc., and Alfred Swaine Taylor, M. D., F. R. S., Fellow of the Royal College of Physicians of London, etc., etc. Second American Edition, thoroughly revised. Philadelphia: Henry C. Lea. 1867.

answer doubtless lies in the fact that, while atmospheric air is only a mixture, the nitrous oxide is a chemical combination which yields its oxygen to the blood reluctantly. This objectionable fact seems to be established, and the insensibility from nitrous oxide does not appear to be so profound that it can be advantageously diluted with atmospheric air when inhaled, like ether; circumstances which, apart from its prohibitory bulk, would tend to restrict its use to short operations.

A perfect anæsthetic should be: —

Always effectual.

Wholly safe.

So far under control that a greater or less degree of anæsthesia can be produced at will and continued indefinitely.

It should of itself support animal life, or be capable, like ether, of insuring a safe insensibility while the patient is breathing atmospheric air.

It should produce its effect neither by asphyxia, intoxication, nor narcotism, the first of which is obviously objectionable, while the last two are followed by vomiting and other inconvenient symptoms.

It should be of small bulk.

It should possess little or no odor.

Of the numerous agents now known to science in this connection, none have proved so unobjectionable as ether and chloroform; the anæsthetic application of the former in Boston constituting the great discovery of a sure and safe immunity to pain, even in surgical operations; the subsequent employment of chloroform for the same purpose showing it to be, on the whole, a convenient, and in many places quite a popular substitute for ether, though it is less safe.

The great objection to ether is its odor; to chloroform, its danger, although few people hesitate to encounter as great danger to life in a long journey by sea or land. To such the danger of chloroform might not be an objection to its use, were it not that ether is perfectly safe, and offers a ready alternative. When chloroform kills, the only warning it gives is the death of the patient, who dies suddenly by shock, and in spite of precautions. With ether, no such accident is possible. Its effect may be readily and perfectly graduated, its danger foreseen and easily averted. When the question of bulk is important, as in the field, it is obviously better to insure to every soldier a painless operation by a sufficient supply of chloroform, even with its attendant danger, than to attempt the impossibility of transporting ether in bulk. But there is no difference whatever in the nausea or vomiting produced by the one or the other, nor in the subsequent aversion to either anæsthetic of patients once thus made sick, nor in the character or degree of other unpleasant symptoms, danger excepted; and the sooner these facts are fully recognized, the better for the absolute safety of the patient, as preference will then be given to ether in spite of its odor. Had ether a pleasant odor, it would be as an anæsthetic far superior to chloroform.

At present, dead drunkenness by inhalation seems to be the most available means of anæsthesia. It remains to discover some efficient agent as manageable and safe as ether, without its odor; or as portable and agreeable as chloroform, which shall not kill by shock; or, lastly, to devise some new principle of annulling consciousness, dependent neither upon the absence of oxygen nor the presence of a merely inebriating agent.

## ADDRESS AT THE DEDICATION OF THE ETHER MONUMENT

### IN THE PUBLIC GARDEN OF THE CITY OF BOSTON, JUNE, 1868.[1]

Mr. Mayor, — It was the wish of the late venerable gentleman who caused this monument to be erected, to rear an enduring memorial of the discovery in Boston from which dates the era of painless surgery; and also that on some fitting occasion it should be offered for the acceptance of his fellow citizens.

In no act of a long life characterized by many deeds of liberality, by the exercise of a refined and cultivated taste for nature and for art, and by a discriminating judgment of men and of passing events, did he show greater discernment than when he organized this work; and although he did not live to see it executed, he had so far supervised its plans, and so intrusted them to skilful hands, that no difficulty was met with in completing its beautiful design in detailed conformity to his wishes.

This monument is intended, in the words of the tablet, which were written since his death, "To commemorate the discovery that the inhaling of Ether causes insensibility of pain; first proved to the world at the Massachusetts General Hospital, in Boston, October, A. D. 1846," by its appliance during a protracted dissection which, when followed by one of the severest operations known to surgery, was a final and conclusive test, in a close and connected series of successful

[1] City of Boston Document, No. 101.

experiments, which proved that pain could be annulled; first, with certainty, no matter who the individual; secondly, with completeness, no matter how great might be its degree; and thirdly, with safety. These three points were all absolutely involved in the discovery, and these alone. Before the consecutive experiments which culminated in those here recorded, neither of these points had been established by conclusive proof. The world was ignorant of the great truths they asserted, the discovery had not been made.

The philanthropist had indeed yearned to relieve suffering humanity; the poet had prophetically announced a world freed from physical pain; the philosopher had made fruitless efforts to unveil the hidden secret. Instances of accidental insensibility had been observed. Here and there an ingenious man had devised and tried some single experiment, with greater or less success, and then abandoned the pursuit; or, tantalized by a possibility at one moment in his grasp, and in the next eluding it, stimulated by a flattering promise of achieving something at once practical and useful, had followed up his experiments hopefully until some great public failure disheartened him, made his proselytes incredulous, and left the world still to suffer pain.

Men had been made insensible to pain through mental excitement, or by the agency of Mesmerism or hypnotism, by the dead drunkenness of alcohol, the narcotism of opium, the inhalation of nitrous oxide and other gases, and even by the vapor of ether. For years all this had been known to be possible, but it attracted little attention. These previous experiments instituted by different persons were inconclusive because they led to no constant result. The anæsthesia could not be relied on, or it was not demonstrated that it could be relied on, either as sure to occur or as proof against the severer forms of pain. The question of danger from this extraordinary trance was also unsettled. No consulting board of surgeons would have dared to sanction the production of prolonged unconsciousness during an operation, before the series of consecutive experiments were made here in Tremont Street and at the Hospital. There had been a lack of perseverance or of good fortune in the experimenters, or an imperfection in their materials or method, and the future discovery which was soon to burst upon the world halted for an interval of years at this imperfect stage. The whole progress of all invention and discovery has been a monotonous catalogue of such imperfect efforts and such failures. But when these consecutive experiments had been made in Boston, the discovery had been made; and in grateful and unhesitating recognition of it the entire civilized world simultaneously rose up to hail it with acclamatory welcome.

Thus was made the discovery, and thus was begun the career of anæsthetic inhalation. Modifications, imitations, and substitutes have sprung up in all civilized countries. New processes and new materials will yet be furnished by science, or demanded by convenience or economy, but after more than twenty years of its successful trial, nothing has been found to surpass, in its efficiency or unqualified safety, the original ether then used.

To commemorate the triple and demonstrated discovery, not of a probable, an uncertain, or an untrustworthy, but of an inevitable, complete, and safe anæsthesia, this monument has been erected in a city which was the humble instrument of Divine Providence in diffusing to the nations this incalculable blessing.

I well remember when the eloquent and gifted man, whose brazen effigy on yonder pedestal so powerfully recalls his living presence, in an address delivered at the Medical College on the 4th of November, 1846, said, with an unconscious foreshadowing of what was soon to happen, "I cannot suppress the remark that the great principle of analogy seems to authorize the hope that . . . further discoveries may be expected scarcely less brilliant than that of vaccination." How far even this prophetic inspiration fell short of the reality! How little did he dream that the lapse of a few brief days would herald to the earth the greatest boon ever accorded to the physical welfare of mankind, — days of discovery that forever silenced the dreadful shriek of agony which many of us can yet recall in the surgical amphitheatre of the institution which is now immortalized, that stilled the moan of the soldier stricken down upon the battle-field, assuaged the pangs of disease, softened the approach of death, and lent a sweet obliviousness in what was once its hour of anguish to all animal existence, from the poor suffering brute up to humanity, to man born of woman, and to woman of whom man is born!

In the name and at the request of my venerable friend, the late Mr. Thomas Lee, of his executors, and of the gentlemen to whom he intrusted the arrangement of this ceremony, I offer this memorial to you, sir, and through you to the City of Boston.

## ANÆSTHETIC INHALATION.[1]

Mr. Editor, — In furnishing, at your request, a copy of the letter sent by the late Sir James Y. Simpson to Dr. Jacob Bigelow, now absent, let me say a few words upon the subject of a controversy in which during former years I had some part, and which from various circumstances has of late awakened a new interest.

The medical world will hear with regret of the decease of one who has occupied so distinguished a position as the late Sir James Y. Simpson, and something more than regret will be felt by the many who have enjoyed his kindness and hospitality. The present is not a time for extended controversial comment; and yet it is perhaps possible to review the positions and condense the statements of Sir James's letter in a way which, if it shall advance the truth at a moment when the subject is fresh in the public mind, its late distinguished writer would have been one of the last to object.

It will be seen that Sir James Y. Simpson considers the introduction of chloroform, and its substitution for ether, to have been on the whole the most important and the culminating event in the history of modern anæsthesia. To this the labors and contributions of the Middle Ages, of Valverdi, Moore, Davy, Hickman, Samuel Jackson, Wood and Bache, Miller, Horace Wells, C. T. Jackson, and Morton, are cited as subsidiary. The announcement in this Journal in November, 1846, which electrified the world, records an occurrence which he views only as one stage in

[1] Boston Medical and Surgical Journal, May 26, 1870.

the gradual development of a discovery, of which the employment of chloroform was the grand and final event. In the endeavor to establish this position, prominence is given to incidents remote in history which had been long forgotten, and would have remained so. The later but unproved suggestions of Davy, and the varying results of Horace Wells, are brought conspicuously into the foreground. The triumphant American discovery of 1846 is shaded quietly into the middle distance, while the most prominent place is reserved for chloroform, because it has, "if not entirely, yet nearly entirely, superseded the use of sulphuric ether."

But in following out this train of thought, may it not well be asked, Who will have contributed the most important part to the discovery of anæsthesia, when chloroform shall have been superseded by some less dangerous agent? — an occurrence which will, in this view, again be the great and crowning feature of the discovery. Plainly, this line of argument is not tenable, leading, as it does, to the conclusion that the great discovery of anæsthesia has not even yet been made, and in fact that it never will be; but that it consists only in the successive substitution of each last and supposed better anæsthetic for a previous one.

The fallacy of this logic grows out of a misapprehension of the nature of the discovery in question, the precise character of which should be borne steadily in mind in testing any claim, whether past or future, to have made it. Its essential points should characterize every perfect remedial agent. Ether was the first anæsthetic proved to be *inevitable* as to the individual, *complete* in its effect, and *safe*. The same test may be applied to vaccination, for example. Inoculation of small-pox, although protective, had proved to be dangerous. But the discovery of Jenner, while practically *inevitable* as to the individual, and *complete* as a protection, was *safe*. Jenner was a discoverer, and his claim is invalidated neither by any previous mode of vaccination, nor will it be by any future one. So the discovery of modern anæsthesia is invalidated neither by the previous use of opium, alcohol, and nitrous oxide, nor by the subsequent use of chloroform.

Nitrous oxide in the hands of Horace Wells sometimes succeeded, but it also failed, as in his final experiment in Boston. The reason of his failures has never been told, but it was this. He used too small a volume of gas, and its virtue was soon exhausted. He employed a common gas bag, instead of the large reservoir now successfully in use, so capacious that the inspired and effete gas may be exhaled as waste. In consequence of this error in his method, as inconsiderable as those of many other inventors who have, like him, narrowly missed great results, his anæsthesia was uncertain, and could not be relied on to occur when it was wanted. Its failure became notorious, and Wells actually abandoned his experiments for nearly a year. Then, indeed, when the complete success of ether showed the disheartened experimenter how nearly he had attained to a great discovery, and by how little he had missed it, his attention was again aroused, and he engaged in new experiments. But it was now too late; the discovery had been made.

Modern dental anæsthesia by nitrous oxide must not be confounded with the uncertain process of Horace Wells. The modern method by the large gasometer is more successful, but this was not the method employed by him. His gas bag was liable to be inadequate, asphyxiating, uncertain. It was liable to fail.

If etherization had not been discovered, what at this moment would the nitrous oxide gas bag anæsthesia of Horace Wells be practically worth to patient or to surgeon?

Horace Wells was not the discoverer of modern anæsthesia, *inevitable*, *complete*, *and safe*, — "a triple discovery," involving three conditions, a notable failure to fulfil either one of which, as had happened in all previous experiments, would render it of little value. These three conditions were first fulfilled by ether. The discovery of modern anæsthesia was made with ether. No previous anæsthetic had accomplished such results. No subsequent anæsthetic has effected more.[1]

Those who remember how the civilized world at once exulted in the great news from Boston, and how for months and even years the question of the discovery of modern anæsthesia was supposed to lie exclusively and indisputably between Morton and Jackson, its two rival and contemporaneous claimants in that city, will examine closely any tardy pretensions based upon a previous imperfect discovery like that of Horace Wells, or upon any past or future modifications or alleged improvements, by chloroform or other agent, of the original and first wholly successful process of anæsthesia.

HENRY J. BIGELOW.

[1] Among the extraordinary and anomalous doings which signalized the late meeting of the American Medical Association was a resolution, put and carried just before separating, attempting to settle by the snap judgment of a kind of caucus vote a question of discovery in science which for years tasked the intelligence of scientific men in Europe and this country.

## DEATH BY CHLOROFORM, AND ALLEGED DEATH BY ETHER.[1]

In the great rarity of so called "death from ether," the case reported in the "Medical Record" of October 1 will probably be quoted, and perhaps also confounded with the usual "death from chloroform," which is quite different. For this reason, we believe that the reporter of this case will pardon the following remarks, based in part upon the omissions of his narration.

Nobody doubts that a patient can be gradually narcotized with ether until life is extinguished; and that this result will follow with a rapidity proportioned to his want of health and strength.

Hence, in administering an anæsthetic to a patient reduced, for example, by delirium tremens, by long disease of the bladder, or of a joint, or by fracture of the hip, care should be exercised. Here a sudden syncope, or even a more gradual falling off, whether of pulse or respiration, may mean something. In the course of ten or fifteen minutes, the vital force, after having given fair warning, may yield with unexpected and startling suddenness.

Exhausting and protracted influences like these are far more potent in their depressing effects upon the system, especially in diminishing its power of supporting anæsthesia, than a recent injury to a more robust subject. Such a patient, cold, pulseless, and nearly insensible as a result of having had one or more limbs crushed by railroad accident some hours before, is usually stimulated by ether inhalation.

[1] Boston Medical and Surgical Journal, October 24, 1872.

As a rule, his pulse comes up, and he undergoes his amputations well.

If the narcotism[1] of ether is ever fatal to an aged or exhausted subject, in the way described, it should be remembered that chloroform would be more fatal to the same patient under the same circumstances.

Death from narcotism, although it may be heralded as "death from ether," is not death from any property peculiar to ether. It is death from a depressing influence common to ether, chloroform, alcohol, and opium, and is most likely to occur with the strongest of these agents. Moreover, precaution will prevent it.

But "death from chloroform," which has given to chloroform its doubtful reputation, is a different thing, which no human foresight can avert. It is death from a small and usual dose of this powerful agent, — death to a healthy person, sometimes as sudden as by a stroke of lightning, without warning of any sort, by shock. We hold that ether has never produced such a result, but always gives fair and adequate notice of the approach of danger.

If these views are correct, it follows that a certain small proportion of "deaths from chloroform," so called, should be subtracted from its bill of mortality, and credited to a "narcotism" common to ether and chloroform. But a similar analysis will wholly expunge the two or three fatal cases for which ether has been by some persons held to answer. Chloroform will still be responsible for its monthly record of death by "shock," small in its percentage it may be, but inevitable, while ether will then have a clean bill of health.

Let us now, with a desire to give to ether a candid hearing, and also because it in some measure illustrates so

[1] The term "narcotism" expresses well enough for present purposes the gradual effect upon the system of anæsthesia in general, while "shock" may stand for the sudden or toxic effect of chloroform.

called "death from ether," consider the fatal case which occurred in the hands of the house surgeon and his assistant at the Bellevue Hospital.

A man of sixty-eight, with a fracture just below the trochanter of eighteen days' standing, — having the lower lobe of his right lung œdematous and its "lower portion in a state of red hepatization," there being also "emphysema" and "thickening of the large bronchi," — had ether "slowly and carefully" administered during "perhaps ten minutes," for the application of a plaster bandage. The patient was then "fully under its influence."

> "A few turns of the plaster had been made, when the patient's breathing was observed to be rather frequent and gasping. The pulse was, however, full and regular. The thorax was compressed two or three times, and the patient's breathing again became normal. As these symptoms not rarely occur during etherization, they excited no special alarm. The ether was, however, withheld from the patient four or five minutes, his respiration and pulse being normal. As he then began, however, to move about, and his muscles were becoming rigid, the ether cone was again applied."

This is not quite clear. The patient was "fully" etherized. Everything, the pulse included, is said to have been as it should be, except the breathing, which became "rather frequent and gasping." Now a patient in his senses, with his chest filled with water, for example, may breathe in this way. But is a patient likely to breathe of a sudden more rapidly when he is fully narcotized? We do not agree that these symptoms "not rarely occur during etherization." With the experience of many thousand cases, we have never seen them. A patient with ether may be faint,[1] as perhaps

[1] Symptoms of pulse and respiration, practically those of syncope, are not unfamiliar to persons in the habit of etherizing. The operating chair at the Massachusetts General Hospital, in use since 1854, was furnished with a hinged back and foot-board, to provide against this contingency. The patient can be at once laid flat.

this one was; or, when fully under its influence, may breathe more slowly, or suspend his respiration, or snore; or, when he does not get air enough, may have spasm of the glottis from asphyxia, producing more asphyxia, discoloration, and general muscular rigidity, but, so far as we know, never an accelerated respiration with gasping when fully etherized, the pulse being full and regular.

Nevertheless, these or other appearances not mentioned led to an attempt at artificial respiration, and to the suspension of the ether inhalation during four or five minutes.

The rest of the story is given in a few words: —

"In a minute or two, my assistant, who was giving the ether, observed the pupils to be dilating rapidly, and the breathing to cease. His heart was still beating, however."

We naturally ask, How, during this critical and not very brief interval, was the pulse, — a most reliable pilot among the possible dangers of etherization? There is no mention of it. Such signs as those mentioned above are hardly compatible with the continuance of a full and regular pulse, and we cannot but feel that the pulse at the wrist, if kept in hand, would have given warning of their approach.

For ourselves, if called upon to indicate, in the absence of complete evidence, the probable cause of this death, we should perhaps rearrange the statement, somewhat as follows.

A man of nearly seventy years, reduced by a fracture near the trochanter of eighteen days' standing, and by pneumonia, was subjected to a somewhat protracted inhalation before coming under the influence of ether. At the end of ten or twelve minutes his breathing became so feeble and irregular that etherization was suspended, and artificial respiration was resorted to. In the course of four or five minutes more, there being some muscular action, and the respiration being also stronger and the pulse better, the ether was again administered, but the same bad symptoms soon supervened. On examination, the pupils were now found to be dilated. The heart was still beating, (although there was probably no pulse at the wrist,) but attempts at resuscitation were this time ineffectual.

Such an account would better accord with previous experience. The vitality of a patient enfeebled by age and disease proves to be easily depressed, and, after giving to the operator good and sufficient warning of his enfeebled condition, he succumbs; an occurrence which may serve as a fresh and salutary lesson to the surgeon to be careful during anæsthesia by ether of a system thus depressed, and still more so during anæsthesia by chloroform. An accident we believe is impossible in using ether, with the pulse held and the respiration attended to. On the other hand, no precaution yet devised by human ingenuity will prevent the insidious shock of chloroform, even in a small dose, from occasionally and abruptly killing a healthy subject. This is the peculiar and usual death from chloroform, and of its approach neither pulse nor breathing gives indication.

Ether is so safe when used liberally, and even prodigally, that after a time the practitioner may perhaps fail to be quite alive to the possible dangers which are inseparable from every remedy of such power. With a tithe of the extreme but vain precaution of English practitioners against the shock of chloroform, we hold that ether would be innocuous. In the above case, an exceptional degree of caution, suggested by the symptoms, might perhaps have saved the patient; but it is important to say that we find nothing in the account to show that the house surgeon failed to exercise as much care, on the whole, as is common in the administration of ether, and such as usually insures to the patient immunity from accident.

## THE HISTORY OF ANÆSTHESIA.[1]

To the Editor of the New York Times: —

Having heard that a meeting was about to be called in New York, the chief purpose of which was to show that Horace Wells was the discoverer of modern anæsthesia, I wrote to Dr. Henry J. Bigelow, of Boston, who perhaps more than any other surgeon now living is familiar with the facts of the early history of this discovery, requesting some statement from him upon this subject. I take the liberty to send you his reply.

Respectfully, your obedient servant,

Elizabeth W. Morton.

My dear Madam, — I received to-day your note of the 16th instant, announcing an effort in New York to show that Dr. Wells was the discoverer of anæsthesia. If this is its real object, the announcement or advertisement of the meeting does not state it. The gentlemen signers who were led to ask for information upon anæsthesia were probably not aware that they were invited to embark in a reconsideration of the ether controversy, — a dispute which was thoroughly investigated and practically settled at the time by those who were familiar with contemporaneous facts, and better than it can be by a generation which has grown up since.

Wells — acting on Davy's old and well known hint that his (Davy's) gas, having relieved his own inflamed tooth, might perhaps produce a further surgical insensibility — tried it, and found that it sometimes did so, but sometimes did not. In fact Wells made so many notable failures that

[1] The New York Times, May 24, 1873.

he abandoned the gas in disgust, and embarked in the picture and other business. If a man who was now to have his tooth drawn or his leg amputated should inhale this gas from a small bag with entire uncertainty whether it would or would not be of any service in relieving pain, this would illustrate precisely the extent and character of Wells's so called discovery. The gas proved in his hands to be wholly unreliable, and as such he dropped it as of no practical value. In fact it was hardly known out of Hartford. Besides, an uncertain anæsthesia had been produced long before, and was therefore not new. Wells made the unfortunate mistake of using a small gas bag, then commonly employed, as it still is, for exhilarating purposes. Long after ether was introduced the large gasometer, now used by dentists, was tried, though not by Wells, and it succeeded, but too late. The discovery of an inevitable and safe anæsthetic (the only one of any value) had been made, and as evidence of its value the whole civilized world, which had ignored the gas process practised by Wells as imperfect and unavailing, at once greeted it with acclamation.

Wells, like thousands of other would be inventors of processes and discoverers of truths, narrowly missed a discovery; but he missed it. He only showed that anæsthesia was possible; but this everybody knew before. What the world did not know and wanted was a sure anæsthetic, as well as a safe one, and this want was first supplied by ether. When, after a year or two devoted to the picture business, Wells heard of the invention of the first inevitable anæsthetic, he at once wrote to Morton to say that, if ether would really do what he claimed for it, it would make his fortune, thus acknowledging the value of Morton's discovery as compared with the uncertain experiments practically abandoned by himself nearly two years before. But at a later period (nearly two years after he had abandoned the gas for picture dealing, and other more promising business) he was unfortunately induced by the advice of persons in Paris, where he then was, to claim the immense discovery.

Wells, like many others, preceded ether inhalation with an imperfect and unreliable or dangerous anæsthesia. Simpson and a dozen others followed with alleged improvements, and all claimed to be discoverers. But ether first produced what was never known before, and what has not been materially improved upon since, an anæsthesia at once inevitable, complete, and safe.

This is what the world is grateful for. These points constitute the discovery of modern anæsthesia. More than this, I hold that the uncertain anæsthesia, which was all that Horace Wells had produced before the discovery of ether inhalation, was then practically, and would be even now, of no value to the surgeon.

Finally, it may be added that Wells was not even the one who improved the gas process, and inaugurated the modern and comparatively successful system of the dentists, by substituting a large gasometer for the small and insufficient gas bag, thus making nitrous oxide what it has since become, an anæsthetic, far inferior to ether, useful in dental and short operations, but dangerous in long ones.

If the above hasty review of the early history of anæsthesia is of any service to you, it is at your disposal.

Your obedient servant,

HENRY J. BIGELOW.

BOSTON, May 19, 1873.

## THE HISTORY OF ANÆSTHESIA.[1]

To the Editor: —

Sir, — In 1800 Sir Humphry Davy discovered that he could produce insensibility to "intense physical pain," in an extensive inflammation of the gum, by inhaling nitrous oxide, and he says, "As nitrous oxide, in its extensive operations, appears capable of destroying physical pain, it may probably be used with advantage during surgical operations in which no great effusion of blood takes place." So that Dr. Wells could claim no originality in the discovery or conception of anæsthesia, or of the fact that nitrous oxide would produce it. Fifty years after Davy wrote the above with regard to the anæsthesia of intense pain in his own gum, Horace Wells made a further small discovery, still prior to that of etherization; namely, that nitrous oxide gas would sometimes prevent a man from knowing that a tooth had been actually pulled from his jaw, and that sometimes it would not. Wells's advance upon Davy's knowledge was a very slight one; and besides, anæsthesia — uncertain, but complete anæsthesia — was already known to be produced by "Mesmerism," so called, alcohol, opium, etc. But his failure to produce insensibility in every case so greatly discouraged him that he renounced the use of the gas, and, as far as he then knew or intended, he gave it up forever. "He said he was disappointed in the effects of the gas, and that it would not operate as he had hoped and thought, as there was no certainty to be placed on it, and consequently he should

[1] The New York Tribune, May 26, 1873.

abandon it, as he had so much other business to attend to, and as the gas would not work in all cases alike, and therefore could not be trusted." Instead of gas he now took up and occupied himself with the invention and patenting of shower baths and coal sifters, and dealt in pictures on a large scale. While he was occupied with nitrous oxide, Wells's experiments excited some attention among his friends and acquaintance at Hartford, but out of that city were almost unknown, unless here and there by reason of their failure, and on that account were considered useless.

Pain still attended surgery. Dr. Wells did not think it worth while to make a single printed or written statement of his alleged discovery of two years before, during the interval preceding the discovery of etherization by Dr. Morton, — which was a different thing. There was no failure in that. In three months it had aroused the whole civilized world. Wells recognized this as successful, and at once wrote to Morton to tell him that, if his (Morton's) operation of administering the gas, as Wells assumes it to be, was not attended with too much trouble, and if it would produce the effect that he (Morton) stated, it would undoubtedly prove a fortune to him. Does this sound like the language of a man who had made the discovery of a valuable anæsthesia, the existence of which would render Morton's discovery wholly superfluous? How was etherization to prove a "fortune" to Morton, if the discovery had been forestalled by Wells's nitrous oxide, and the ground preoccupied by that, as alleged? Fortunately this letter has been carefully preserved. It is too plain, from all the circumstances, that Wells, discouraged by failure, had practically abandoned his discovery when he was on the very verge of making it valuable. Hundreds of other discouraged inventors have done the same thing.

It was only natural that, when Wells saw how etherization was received by the world, and how nearly he had grasped this prize, this "fortune," and yet missed it, his sensitive nature should feel the misfortune deeply. He again set to work with nitrous oxide, but too late. The discovery had been already made of an anæsthesia which was not only safe, but which, unlike nitrous oxide as administered by Wells, never failed. Wells subsequently exerted himself to bring forward his nitrous oxide; tried it in a case or two of surgery, and, becoming more and more excited about his claim and his unfortunate failure, even repudiating a part of the letter he had written to Dr. Morton in 1846, at last died manifesting signs of insanity.

If Wells's method — i. e. the one he employed before the discovery of etherization — had stimulated him to further experiments, and to the use of a larger gas bag, instead of the common small one which failed, the result might have been different; but if his original method had remained the only resource of surgeons, there would be no surgical anæsthesia in the world at the present time.

HENRY J. BIGELOW.

BOSTON, May 22, 1873.

## ALLEGED DEATH FROM ETHER.[1]

To the Editor of the British Medical Journal: —

Sir, — Your issue of October 11 contains the following: — "We have this week to make the sad announcement of a death from the inhalation of ether. It occurred at the South Hants Infirmary. We shall be glad of the comments of Dr. Morgan and our Boston contemporaries."

The avowed interest attaching to death from ether, compared with that attending the rather common occurrence of death from chloroform, attests its rarity; and those who have been long familiar with the safety and efficiency of the former may think it perhaps a little late to subject it in England to an experimental test which the comparative fatality of chloroform seems at length to have secured for it. I venture to comply with the invitation with which you have honored your Boston contemporaries, believing that until some anæsthetic shall be discovered equally safe, with less odor and less bulk, or perhaps some better form of anæsthesia than that by inhalation, ether must be considered on the whole our best anæsthetic. We need not here distinguish too nicely between anæsthesia, narcotism, and inebriation when effected through the lungs. It is more important that special attention should be directed to several points connected with this subject which seem to be inadequately emphasized in contemporary European literature, especially asphyxia, pulse, and the real difference between what the

[1] Boston Medical and Surgical Journal, November 20, 1873.

journals somewhat promiscuously denominate "death from ether" and death "from chloroform."

The Massachusetts General Hospital numbers more than 15,000 cases of ether inhalation, 6,000 of which have been recorded within the last five years. The quantity of ether consumed during these five years has been about 2,800 pounds, — half a pound, more or less, to a patient; in one case four and a half pounds in twelve hours. It fell to my lot, in 1846, and for a year or two after the discovery of ether anæsthesia, as junior surgeon, to administer most of the ether in that institution; and having been personally cognizant of a large proportion of the cases of its administration there, down to the present time, besides those in my own practice, I have never been satisfied of the occurrence of a single death which could be attributed to any property of ether, apart from the gradual and progressive inebriating influence which it possesses in common with other anæsthetic agents.

A detailed report of a case involving such urgent symptoms and prompt action as the one described is obviously liable to inaccuracy, and the account should therefore be accepted with reservation, and rather as a good illustration of an emergency quite likely to recur in the experience of those who may believe, with a late English medical journal, that the less air admitted during ether inhalation, the better the anæsthesia, or, with the French chemist, that nitrous oxide only asphyxiates. Nobody doubts that asphyxia produces insensibility. This is easily shown with a bag containing a few gallons of atmospheric air. But this insensibility, necessarily brief, is unattended by exhilaration. It is distressing, accompanied by lividity, by rigidity if pushed far enough, and is doubtless responsible for much of the dread which certain patients have of pulmonary inebriation.

The case in question is reported as follows: —

"David Newman, aged fourteen, a strumous lad, who had suffered from repeated attacks of corneïtis, was admitted an in-patient of the above institution on September 25, 1873, under the care of Dr. Lake. On Wednesday, October 1, he was brought into the operating room in order that iridectomy might be performed. When on the table, he exhibited considerable alarm, and required some persuasion before he was induced to lie down. Dr. Griffin having taken charge of the pulse, half an ounce of ether was poured on a sponge contained in a cone of spongio-piline, and the latter was closely applied to the mouth and nose. After a few minutes' inhalation, the ether being nearly exhausted, three drams more were poured on the sponge. Shortly after commencing to inhale this second quantity, he began to struggle violently, getting at length into a state bordering on opisthotonos, his face becoming intensely scarlet. Dr. Griffin then announced that his pulse, which up to this time had been perfectly natural, had become very feeble. The ether was at once discontinued, when, the pulse having improved, Dr. Lake operated, no more ether being administered. At the close of the operation, which occupied only a few seconds in its performance, and before the eye could be bandaged, the pulse became imperceptible, the breathing was suspended, and the countenance livid. The tongue was drawn well out of the mouth, and held there. The calves of the legs were vigorously flagellated, and the chest freely slapped with a wet towel. The effect of these measures was to cause the patient to respire freely, to cry out lustily, and to kick about on the table; but this improvement did not last long, — probably about a minute. The pulse at the wrist did not return, and the breathing again stopped."

Artificial respiration, electricity, etc., were resorted to, but without effect, and the autopsy revealed nothing of importance.

In order to be clearly understood, let me here concisely restate this account, as I interpret the phenomena.

A feeble boy was etherized. During this process, though only partially narcotized, he was very completely asphyxiated, and when nearly dead was operated on without efforts at resuscitation. When at last his absolute prostration awakened serious alarm, he was vigorously flogged with the view of restoring his exhausted strength; and under this active stimulus was excited to a final muscular effort which expended and extinguished his flickering vitality. I believe that such a death might have occurred without the ether.

Let us consider the circumstances in detail, and see whether or not they substantiate this hypothesis; and, first, the apparatus employed for inhalation. This was calculated to produce asphyxia.

If the spongio-piline was covered, as usual, with rubber, no air could reach the patient, except in the interstice between the cone and the patient's face. But, according to the account, the cone was closely applied. If so, absolute asphyxia would ensue. It may seem superfluous to say that during the etherizing process a patient must live, as usual, upon oxygen. Let us even needlessly assert that without it a man must die. Ether will not save his life, if he is deprived of oxygen. It would not have saved Desdemona.

Asphyxia did ensue; but its symptoms passed unheeded. The patient struggled violently. Now a half-conscious struggle often results from mere muscular excitement, and is of little moment. But a rigid struggle, with opisthotonos, is very different. Such spasm is connected with asphyxia, and may involve the muscles of the larynx. In this connection let me remark that there is a wide distinction between the common and desirable snore of a relaxed and vibrating soft palate, and a croupy stertor of the contracted laryngeal aperture. The latter is a part of that general rigidity of which opisthotonos is a manifestation, and by excluding air it indefinitely prolongs the asphyxia which occasions it. Air is its only remedy.

These appearances are familiar, in the practice of the Massachusetts General Hospital, even to the house pupils and ward tenders, to whom etherization is habitually intrusted. Lividity of the forehead indicates a probable similar color of the blood within the head, and announces that spasm may not be far off. Conversely, muscular spasm and laryngeal stertor direct attention to the color of the face. All these symptoms raise the question of admitting air promptly, and until the natural color returns. Indeed, it sometimes happens that because the muscles are rigid a patient seems imperfectly etherized, and the experimental admission of air, relaxing the muscles, proves the contrary. Even a half-conscious resistance, terminating in insensibility, often makes the patient a little livid; so that a struggle then suggests examination of his condition, and sometimes an interval and recommencement.

If all this be true of inhalation with a sponge, through the meshes of which air has free access to the lungs, and which for hospital use, if not the most economical, is beyond comparison the simplest and safest ether inhaler, what were the chances of a slender boy, struggling desperately for breath, rigidly convulsed with opisthotonos, his face congested, his mouth and nose still sealed by an impervious cone forcibly and closely applied until the pulse gave way?

I unhesitatingly submit asphyxia as the primary cause of death upon this report.

Notwithstanding this condition of the patient, he was operated on. With so complete asphyxia, it would in Boston be considered of the first importance, before operating, to re-establish respiration, pulse, and color; after which more ether might be administered, to complete the anæsthesia. But in this case no such efforts were made, and no such interval was allowed. After a few seconds, which were occupied by the operation of iridectomy, the patient still livid from his struggle with the closely applied cone, "the pulse became imperceptible, the breathing was suspended," and in "about a minute" he was dead.[1]

To this overwhelming effect of asphyxia upon a slender subject was doubtless added a certain amount of ether inebriation; but there is abundant evidence that this was but partial and incomplete. The quantity of ether administered was inconsiderable; and it is distinctly stated that the patient, when his legs were vigorously flagellated, and the chest freely slapped with a wet towel, "cried out lustily, and kicked about on the table," during the one minute he lived after the operation. Narcotism had not even reached insensibility to pain. No such imperfect ether anæsthesia can be held as principal in such a death.

It would be equally unphilosophical, in view of these facts, and in an endeavor to shift responsibility, to accuse the improbable shock of so slight a surgical operation, and still more any mysterious and as yet undiscovered property of ether, outside of that familiar, gradual, and comparatively innocuous influence which it possesses in common with other intoxicating agents. Further reference will be made to this.

[1] The fact that "the pulse improved" during a brief interval does not necessarily modify the general aspect of this case. See "Principles and Practice of Medical Jurisprudence," by Alfred Swaine Taylor, M. D., etc., etc. Philadelphia, 1873, vol. ii. p. 35.

A word about restoratives. The most effectual method of resuscitating a patient asphyxiated or over dosed with ether is at once and quietly to get good air into his lungs. The volatile quality of both chloroform and ether makes their elimination from the pulmonary surfaces so easy, that, even when breathing seems to have ceased, a little thoracic movement, artificially assisted, generally enables the patient himself to re-establish respiration, and brings up the pulse. A feeble boy, who had exhausted his strength in a violent struggle for breath and life, would have no great stock in store to respond to a vigorous flagellation. In this respect he might differ from one who had gone tranquilly to sleep with opium.

In arraigning ether, let us not confound things. All powerful therapeutic agents and expedients may, under certain circumstances, contribute to depress the system, — ether and chloroform among the rest; chloroform, as stronger than ether, possessing, of the two, the greater depressing influence. But this effect of a mere narcotism common to both, and which may contribute to the death of a feeble or dying patient, is not the real subject of discussion in the medical journals. The question is, Has either of these agents, besides this gradual narcotic power, any additional, different, and peculiar quality which renders it dangerous? To this I unhesitatingly reply, that chloroform has, and ether has not.

When we say "death from chloroform," we mean death by a shock or poison peculiar to chloroform, even when inhaled by a healthy person, under the most favorable circumstances, with abundance of air, and with every precaution; sometimes occurring at the beginning of anæsthesia undertaken for a trivial operation, almost as if by prussic acid; the sudden failure of a normal pulse indicating that the patient is beyond recovery.

With ether I believe this to be simply impossible. It always acts slowly, never depressing the vital powers suddenly, or beyond recovery, without fair warning by the pulse in time to avert danger by the simple expedient of filling the lungs with unadulterated air.

In a somewhat extended paper upon anæsthetic agents, — written in 1848 at the request of the American Medical Association, and published in the Transactions of that body about one year and a half after Morton performed his first painless extraction of a tooth, and only a few months after Professor Simpson's first experiment with chloroform, — the absolute necessity of air, the essential indication of the pulse, the difference between the snore of narcotism and the livid stertor of asphyxia, are all specified and insisted on. I may perhaps be pardoned for quoting, in conclusion, the following passage, which touches the main point of modern ether discussion.

"Ether does not prevent, nor is it to be considered responsible for, the ordinary collapse resulting, in certain states of the system, after certain injuries and certain operations. The strong argument in behalf of ether is, that so few instances have occurred in which it could be even suspected of agency in fatal results.

"With chloroform the evidence is a little different. Two somewhat remarkable cases of death, occurring during the brief administration of this agent for surgical purposes, at once present themselves, — the Cincinnati case, and that of Mr. Meggison at Winlaton. In these cases death occurred in about five minutes from the beginning of the inhalation. . . . These instances suggest a specific cause of danger. This is the sudden impression upon the system of a powerful inebriating agent. Abundant alcoholic stimulus has often produced immediate death; and analogy would suggest that inebriating vapor in the lungs may be the equivalent of similar fluid in the stomach, and that in one or both of the cases mentioned chloroform may have produced a sudden and overwhelming shock upon the system."[1]

Your obedient servant,
HENRY J. BIGELOW.

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## NOTE.

THE inodorous and transitory character of anæsthesia by nitrous oxide, notwithstanding its attendant asphyxia, may perhaps recommend it for the brief extraction of a tooth ; and we should not ignore the fact that chloroform insensibility is perhaps as safe as many other experiences which people do not hesitate to encounter, — crossing the Atlantic, for example ; and yet one accustomed to the use of ether in surgical operations protracted during an hour or more, with an occasional examination or inquiry about the pulse, and a suggestion to admit air if the medical student in attendance happens to forget it, is not a little impressed by the solicitous and apprehensive circumspection attending English anæsthesia.

Under these circumstances, a few purely practical suggestions in a familiar form, however superfluous or even trite to a part of the surgical world, may perhaps not inappropriately serve as a record of the current views and practice of etherization in the Hospital with which I am connected, — which has, perhaps, a larger experience than any other of this form of anæsthesia.

Accept the odor and the bulk of ether as a cheap compromise for the safety of the patient and the confidence it gives the operator.

Believe that its anæsthetic effects, whether pleasant or objectionable, do not differ materially from those of chloroform.

Recognize the fact that, while chloroform may kill without warning, ether never does.

Aim at anæsthesia by inebriation, not by asphyxia. With ether

[1] Anæsthetic Agents, their Mode of Exhibition and Physiological Effects, by Henry J. Bigelow, M. D., one of the Surgeons of the Massachusetts General Hospital. Transactions of the American Medical Association, vol. i., 1848.

vapor insure air to the patient. Though he struggle at the beginning, if he is not rigid or too livid, it is safe to compel inhalation; but if you can devote more time to the process the resistance will often be less.

Before etherizing, remove false teeth, and loosen a tight dress.

Use, and let hospital assistants use, a good-sized bell-shaped sponge; and then it may be a question of less rather than more air. The various forms of apparatus which restrict or graduate the quantity of air require more attention and more assistance. Of these a close bag is the worst. If the sponge is damp, it retains ether better, while the vapor is perhaps a little softer than when absolutely pure. The ready ignition of the latter suggests the precaution of moistening the skin and saturated linen with water before employing near the face even galvano-cautery.

The gravitation of the vapor makes it practically safe by night, if lamps are held above it.

Keep the pulse in hand; at any rate, examine it often. When the pulse is right, the patient is so. With chloroform, the pulse may be right and the patient wrong. If slow or feeble,[1] or if the patient snores more than he need, save his strength by giving air, — at any rate, until the pulse comes up; but renew the ether before he is sensible of pain. If the pulse shows that he is sud-

[1] "Here is the precaution against danger; . . . this sign is *the diminution of the force and frequency of the pulse.*

"In an early case of the administration of ether by Dr. Morton, which has been reported, the danger from over narcotism was quite as imminent as in any case I have since seen mentioned. As a bystander on that occasion, I casually felt the pulse, and found it barely distinguishable; and though it subsequently still decreased, the means at once adopted for the restoration of the patient proved ultimately successful. This occurrence pointed to the pulse as an index of the stage of narcotism; a few subsequent experiments confirmed the belief; and I have not since hesitated to push etherization to complete insensibility, and to continue it, if necessary, during a length of time, provided the pulse remained full and strong. If it be retarded by ether, it is curious to observe with what certainty it recovers force and frequency, after a few inspirations of pure air. It will be inferred from these remarks that the pulse is to be carefully examined during the whole anæsthetic process, and that inhalation is to be temporarily discontinued at its indication." — Anæsthetic Agents, etc.

denly faint, lay him down and give him air. Faintness not unfrequently results from nausea, and is relieved by vomiting. In a case of doubtful pulse, a contractile pupil reassures the operator; a dilated pupil renders him more cautious.

If the patient is livid or rigid, give him air.

If his glottis contracts, give him air.

If he breathes badly, put the finger inside the cheek to admit air over the base of the tongue.

Should he vomit, of which there is usually timely notice, give the matter free exit by turning the patient, if recumbent, well to one side. Although there is less nausea with an empty stomach, it is not well to starve a patient about to encounter a protracted operation.

From time to time evacuate the tracheal mucus from the fauces, during an expiration, with a sponge held in dressing forceps.

In operations about the nose and mouth, give, for convenience, a powerful dose before beginning. Impregnate the whole circulation to the degree it usually attains in the middle of a long operation. The patient is then easily kept quiet. Otherwise a volume of fresh blood may find its way to the brain, and suddenly revive him. Let the repeated dose be also heavy.

In these operations, expect blood in the trachea, and evacuate it like the mucus; but, by reason of its quantity, more promptly.

Indeed, if such an operation promises much blood, have a tracheotomy tube ready, with hooks to hold the incision open while they compress the veins, so that the tube can be entered by a cut or two in a few seconds.

Or insert the tube before the operation, and put a sponge in the pharynx. The patient may then be etherized through the tube. I have had occasion to resort to these expedients.

In artificial respiration, act with the patient, and not against him. He will not cease to breathe at once, and wholly. Enjoin silence; watch the first attempt at inspiration, and at the expiration compress the thorax, aiding its elastic reaction, if absolutely necessary, by Silvester's, or other quiet method. See that the tongue is well forward.

Do not cool the patient by exposure and wet surroundings.

Being first assured that he can swallow a teaspoonful of water, feed him, if you like, with stimulus, during the expiration, but not the inspiration.

Give to all painful surgery, without exception, the benefit of anæsthesia; but a patient unequivocally exhausted by long disease, of the bladder, or of a joint, for example, or who is an habitual inebriate, may require care, without which protracted narcotism may gradually depress his pulse beyond the rallying point. On the other hand, a healthy laborer, who reaches the hospital some hours after a railroad accident, cold, and literally pulseless at the wrist from hemorrhage and exposure, is, as a rule, stimulated by the ether, during and after at least one amputation.

Notwithstanding every expedient, there is occasionally an untoward subject who is habitually tetanic and livid whenever etherized; or, more rarely, one whose respiration is notably intermittent before he becomes insensible. The latter requires attention. In children, it may be added, anæsthesia is cumulative.

Such are some of the minor considerations and prompt precautions which collectively determine the question of life or death in the exceptional emergencies of anæsthesia by ether. Many of them apply with equal force to chloroform; but against the shock of chloroform and its sequences, whether "chloroformic syncope," "cerebral anæmia," or "cerebral congestion," precaution avails nothing.

## A SUGGESTED PHYSIOLOGY OF ANÆSTHESIA.[1]

In the present state of anæsthetic science it seems probable that consciousness and sensibility are connected with the readiness with which the necessary oxygen is yielded by the blood to the cerebral tissue, and is in some proportion to it. It is evident that this supply of oxygen will be diminished either by its absence from the blood, or by an obstacle to its transfer to the tissues. The question seems to be of the relation of inebriation to asphyxia, and of the influence exercised by each of these conditions upon the oxygenizing process. In mere asphyxia there is no oxygen supplied to the blood. In mere inebriation certain experiments make it probable that the transfer is impeded. If this be true, the surface might be colored by oxygenized blood corpuscles, while the brain tissue would be really asphyxiated by the non-transfer of their oxygen.

In practical anæsthesia it is difficult to say how much insensibility is due to a want of oxygen in the blood, and how much to its non-transfer from the blood to the brain, assuming that to be the machinery of inebriation. There is little doubt that inebriation benumbs the sensibility of the brain to asphyxia, or, in other words, that drunkenness renders a patient comparatively indifferent to suffocation. A nice question is, how far an increased amount of oxygen in the air tubes will compensate for a loss of transfer power in the blood. Upon this point it may be stated that a very little oxygen added to nitrous oxide materially interferes with its

[1] Now first published.

anæsthetic power, which is in fact largely dependent upon asphyxia. On the other hand, ether inebriates in spite of enough air to arterialize the blood. It would seem that anæsthesia is better when it depends upon an impeded transfer process of the oxygen than it does when the oxygen is withheld from the air tubes; or, in other words, that it is better to allow the oxygen to reach the blood corpuscles, if we can stop it there, by the inebriating or by any other influence, than to cut it off from the air tubes.

# A HISTORY OF THE DISCOVERY OF MODERN ANÆSTHESIA.[1]

Dr. Henry J. Bigelow, *Professor of Surgery in Harvard University.*

Dear Sir, — I am preparing a report on the progress of practical medicine in this country for the past century. In such an essay a notice of America's greatest contribution to medicine, modern anæsthesia, is indispensable. If you have the time and are willing to prepare a history of its discovery, with which you are so familiar, you will not only confer a favor upon all interested in it, but will put on record an authentic account of the discovery by one who was an eyewitness and actor in its early scenes, and to whose statements, on account of their disinterestedness, great value is attached.

Very truly yours,

Edward H. Clarke.

My dear Sir: — A quarter of a century ago, your simple proposition would have reawakened a discussion which had already exhausted the subject. Even so long ago as 1848 I thought it discreet to preface a paper upon the abstract question of discovery, as decided by historical precedent, with the disavowal of an intention to "dig up the well-worn hatchet of the ether controversy." But I see no objection to a review now — final, so far as I am concerned — of the occurrences you refer to, especially if I offer no opinion without its reason.

The singular persistence of the controversy was due to a variety of causes. People differ in their views about what

[1] A Century of American Medicine, 1776–1876. Philadelphia, 1876.

constitutes a discovery or a discoverer. A voluminous mass of sworn testimony availed little in those days, for want of some machinery to reach and fix a decision based upon it.[1] One of the contestants, at least, felt this, and vainly urged a court of justice. Preponderating opinions and evidence were laboriously and repeatedly brought to the surface by Congressional committees, and by other bodies and committees of those most familiar with the circumstances; but, for the lack of a tribunal accustomed to estimate the weight and quality of scientific evidence, not to say evidence of fact, no absolute decision was reached. The result was, that every new discussion began and ended like the preceding, and to as little purpose.

When the discovery was announced (October, 1846), the circumstances were few and recent, and the details of its progress were known. But when history was obscured, when another State, and even another nation, had set up each its own discoverer, and readers were perplexed with volumes of new reports and new testimony, it became less easy to sift the evidence. Claims till then distinct overlaid one another. Each alleged inventor, with his partisans, aimed to secure the whole honor. Opinions were pronounced by people who knew little of the facts. Attempts were even made, in more than one instance, to forestall or manufacture public opinion, by procuring in promiscuous medical assemblies and legislatures sudden votes designating some discoverer by name, with a view to influence the erection of statues. In a scientific view such votes are not worth the paper which records them; but it cannot be doubted that in a free country every citizen has the inherent right, of which the late Lord Timothy Dexter so liberally availed himself, to erect in his front yard a statue with an inscription.

[1] See Congressional Debates for the Sessions of 1853 and 1854.

The claimants to the discovery are three, — Dr. Wells, Dr. Jackson, and Dr. Morton. In discussing their claims, we cannot overlook the fact that the discovery was equally possible to either of them, or indeed to any moderately ingenious person whose attention should have been directed to the subject. This greatest single step forward in the history of medicine, like the division of the Roman printing block, was a very small advance in strictly scientific knowledge. Facts of insensibility to pain, produced both by gas and ether, were already known to the world. Art needed only an extension of their application; and so far as art or science was involved, either Wells, Jackson, or Morton was competent to the work.

This simple statement comprehends certain points of vital importance. The first essential requisite of modern anæsthesia is, that it shall be always attainable, and, when attained, complete. A second requisite is, that the insensibility shall be safe. The discovery embraced the threefold and essential novelties, that it is, under proper guidance, *complete*, *inevitable*, *safe*, and not, like all previous stupefaction, partial, occasional, or dangerous. If only partial or occasional, or if dangerous, neither the patient, the dentist, nor the surgeon would consider it of value. Even so late as a year after the discovery, many surgeons, and, extraordinary as it may now appear, some hospitals, absolutely declined to use the new means of producing insensibility, on the ground that it was attended with danger.

Readers of the present day may not remember how surprisingly far previous knowledge of anæsthesia had extended. Although there has been a want of discernment in attempts to point out precisely what the new advance upon previous knowledge was, one great difficulty has been, that this advance was so small, in a strictly scientific view, that it was not easy to measure it. This difficulty was enhanced by the magnitude of the spoil, whether in mere honor, or, as beyond all question it should have been, in emolument.

A rapid review of the history of early anæsthesia will bring us to the period with which we are especially concerned.

In the anæsthetic state, the action upon the brain may be a primary one, as by its compression, or by hypnotism; or secondary, as by narcotic and inebriating agents absorbed into the blood, from the lungs, the digestive tube, the skin, or other tissues. A few extracts, abridged from the familiar literature of the subject, will show that surgical anæsthesia in these various forms has been long known, and longer sought.

The use of poppy, henbane, mandragora, hemp, etc., to deaden the pain of execution and of surgery, may be traced to a remote antiquity. Herodotus ascribes to the Scythians the use of a vapor of hempseed to produce drunkenness by inhalation. In China, Hoa-tho, in the year 220, administered hashish (*Mayo*) and performed wholly painless amputations; the patient recovering after a number of days. Hashish, described by Herodotus twenty-three centuries ago, is the active agent of the modern *Bhang* of India.

Pliny, who perished A. D. 79, says of mandragora: "It is drunk before cuttings and puncturings, lest they should be felt." Dioscorides gives an elaborate method of preparing mandragora to produce anæsthesia (*ποιεῖν ἀναισθησίαν*) in those who are to be cut or cauterized, — "or sawed," adds Dodoneus, — and who in consequence "do not feel pain." Half an ounce, with wine, says Apuleius, a century later, enables a patient to sleep during amputation "without sensation." "Eruca" was used by criminals about to undergo the lash. "Memphitis," a "stone," so "paralyzed parts to be cut or cauterized that they felt no pain."

Theodoric, about the year 1298, gives elaborate directions how to prepare a *spongia somnifera*, by boiling it dry in numerous strong narcotics, and afterwards moistening it for inhalation before operations. In 1832, M. Dauriol, near Toulouse, cites five cases of insensibility during surgical operations induced by him with the aid of a similar "sponge." It is said that persons unpacking opium have fallen suddenly.

In 1532, Canappe described the inhaling sponge of Theodoric, and at the same time warned surgeons against giving opium (*à boire*), which "sometimes kills." But in later years, and until ether was introduced, it was the rule to give opium before operations.

September 3, 1828, M. Girardin read to the Academy of Medicine a letter addressed to his Majesty, Charles X., describing surgical anæsthesia by means of inhaled gases.

Richerand suggests drunkenness in reducing dislocations. Patients while dead drunk have been operated upon painlessly, and a dislocated hip was thus reduced after a bottle of port wine. Haller, Deneux, and Blandin report like painless results in surgical and obstetric experience.

Baron Larrey, after the battle of Eylau, found in the wounded who suffered amputations a remarkable insensibility, owing to the intense cold. Of late years congelation has become a recognized agent of local anæsthesia.

Hypnotism is a very remarkable cerebral condition, by which surgery has been rendered painless. It is the grain of truth upon which the fallacies of Mesmerism, animal magnetism, and the rank imposture of so called spiritualism have been based.

The experiments of the Grotto del Cane are familiar, as also are recoveries from accidental asphyxia after complete insensibility.

About a year ago, two healthy men, at my request, inhaled atmospheric air from a common gas bag. As carbonic acid replaced the oxygen, they both became livid, and, to every external sign, utterly insensible. One was really insensible; the other nearly so, but, being a plethoric subject, it was deemed prudent in his case not to press the inhalation further.

Nitrous oxide after a time asphyxiates, owing to the chemical combination of its gases, — on that account parting reluctantly with its oxygen. But it also exhilarates, and its anæsthesia is probably something more than a condition of asphyxia.

These facts show that from time immemorial the world has been in possession of an anæsthesia which was occasionally resorted to, and not unfrequently amounted to complete insensibility. But, as a rule, the following propositions held good in respect to it: —

It could not be relied on to affect everybody.

It was often insufficient.

It was sometimes dangerous.

What surgeons and patients needed was an inevitable, complete, and safe condition of insensibility; and this they were soon to have.

The moment arrived. In three months from October, 1846, ether anæsthesia had spread all over the civilized world. No single announcement ever created so great and general an excitement in so short a time. Surgeons, sufferers, scientific men, everybody, united in simultaneous demonstrations of heartfelt mutual congratulation.

It is to be regretted that no single individual stood out clearly, at this time, to receive the homage and gratitude of the world.

Nothing like the new anæsthesia had been known before. Whatever has been devised since has been a mere imitation and repetition of this, — I may almost say, with no single substantial advantage over it. Our English friends, with a pardonable pride in matters of scientific discovery, not unfrequently formulate their convictions thus: "A. had indeed shown this, and B. that; but it was reserved for our own C. to make the imperishable discovery." It is probable that the average Englishman still believes that modern anæsthesia is identified with chloroform. But the discovery of a practicable, safe, and efficient means of insensibility had been made a year before chloroform was thought of, and nothing important has been added to it since. Chloroform is at a first inhalation of an agreeable odor, more portable and less inflammable than ether, qualities which eminently adapt it to army use; but it will do nothing that ether does not do as well, and is sometimes, though very rarely, it is true, followed by fatal consequences.

We are now to examine the claims of the three individuals mentioned to the discovery of the new anæsthesia. Let us look first at those of Dr. Wells. And as preliminary to the examination of his claim, let us here revert to an interesting point in this history. It is impossible to read the annexed statement, familiar though it be, without renewed amazement that this great blessing to animal existence was distinctly offered to scientific men, and as distinctly neglected by them for half a century.

The following are the words of Sir Humphry Davy, at the beginning of the present century; half the century had nearly elapsed before they were again thought of: —

"In one instance, when I had headache from indigestion, it was immediately removed by the effects of a large dose of gas" (nitrous oxide), . . . "though it afterwards returned, but with much less violence. In a second instance, a slighter degree of headache was wholly removed by two doses of gas.

"*The power of the immediate operation of the gas in removing intense physical pain I had a very good opportunity of ascertaining.*

"In cutting one of the unlucky teeth called *dentes sapientiæ*, I experienced an extensive inflammation of the gum, accompanied with great pain, which equally destroyed the power of repose and of consistent action. On the day when the inflammation was most troublesome, I breathed *three large doses* of nitrous oxide. The pain always diminished after the first three or four inspirations; the thrilling came on as usual, and uneasiness was for a few minutes swallowed up in pleasure. As the former state of mind, however, returned, the state of organ returned with it; and I once imagined that the pain was more severe after the experiment than before."

Toward the conclusion of his book he adds: —

"*As nitrous oxide, in its extensive operations, appears capable of destroying physical pain, it may probably be used with advantage during surgical operations in which no great effusion of blood takes place.*"

The great discovery was here clearly pointed out to every tyro in medicine and chemistry. There were three experiments, of a completely original character, and with a new agent, in a direction to which contemporaneous attention was not, as afterwards, leaning. Upon these an original hypothesis was methodically constructed and distinctly enunciated in print. It only remained for somebody to test this hypothesis, this guess, and to convert the guess into a certainty. But neither dentist nor surgeon responded, and the world for nearly fifty years attended exhibitions where people danced, laughed, and became unconscious, while hospital patients were undergoing amputation, alive to all its agony.

In 1844 Horace Wells appeared, exactly repeating the hypothesis that Davy had printed. Whether he got this idea from Davy, or from his friend Cooley, or from his own brain, is not to the purpose. Davy had announced it, and the scientific world knew it. Did Horace Wells convert into a certainty the probability of Davy? He did not. He signally failed to do so, and, mortified by his failure, he gave up all attempts in that direction. More than two years elapsed, and the ether discovery was made and completed. Then, and then only, was Wells stimulated to renewed effort. But it was too late; the discovery of a surgical anæsthetic had been made.

These facts deserve a careful examination. Wells had experimented in about "fifteen cases," and with varying success. This he states distinctly in his first reclamation, before his claim had expanded so as to embrace, as it afterwards did, the whole anæsthetic discovery.

He was "so much elated with the discovery," (to use his own words,) "that he started immediately for Boston," and obtained from Dr. Warren permission—as Dr. Morton, imitating Wells, subsequently did with ether—to exhibit the anæsthetic properties of gas before the medical class. Dr. Warren was the principal New England surgeon of that day, and it was the obvious thing to do. This experiment, which was in tooth-pulling, proved an utter failure, and was called, as Wells says, "a humbug affair." Completely discouraged, he went home, told his friends that the gas "would not operate as he had hoped," and wholly ceased to experiment, from the date of his failure in Boston, in December, 1844, until the spring of 1847, after he returned from Paris, an interval of more than two years. Wells's want of success can now be satisfactorily explained. He had, through Colton, in following Davy's instructions, made use of the traditional exhilarating gas bag, and of Davy's exhilarating dose. This volume of gas is inadequate to produce anæsthesia with any certainty; and Wells failed to suggest a larger dose. This small omission closed his chances. He narrowly missed a great invention. Inventors by thousands have missed inventions as narrowly.

Modern dental insensibility by nitrous oxide is unfailing, because the volume employed is much larger. It is also usual to exhale it into the atmosphere. Horace Wells had no hand in this method, of which the first demonstration was in a breast excision performed by myself at the Massachusetts General Hospital, in April, 1848, by means of about sixty gallons of gas, as a substitute for ether.

From all this it will be seen that Wells did not, as has been claimed for him, "discover that the inhalation of a gaseous substance would *always* render the body insensible to pain during surgical operations," but only that it would *occasionally* do so; and until long after the ether discovery, his experiments were not "surgical operations," but only tooth-pulling. Wells's anæsthesia had no value to patient, dentist, or surgeon. In endeavoring to trace dental anæsthesia, as Davy had directed, from toothache to tooth-pulling, his experiments unfortunately and erroneously showed that what availed in Davy's hands for toothache would not always avail for tooth-pulling. His slight, but fatal, error of using an inadequate volume of gas damaged the knowledge of his day; so that a scientific person who had read Davy's encouraging and unqualified prediction, based upon his three successful experiments, would have been discouraged and thrown off the track by witnessing Horace Wells's contradictory results.

Wells returned from Boston to Hartford. Having hoped much from anæsthesia as a money speculation, he now left it for more promising enterprises. He got up a panorama or exhibition of natural history at the City Hotel in Hartford; initiated an extensive business in the sale of patent shower-baths; and somewhat largely invested in cheap copies of Louvre pictures painted in Paris, to be framed and sold by auction in this country. This carried him to Paris about December, 1846; an important event in his career, as we shall presently see.

Before he went, however, the ether discovery was made, (October, 1846,) and he received from Morton the following letter: —

BOSTON, October 19, 1846.

"FRIEND WELLS: Dear Sir, — I write to inform you that I have discovered a preparation, by inhaling which a person is thrown into sound sleep. The time required to produce sleep is only a few moments, and the time in which persons remain asleep can be regulated at pleasure. Whilst in this state the severest surgical or dental operations may be performed, the patient not experiencing the slightest pain. I have perfected it, and am now about sending out agents to dispose of the right to use it. I will dispose of a right to an individual to use it in his own practice alone, or for a town, county, or State. My object in writing to you is to know if you would like to visit New York, and the other cities, and dispose of rights upon shares. I have used the compound in more than one hundred and sixty cases in extracting teeth, and I have been invited to administer to patients in the Massachusetts General Hospital, and have succeeded in every case.

"The Professors, Warren and Hayward, have given me written certificates to this effect. I have administered it at the Hospital in the presence of the students and physicians, the room for operations being as full as possible. For further particulars I will refer you to extracts from the daily journals of this city, which I forward to you.

Respectfully yours,

WM. T. G. MORTON."

To this Wells returned the following remarkable and conclusive reply: —

"DR. MORTON: Dear Sir, — Your letter, dated yesterday, is just received, and I hasten to answer it, for fear you will adopt a method in disposing of your rights which will defeat your object. Before you make any arrangements whatever, I wish to see you. I think I will be in Boston the first of next week, probably Monday night. *If the operation of administering the gas is not attended with too much trouble, and will produce the effect you state, it will undoubtedly be a fortune to you, provided it is rightly managed.*

Yours in haste,

H. WELLS."

Wells would not have thought that Morton's "operation" of "administering" his so called "gas" (meaning ether) would prove "a fortune" to him, if his own results of two years before had, in the opinion of himself or anybody else, any considerable anæsthetic value.

The rest is briefly told. Wells soon after sailed for Europe, to prosecute the picture business already mentioned. The distinguished American dentist, Brewster, resident in Paris, hearing of his brother dentist Wells, sent to him, "begging him to call on him," and asked him, "Are you the true man?" "His answers, his manners," writes Brewster, "convinced me that he was." "Dr. Wells's visit to Europe," writes Brewster again, "had no connection with his discovery, and it was only after I had seen the letters of Drs. Ellsworth and Marcy that I prevailed upon him to present his claim to the Academy of Sciences, the Academy of Medicine, and to the Parisian Medical Society." The quarrel of Jackson and Morton was Wells's opportunity, and Brewster's persuasion thus secured for him a European hearing.

Thoroughly uneasy, Wells returned home (March, 1847). The world was everywhere ringing with ether announcements. From this period his claim rapidly expanded, until it embraced the whole discovery, unsettled his business relations, embittered his life, unhinged his reason, and he at last died in New York very suddenly, after extraordinary acts which led even to his arrest, but for which he could not be considered responsible.

Thus perished Wells, volatile, ingenious, enterprising; an experimenter, like scores of others, in the field of anæsthesia, but, like them, unsuccessful in establishing anything of value. So far as his labors went, he left scientific knowledge, as well as its application to art, just about where Davy had left it half a century before. But he had kept the subject alive, and had unintentionally planted a seed in the mind of his ambitious partner which yielded fruit.

We now come to the claims of Dr. Jackson and Dr. Morton; and these, for convenience, we will consider together.

It is significant that Wells, Jackson, and Morton were all in contact at some period of their anæsthetic experiences, of which they shared in some degree a common knowledge. Wells, while in Boston, visited Jackson's laboratory; and Jackson says that he knew of Wells's experiments; and it should be observed that his advice to Channing and Peabody was after Wells's visit. Morton had been Wells's partner in dentistry, and boarded at Jackson's house. In 1844 he had been a student of Jackson, who testifies in a certificate that he was a "skilful operator in dentistry," and had "studied the chemical properties of the ingredients required for the manufacture of artificial teeth."

Gas and ether were long familiarly known to produce effects so similar that whoever thought of one as an exhilarator or anæsthetic must have thought of the other. For example, while in college, in 1837, I twice made a gasometer of nitrous oxide, and then substituted for it ether, as affording equal exhilaration. Brewster, in 1847, said, "It required neither a physician nor a surgeon to tell . . . that ether would produce insensibility, . . . as there is scarcely a school or community in our country where the boys and girls have not inhaled ether to produce gayety, and many are the known cases where they became insensible." In short, gas and ether experiences were very similar. Wells had been, at the outset, distinctly advised to try ether, but elected gas as less dangerous. If, when afterwards "disheartened by the failure" of his gas experiment in Boston, he remembered ether, he doubtless thought it would be hardly worth his while to recur to an agent so similar in its effects.

In September, 1846, Jackson and Morton had their well known interview. At this interview Jackson made a suggestion, which was soon followed by a discovery, and by a controversy concerning the value of this suggestion. Jackson claimed that the suggestion was the whole discovery. Morton took the extreme opposite ground in behalf of his experiments. These he alone had conducted, and, while Jackson beyond all question kept aloof, he, recognizing their generally conceded danger, had gone on with them, notwithstanding, and proved what was before only suspected.

The interview was briefly this; and as it is the only point at which Jackson touches the progressive line of Morton's investigation, it should be stated strongly for Jackson. On the 30th of September, 1846, Dr. Morton went to the laboratory of Dr. Jackson, whom he knew well, having been a student under him, and recently in his house, and took from a closet an India-rubber gas bag. In reply to an inquiry of that gentleman, he said, in substance, (and all that Jackson claims Morton to have said may be admitted,) "that he meant to fill the bag with air, and by its aid extract the teeth of a refractory patient." [1] A conversation ensued upon the effects of the imagination, and among other things of nitrous oxide, in producing insensibility. Jackson treated Morton's proposition lightly. He told him to go to an apothecary and procure sulphuric ether — the stronger, the better — which would produce the insensibility he desired. The ether was to be spattered on a handkerchief and inhaled; in a moment or two perfect insensibility would be produced. "Sulphuric ether," said Morton, "what is that? Is it gas? Show it to me." Jackson showed him some ether, and after further conversation Morton went to pro-

[1] Let it be observed here, that, if the patient was intelligent enough to obey instructions, and Morton meant to administer air, the patient would have become insensible by asphyxia. (See *ante*, pages 138, 139.)

cure it. Such was the substance of the interview at which Morton professed ignorance of ether, and Jackson entire knowledge of it. Jackson's knowledge and Morton's alleged ignorance we may now consider.

Dr. Jackson, if we may judge from his later attitude, was not indifferent to renown; nor was he regardless of the suffering of other people. He claims to have discovered, in 1842, that ether insensibility was infallible, thorough, and safe, and yet he cared so little for his reputation that he did not publish his discovery; and he forgot his humanity so far, that he allowed patients the world over to encounter the agonies of amputation during four years more. This extraordinary circumstance cannot strengthen belief in the fact of the discovery at this early date.

In a long communication to Humboldt, in 1851, and in certain other communications to learned foreign societies and individuals, Jackson lays great stress upon the elaborate mental process which enabled him to construct, in 1842, an hypothesis of insensibility, based upon the distinct functions of nerves of motion and sensation, superficial and deep sensibility, etc. But the more studied and complete this hypothesis, and the more circumstantial the evidence of its careful elaboration, the more remarkable is it that it was laid on the shelf for four years. Without questioning the entire honesty of Dr. Jackson's convictions, it is safe to say that it is difficult to measure the original strength of any belief which has lain dormant for four years, especially if that belief has since proved to be a valuable truth. Dr. Jackson claims, indeed, to have mentioned his hypothesis to several persons during this interval; but this testimony, if carefully examined, relates chiefly to a narrative of his chlorine gas experiences. In fact, some of Dr. Jackson's immediate family had, during this same interval, in 1844, submitted to painful tooth extraction by Morton, and yet no anæsthesia was mentioned then. The hypothesis seems to have had for several years a precarious existence.

The only striking testimony is that of Peabody, a pupil, who was advised by Jackson to employ ether in having a tooth drawn, but who, after consulting his father, an accomplished amateur chemist, was deterred from doing so by the reputed danger, which Jackson's suggestion did not outweigh. But this advice was a year after Wells's experiments and failure in Boston, and his conversations at that time with Jackson. Whenever tooth-pulling was brought to Jackson's notice, how could he fail to think of Wells's experiments with gas? And who could think of gas as an inebriator, without its co-inebriator, ether? the obvious and only possible conclusion being, that what gas had done, ether might do, namely, sometimes succeed and sometimes fail. I have no doubt that this thought did occur to Jackson's mind when tooth-pulling happened to be talked of, especially after Wells's experiments.

It also occurred to Morton's mind. He knew more of Wells and of his varying experiments than Jackson did, and there is no question that Morton the dentist, oftener than Jackson the chemist, dwelt upon painless dentistry. His business was "mechanical dentistry," making sets of teeth; and he was daily suffering in purse because patients feared to have their teeth drawn. "I will have some way yet," said Morton to Gould, in August or September, 1846, a short time before the discovery, "by which I will perform my operations without pain." "I smiled," says Dr. Gould, "and told him, if he could effect that, he would do more than human wisdom had yet done, or than I expected it would ever do."

Who that remembers the late Dr. Gould, cautious, accurate, truthful, judicial, the friend and brother scientist of Dr. Jackson, will doubt this sworn testimony? It was Dr.

Gould who, when his wife told him of rumors that Dr. Morton had drawn a tooth without pain, under the influence of something inhaled, exclaimed, "Yes, that can be done, ether will do it," — so obvious was the transition from gas inebriation to ether inebriation, from gas insensibility to ether insensibility, in the mind of one who happened to have his attention drawn to the subject of anæsthesia by inhalation.

Morton knew of gas, and of Wells. He was in eager pursuit of anæsthesia. He believed in it. If he knew also of ether, he was, in all human probability, on the verge of discovery. Did he know of ether?

It is fortunately established beyond all question that Morton made long inquiries about ether in July, and also a short time before the October experiments. If we reject the evidence of Wightman and Metcalf on this point, both of them disinterested, accurate, reliable, we must reject all human testimony.

Wightman, the philosophical instrument maker, afterwards Mayor of Boston, narrates a conversation with Morton in the cars, when moving his family from his country residence to Boston. During this conversation he informed Mrs. Wightman, who asked him who Dr. Morton was, "that he was a dentist who was experimenting upon the relief of pain in dental operations." Wightman fixes the date of this journey, September 28th, by items of expense charged in his daybook, of which the leaf was produced, as part of his sworn testimony. This enables him to fix the time of several previous conversations with Morton, concerning Mesmerism, the effects of the imagination, etc., and especially of one as to whether rubber or oiled silk bags would hold "common ether."

Metcalf, the well known apothecary, a scrupulously conscientious witness, equally substantiates the date of a conversation half an hour long about ether with Morton, who held in his hand a bottle of it which he had brought with him. In this conversation, "entirely about the inhaling of ether," interspersed with anecdotes of exhilaration and insensibility, Metcalf told Morton of "a person to whom he had given it, who was exceedingly wild, and who injured his head while under the influence of it, and did not know when he got over the influence of the ether that he had hurt himself, until it was called to his attention." "Morton," Metcalf testifies, "when he went away, knew as much about it as I did, for I gave him all the information which I had." Metcalf sailed for Europe in July, 1846, just after this conversation. While in Italy, in the early part of 1847, he took up a newspaper announcing the discovery, by a Boston dentist, of insensibility through ether inhalation. "I said at once," testifies Metcalf, "that I was sure Morton must be the man, for he was engaged upon ether before I left home; and that I now knew why he had been so curious, and at the same time shy, in his conversation with me." To those who know Mr. Metcalf this evidence has all the weight of personal experience.

There can be no question that Morton knew about ether. How much he knew about it is less important. But it should be mentioned that he claims to have made repeated experiments with it upon animals in the summer of 1846.

Morton's explanation of his professed ignorance of sulphuric ether was this. During the summer, while boarding at Dr. Jackson's, he had heard frequent and protracted expositions of Jackson's claim to the invention of the electric telegraph, then recent, and the important features of which Jackson was satisfied he had communicated to Morse during an ocean passage. Dr. Jackson had, indeed, a well stored and suggestive mind, which made it more than likely that he had furnished information of which Morse, while originating and mentally evolving a system of electric telegraphy, may have been glad to avail himself. A sharp public discussion, with pamphlets, ended with a verdict in Morse's favor. In going to Jackson, Morton feared that, if there were any deliberate conference, Jackson might set up a similar claim of participation in his own search for painless dentistry, and therefore took the shortest way to exhaust his knowledge for his own benefit, without discussion. There can be little doubt that Morton was in this matter reticent, as Metcalf states, and intended to keep it a secret from his brother dentists. I am also inclined to believe that Morton at first cared little about the abstract question of discovery, and would have willingly left a large share of any honor unquestioned in the hands of Jackson. But when Jackson made a claim upon the patent, and the profits beyond the amount to which Morton conceived him to be entitled, then he defined his own claim to the discovery. It may be stated in this connection, that the surgeons of the Massachusetts General Hospital, who had no interest whatever in this difference, and could have none, were friends of Jackson, and strangers to Morton. They yielded, when it became necessary to take sides, only to their deliberate conviction of the justice of Morton's claim.

It will be advantageous, at this point, to take a general view of the "Ether Controversy." For this purpose, I find I can do no better than to quote the following letter, written when the occurrences were fresh, to the Hon. Robert C. Winthrop, in Washington: —

January 26, 1848.

DEAR SIR, — I believe most fully that Dr. Morton deserves any reward Congress may grant to the discoverer; because, although many people have *thought* that a man could be intoxicated beyond the reach of pain, Dr. Morton alone *proved* this *previous possibility* to be *a certainty*, and *safe*. A tabular form will make the matter plainer than words: —

| | | |
|---|---|---|
| Before October, 1846, who made the suggestion? Here is the only ground of dispute. | Discovery in October, 1846. Consecutive experiments by Morton. | After October, 1846, *Morton alone* took the responsibility of danger, and proved that it was,<br>1st. *Certain.*<br>2d. *Safe.* |

The last two points, namely, the consecutive experiments, and their confirmation, which nobody denies to Morton, make him, in my eyes, the discoverer. The only doubt is as to who made the suggestion. To me this is of no importance. Dr. Jackson says: "I did. I told Mr. Morton to try the experiment, and unless I had so told him he would never have tried it." Dr. Jackson adds: "I first tried ether when I was suffering from chlorine, in 1842. I afterwards recommended it to Mr. Peabody." But Dr. Morton confutes even these positions. He says to Dr. Jackson: "I show, by the evidence of Dr. Gould, Mr. Wightman, and Mr. Metcalf, that I was experimenting with ether before the interview in which you claim to have brought it to my notice. In 1842 you only re-discovered what was before clearly in print in Pereira's Materia Medica. You claim that you told Mr. Peabody what you *knew* of ether. Now you could not *know* it. You have stated all your grounds of deduction, and the widest inference you could draw from them is a suspicion of the properties of ether; and a suspicion in science, an unconfirmed theory, amounts to nothing. Finally, what you claim to have discovered in 1842 you kept to yourself during four years. Do you expect the world to believe you knew its value? Do you expect it to reward you for letting people suffer during that length of time? Besides, the suggestion of anæsthetic agencies occurred to Davy; especially was it followed out, though unsuccessfully, by Horace Wells, who, disgusted with failure, abandoned his attempts." These and others had hypotheses as well as Dr. Jackson. Morton alone proved the hypothesis. Without Morton there is no evidence that the world would have known ether to the present day. I believe this covers the ground of important argument and difference in the pamphlets. . . .

Respectfully your obedient servant,

HENRY J. BIGELOW.

At the interview referred to, Jackson's partisans tenaciously insist that he assumed direction, as a physician might have done, of the administration of a remedy; while Morton acted only as a "nurse." Let us examine, then, the often-quoted "nurse" argument with which the opponents of Morton have endeavored to handicap him at the outset. Here is its fallacy. A physician, by common understanding, possesses a positive knowledge of the effect of his remedies in advance of their administration. Such knowledge was impossible to Jackson. Again, a physician is employed expressly to direct, and a nurse to obey. Under these circumstances a nurse is not likely to get much credit for originality, which is in fact absolutely excluded by the terms of her contract. There was no such contract here. Morton was not a mere agent, without preconceived plan, automatic in action, and irresponsible as to results. On the contrary, he was already conducting an independent investigation. He was in pursuit of anæsthesia when he went to the laboratory of Jackson, with whom the subject, even admitting his claim, had slumbered for years. He had been before, and in the same way, to books, apothecaries, instrument makers, — in short, to various usual and available sources of knowledge,— as is customary with every investigator or discoverer. The purpose, the investigation, the patient, the discretion, the responsibility, were all his. Morton was not a "nurse."

Morton had a combination of qualities such as few other men in the community possessed. Fertile in expedients and singularly prompt in execution, he was earnest and persevering beyond conception. His determined persistence is remembered even at this interval of time, as having been a terror to his best friends. Nobody denies that Morton, recklessly and alone, faced the then supposed danger attending ether stupor. If all accredited scientific opinion had not been at fault, and in the case of any fatal result, he would have infallibly been convicted of manslaughter, with little probability that anybody would have come forward to say, "The responsibility is not his, but mine."

In fact, Dr. Jackson endeavored at this time, by word and deed, to keep both himself and his reputation clear of Morton, as a reckless and dangerous experimenter. The only operations under ether witnessed by him during the first three months were on November 21, 1846, and January 2, 1847; and a part of this time he was absent from the State.

"But," it has been a hundred times said, "Jackson made a suggestion, and Morton used it." It is evident that we cannot escape some discussion of the relation of "suggestion" to "discovery," no matter how little the suggestion may be intrinsically worth, or how fortuitous its success. The simple question is, What was the actual value of Jackson's suggestion to Morton at the time it was made? I distinctly mean before Morton had handled it.

A suggestion in science varies in value as much as a suggestion in common life, where advice is not always sound advice. It may indeed turn out fortunately, like a suggestion, for example, to wager money on the ace of spades. But because it may prove so, the advice does not necessarily imply merit in the adviser. This is an extreme case. At the other extreme is a mathematical certainty, such, for example, as that twice two make four, a truth the value of which is not afterwards augmented for intelligent people by a material test or demonstration that twice two apples make four apples. A similar example of mathematical certainty is that calculated by Leverrier, (liable only to the instrumental fallibility of dividers, telescopes, and equations,) which did not become more absolute, nor more true, when Galle saw the planet where Leverrier told him it must be. Mathematics is unerring, while predictions in physiology are as uncertain as predictions about the weather a week hence.

Yet it has been argued that Jackson was Leverrier, and that Morton was Galle.

Jackson's alleged hypothesis, before Morton took hold of it, had only the value of a lottery ticket, which, through Morton's unaided, dangerous, and acknowledged efforts, drew an immense prize; or of "the cast of a die," — "for in that light," says Watt, whose name is identified with the history of steam, and the soundness of whose practical views no one will dispute, "I look upon every project that has not received the sanction of repeated success." A statement of the grounds upon which this view is based will enable others to draw their own conclusions. Let us begin with Jackson's experiments.

"Having, in 1841–42," says Jackson, "got my lungs full of chlorine gas, which nearly suffocated me, I immediately had ether and ammonia brought to me, and alternately inhaled them, with great relief." The next day, still suffering, and "perceiving a distinct flavor of chlorine in my breath," the experiment was repeated "with perfectly pure washed sulphuric ether," and "with entire loss of feeling." "All pain ceased." He "fell into a dreamy state, and became unconscious of all surrounding things."

In other words, he inhaled ether, until, seated as he was "in a rocking-chair, with his feet in another chair," he fell asleep. So far there was nothing new. Pereira,[1] for example, says: —

> "The vapor of ether is inhaled in spasmodic asthma, chronic catarrh, and dyspnœa, whooping-cough, and *to relieve the effects caused by the accidental inhalation of chlorine gas. . . .* When *the vapor of ether, sufficiently diluted with atmospheric air,* is inhaled, it causes irritation about the epiglottis, a sensation of fulness in the head, and a succession of effects *analogous to those caused by the protoxide of nitrogen* (vide p. 156), *and persons*

[1] Elements of Materia Medica, etc., London, 1839, pp. 210, 211.

*peculiarly susceptible to the action of the one are also powerfully affected by the other.* (Journal of Science, vol. iv. p. 158.) *If the air be too strongly impregnated with ether, stupefaction ensues.*"

Such was contemporaneous knowledge. Jackson's experience was identical with that recorded by Pereira. And Pereira further distinctly calls attention to the similar effects of inhaled gas and inhaled ether, and to the stupefaction caused by ether.

Pereira adds, in regard to the danger of this condition: —

"In one case this state continued, with occasional periods of intermission, for more than thirty hours; for many days the pulse was so much lowered that considerable fears were entertained for the safety of the patient. In another case, an apoplectic condition, which continued for some hours, was produced."

I shall revert to this subject of danger.

But Dr. Jackson alleges that he now advanced a step further, and logically inferred the entire safety and inevitable certainty of ether anæsthesia in all cases, and during the severest surgery. This was an unwarrantably wide inference, as we shall see.

Further still, Dr. Jackson claims to have invented a method upon which the truth of his hypothesis largely, as he supposed, depended; and he offers this method as evidence that he made the hypothesis and the discovery. It is plain that a discovery may be in this way rendered more probable. Whoever is in possession of a new method is more likely to find the way to a new truth. But if the alleged method proves to be partly erroneous and partly an old and familiar matter, then the proof of alleged discovery is no stronger because of it. In fact, just so far as the hypothesis was apparently stronger by reason of the method, it becomes weaker when the method falls to pieces. Let us, then, examine this alleged method.

Dr. Jackson has from the first insisted upon two points as peculiar to his invention and essential to his discovery. By these safety and certainty are secured, and a neglect of them explains previous uncertainty and danger. They are purity of the ether, and an admixture with it of atmospheric air.

If these conditions are either not essential or not new, we find ourselves, at least so far as method is concerned, where Pereira left us.

From time immemorial, the familiar way of inhaling ether has been with air from a handkerchief. Pereira, as before quoted, distinctly stipulates for air. Says another writer, "Animals breathe oxygen. Without oxygen a man must die. Ether would not have saved Desdemona." This needs no ghost for its enunciation. But the fact is, in etherizing by a sponge or cloth, the difficulty is as often to exclude air enough as to admit air enough. Some good authorities maintain that there is advantage in its exclusion, — that the insensibility from gas, for instance, is due to asphyxia. Even in etherizing, they aim to take advantage of this condition by restricting the air supply. The French ether bag, still in use, is expressly arranged for this purpose. In short, while it requires especial effort to exclude air, partial asphyxia is not dangerous; and a claim to the discovery of the safety or certainty of ether stupor based upon the admission of air cannot stand.

A claim based upon pure ether is equally void. Tolerably pure ether is better, but by no means essential, for safe insensibility. The specific gravity of pure ether is not very far from 0.718, but this is very difficult to obtain; that of our usual inhaling ether of Powers and Weightman is 0.724, and that of Squibb (*fortior*) about the same. That of the ether of the old Pharmacopœia, and of the shops in the year 1840, was not far from 0.750; and this is a very practicable anæsthetic. Its slight adulteration with alcohol and acid is not especially deleterious when inhaled. In fact, anæsthesia resembles dead drunkenness, which is equally possible with brandy, or with brandy and water. The real danger was not from impure ether, but from over-inebriation, — a danger which exists to-day with the best ether.

The discovery was not in the admission of air, nor in the use of a particular quality of ether. It was, that the inhalation of ether, which had been familiarly resorted to for years, could be prolonged beyond the usual stage of exhilaration to a stage of stupor, possessing the *complete* insensibility of a dangerous coma, yet, unlike that condition, *safe*; and that all this could be effected *in every case*.

The history of ether anæsthesia was the gradual discovery of the following facts: —

That ether inhaled produced, capriciously, in certain instances, unconsciousness. (Old.)

That it possessed the power of producing stupor in every case. (New.)

That this stupor could be exactly graduated as to time. (New.)

That it could be increased or diminished, and arrested short of danger, and so made safe. (New.)

That there were certain infallible indications of danger. (New.)

That, while thus controllable and safe, it could be made at will so profound that even amputations should not be felt. (New.)

All that is new belongs to Morton.

A person inhaling ether from his handkerchief would drop it when his hand and senses were benumbed. As air entered the lungs he would revive. Such was Jackson's self-experiment, already covered by Pereira. But a second person, who should now seize the handkerchief and compel the continued inhalation to the stage of stupor, might obviously make a valuable study of this new ground. He could draw his patient's tooth, or amputate his leg, and thus measure the insensibility. He could repeat the experiment until satisfied that insensibility could be always attained, and that it was safe. All these experiments Morton tried upon others, and when he had tried them the discovery was made.

Jackson virtually claims that his inference extended to the *universal efficacy*, the *completeness*, and the *safety* of the stupor.

Of the universal efficacy of the new stupor Jackson could have no valuable opinion. Such knowledge was possible only through observation of many cases, with an experience which could say: "Administer ether as for exhilaration. Protract its inhalation beyond this usual stage, and you will inevitably reach an ulterior condition of stupefaction. During this process a patient may struggle with a giant's force; or perhaps will tell you of his extreme distress; or after five or ten minutes of inhalation will satisfy medical bystanders, as patients sometimes do now, that he is not amenable to ether. Another will assure you, with apparent reason, that he is dying; or, livid with asphyxia, will compress his lips and cease to breathe; or may, for a long time, alternate between lividity with a failing pulse, and arterialization with a partial return of consciousness.[1] But through all these apparently alarming indications urge the process discreetly, and you will ultimately and inevitably reach a stage of stupefaction."

Dr. Jackson could not say all this, because he knew noth-

[1] Such patients are familiarly known to our hospital attendants as "bad etherizers." Some of them are inebriates. If they return for a second operation, they seldom fail to exhibit the same symptoms as before.

ing of it; nor did anybody else, until Morton established the fact that there was no exception to the potency of ether. These and other contingencies, once startling, still occur with the best ether, and the experience of a quarter of a century. Had Morton been a timid or a discreet man, anæsthesia might have been delayed beyond the present generation. Morton compelled inhalation in spite of indications to arrest it, incurred the responsibility of doing so, and is entitled to the credit.

The completeness of the insensibility — its adequacy, for example, in amputations — was settled only by repeated observation, with varying results but gradually accumulating evidence: from the tooth first painlessly extracted, through several failures to comparative success in dentistry; then the removal of a venous tumor of the jaw, where the patient was doubtfully insensible; then a fatty tumor of the arm, with complete insensibility; and finally, after an inconsiderable operation or two, the amputation of a leg, practically successful. Everybody awaited this final test by amputation, and then only was the accumulated evidence deemed conclusive. It was, indeed, beginning to be felt that the process was a safe one, and that it promised satisfactory results; otherwise the hospital surgeons would not have permitted this test of it in a patient weakened by disease. But this experiment, like the rest, so far as anæsthesia was concerned, was Morton's, and a part of his well organized enterprise to investigate and establish the new insensibility. As this amputation has been repeatedly published as mine, it should be stated that it was performed by the late Dr. Hayward. That anæsthesia was employed at all on that occasion Alice Mohan has to thank me; although, if anæsthesia had not been employed in this particular instance, the test of amputation would have been delayed only till another should occur. The circumstances may illustrate the sort of obstacles Morton encountered. The looked for opportunity had arrived; but, through various antagonistic influences, Morton, in spite of his earnest request, had been notified that ether would not be administered, and that he need not attend the operation. Of this he informed me the night before, and by arrangement with him I carried him to the hospital the next day, just before the operation, there to await events. A dose of laudanum had been administered, and Alice Mohan was carried to the amphitheatre, for operation without ether. I there strongly urged the employment of the yet ostensibly secret agent; partly on the ground that it then was really known, but especially from the consideration that humanity ought to supersede any doubts connected with professional etiquette. This and other considerations prevailed, and, after a delay of half an hour, Morton, whose presence had been till then unknown except by me, was brought up, and the patient was etherized.

The evidence of all this slowly accumulating anæsthetic surgery, at which Dr. Jackson was not present, was claimed for him in virtue of the "nurse" argument. What light could a repetition of the chlorine experiment of Pereira throw upon the question whether a patient could sleep during an amputation?

Ether exhilaration was familiar; but, on the other hand, it was well understood that ether stupefaction was in certain cases dangerous. Physiologists had also found that the smaller animals very frequently died of it. Brodie wrote of the new discovery: "I have heard of this before, and had tried it on guinea-pigs, whom it first set asleep, and then killed. The great question is, Is it *safe?*" This was, indeed, the question. Could danger be avoided? what was its exact character? and what were its indications?

On the 2d of January, nearly three months after the discovery, Jackson came to the hospital for the first time.

To that date, he had been present at one operation only, that at the Bromfield House, November 21. He was not cognizant of current experiment, and brought voluntarily a bag of oxygen, which he urged upon the hospital surgeons as a necessary precaution against danger, erroneously supposed by him, at that late date, to be asphyxia, instead of over-inebriation, of which the essential indication is the pulse. It was some weeks after the discovery that this source of danger, and its sign, were understood; and in the mean time Morton might have killed anybody. A patient was, in fact, in great danger from over-inebriation at the first private operation. He was inhaling, in the continuous way that was at first supposed to be essential to protracted insensibility, through a glass globe of ether, and long after insensibility was manifested. The operation was far from completed, when a bystander happened to feel the pulse. There was no special reason for doubt, inasmuch as the patient was, in general appearance, like all former thoroughly etherized subjects. The pulse proved to be barely perceptible, and the patient to be etherized almost beyond recovery. The bystander, after repeated observation of other cases, published the fact, then first observed, that in ether anæsthesia the pulse stood as a beacon between safety and danger, between harmless inebriation and fatal narcotism. This was the discovery that ether was not dangerous; because this showed that its danger gives warning, and is under control. The operator was Dr. Dix, the bystander myself, and the discoverer Morton. To his impetuous, unremitting, reckless experimentation to establish anæsthesia, surgeon, bystander, patient, ether, and apparatus were all for the time, and in that relation, subordinated. Morton had asked me to be present, because I was more familiar with the new process than anybody except himself, and for the purpose of aiding him, in emergency, with professional advice. But the anæsthesia was his. I assumed no responsibility. Had the patient died in a "stupor," as he might well have done, Morton was liable; and as the patient did not die, his was the credit. This was real danger. But there was other danger, more startling, though only apparent; such as prostration, "trance," or "mania," lasting for hours, and for which Morton was in one instance threatened with prosecution. What was Dr. Jackson's responsibility? None whatever. He was then absent from the State. What had Pereira's chlorine experiment taught him about all this danger? Absolutely nothing; nor could it do so. And he could impart nothing.

In view of these facts, which leave Jackson standing upon the naked experiment of Pereira, we may fairly pause, and ask, What, in the fullest sense, were the exact significance and value of the suggestion made by Jackson to Morton?

Caleb Eddy says, in his sworn testimony: "I said to Dr. Jackson, 'Dr. Jackson, did you know, at such time, that, after a person had inhaled the ether and was asleep, his flesh could be cut with a knife without his experiencing any pain?' He replied, 'No, nor Morton either: he is a reckless man for using it as he has.'"

Waiving this testimony, it is clear that the whole of the peculiar knowledge embraced in the suggestion of Jackson to Morton would have been accurately and fully conveyed in the two words, "Try ether." This suggestion should be fully credited to Jackson. Morton never disputed the fact of the suggestion; on the contrary, he at once proceeded to square the account. Jackson at first distinctly agreed to receive five hundred dollars as full compensation for the assistance he had rendered. As the evidence grew, and the greatness of the discovery became more apparent, Jackson raised his demand to ten per cent on the sales of patent rights. Later, when it was clear that the lottery ticket had drawn an immense prize, Jackson again increased his demand to twenty-five per cent, which Morton refused. The controversy was then opened.

I very early urged the inexpediency of a patent, if only on the ground that, like Whitney's cotton gin, for example, this invention was so valuable that the world would combine, as the event has shown, to take possession of it; and that the question of equivalent might safely be left to public generosity, which has generally recognized such debts. Ether anæsthesia was at first opposed on the ground of its danger, of quackery, of religion, and of professional etiquette. Much of the early opposition to a patent[1] came from dentists, who desired to use the new method without pay; and they confused with it the question of humanity to suffering. But in those days dentists had secret methods to which they attached a money value, and which went far to justify both secrecy and patent. The question of secrecy should, however, be detached from that of equivalent. Dentists and physicians, lawyers and clergymen, dealers in food, heat, light, labor-saving methods, — in short, in comfort, knowledge, and value, — rightly exact a pecuniary equivalent proportioned to their services from those who can pay it without inconvenience. The more distinctly this is recognized, the better we shall understand the nature of real humanity, and the

[1] The first statement of the fact of operations under insensibility was a paper in the Boston Medical and Surgical Journal of November 18, 1846, entitled, "Insensibility during Surgical Operations, produced by Inhalation. Read before the Boston Society for Medical Improvement, November 9, 1846, an Abstract having been previously read before the American Academy of Arts and Sciences, November 3, 1846, by Henry Jacob Bigelow, M. D., one of the Surgeons of the Massachusetts General Hospital." A copy of this was sent by a gentleman to his friend, Dr. Boott, of London, and by him transmitted to several London surgeons. Their replies to Dr. Boott I have in my possession. This paper also announced the patent, and the connection with it of the names of Morton and Jackson.

more readily lend assistance and charity to those who need them. Jackson was right in expecting a money return for the service he had rendered. The only question here is how much he himself, at first, considered a fair equivalent for this service. This has been shown.

After it became evident that the patent was worthless, Jackson repudiated the division, and claimed the whole discovery, in virtue of the "nurse" argument. Under these circumstances Morton properly insisted that the "suggestion" could have been picked up from almost any source, by any man actively searching for painless dentistry, who knew anything about Wells's experiments with gas, and who also knew the familiar and similar action of gas and ether. Morton was right.

But Morton also urged that this was a discovery, not in science, but in art; that surgical anæsthesia was due, not to any great scientific novelty in the long recognized ether insensibility, but to his having worked out the application of this insensibility to use in art, with enterprise and perseverance, through many details, in the midst of danger, till he gave to the world a perfected system of efficient and safe anæsthesia. Morton was again right.

When a discovery is great, not from the intellect invested in it, but because it ameliorates the condition of mankind, then its recognition has more of a business character, and the gratitude and honor bestowed by the world are more nearly an equivalent for value received. The world does not concede the equivalent until it has received the value; and it is apt to examine with business exactness the claims of those who profess to have acted as agents in the matter.

This suspicion of discoverers who do not appear until after the world has been made to recognize the discovery is justified by the fact that hardly an invention of importance was ever made known that it was not at once claimed, often simultaneously, from a variety of sources. This is not remarkable. The world, whether in science or in art, is built up to a certain point by the easy and wide transmission of knowledge. Upon this elevation stand a multitude of philosophers, engaged often in identical researches, and possessed of much information upon the subject in question. Each of these may honestly believe that his imperfect knowledge is the perfected knowledge in question. In such a case the world is liable for a short time to confound claims, to confuse the incomplete result of a few data with the completed demonstration from many, the unproved with the indisputable, theory with fact. Recognize this fallacy and the question of invention is comparatively simple. Yet it is not recognized. There is at this day the same claim to priority in invention as existed half a century ago. The writer of a Life of Fulton then said: "Those who question Mr. Fulton's claim are precisely those who have been unsuccessful in their own attempts; and it would seem that exactly in proportion as their efforts were abortive, and as they had thrown away money in fruitless experiments, their claims rose in their own estimation and that of their partisans." The witness — I believe before the House of Commons — probably did not overstate the matter when he gave it as his opinion, that, if a man were to show that he had found a road to the moon, his neighbors would testify, that, if they had not been there themselves, they knew several persons who were familiar with the road in question. It is hardly too much to say, that, at the present day, every invention or discovery having a large supposed value is systematically contested.

Morton, in his attitude of investigator, had a right to receive a hint or suggestion of greater solidity than that of Jackson, without impairing his merit as inventor. Every invention is preceded by such hints or suggestions, derived from experiment, books, or people. Curtis (on Patents) says: "It is clear that many suggestions may have been made, or many hints taken from others, without invalidating the claim of a party to be considered as the author of the invention."

Of a hundred instances easily cited to illustrate this, let us confine ourselves to a medical one, that of the invention of vaccination to avert small-pox.

The young countrywoman of Sodbury said of small-pox, "I cannot take that disease, for I have had cow-pox." The Duchess of Cleveland, when Lady Mary Davis and other companions taunted her as likely to deplore the loss of that beauty which was her boast, as the small-pox was then raging in London, said that she had no fear about her beauty, for she had had a disorder which would prevent her from ever catching the small-pox. Were these discoverers? Surely, yes, if Dr. Jackson was one. In fact, the hint that they and others gave to Jenner in the vale of Gloucestershire, where he resided, embodied more knowledge of vaccination than Dr. Jackson's suggestions did of ether anæsthesia.[1] But neither the milkmaid nor the Duchess of Cleveland was ever honored as a discoverer of truth, or as an inventor of a method, while Jenner was so honored. The reason is obvious. They, like Dr. Jackson, asserted a doubtful fact, and had neither time nor inclination to pursue the subject; but Jenner, by multiplying instances of cow-pox inoculated like small-pox, and already supposed to be, like small-pox inoculation, protective, conclusively proved that it was thus protect-

[1] The experiences of the milkmaid and the Duchess might easily have apprised them of their own immunity from small-pox. But Jackson, through his chlorine experiments, could have no evidence that ether stupor was capable of affecting all persons, or that it gave immunity from real surgical pain, or was free from danger. No self-experiment could touch these points.

ive, and also safe. He did with cow-pox what Morton did with ether.

The parallel in this case is very close. Jenner and Morton were in pursuit of what the scientific world regarded as a chimera. Because they believed in its possibility they encountered prejudice and opposition. They both received from others a hint, suggestion, or surmise, which afterwards proved to be capable of development into a truth of great value. This suggestion was based on narrow induction, and had therefore obtained no previous general credence. It had also slumbered for years at that stage of its development. The world had not believed it.

Jenner and Morton, both men of singular persistence and perseverance, took hold of a suggestion, of which, from the nature of their daily pursuits, they felt the immense value. But for them it might have slumbered indefinitely. They dragged it through till the world recognized it and them. This they did at the risk of injuring people's health, of killing them, and of being held responsible for so doing. Nobody has ever doubted that Jenner was the inventor of vaccination, and nobody should doubt that Morton was the inventor of modern anæsthesia. Here the parallel ceases. The English people voted Jenner a reward of $150,000.[1]

[1] In decisions relating to discovery, unanimity is not to be expected. There can be none where partisanship and large interests are involved. The question then is, where the weight of evidence lies. Even Jenner, with no rival, encountered great hostility both to himself and to his discovery. The House of Commons (June 2, 1802) voted him ten thousand pounds by a vote of 59 to 56, a majority of three only. A further sum of twenty thousand pounds was voted (June 29, 1807) by a vote of 60 to 47, a majority of thirteen. Morton's award of $100,000 for his patent passed the Congressional Committee. It was arrested, not wholly by Jackson, but by the partisans of Horace Wells, who published what afterwards filled an octavo volume, containing little argument, but full of bitter invective against Morton, and who promised, if only delay were granted them, to make a conclusive case for Wells.

The world demands convincing demonstration, — and not by an individual for himself or to himself, but to the public and for the public, with overwhelming clearness. Then, and not till then, it responds with acknowledgment, concession, or gratitude.

Sydney Smith, in the Edinburgh Review, insists on this. In fact, he wittily overstates the claim of the mere publisher of a novelty, when he says that "he is not the inventor who first *says* the thing, but he who says it so long, loud, and clear, that he compels mankind to hear him." [1]

[1] It is easy to understand what is here meant. For instance, I have amputated more legs after applying a tight bandage from foot to hip before tightening the tourniquet, than in any other way. Similarly to the arm, for a needle in the hand. A hundred surgeons have done the same thing. Sir Charles Bell went a step further, and announced the dry method in print. "I may here observe," he says, "that by the management of the tourniquet, blood may be lost or gained. If the limb be uniformly rolled before amputation, the veins are emptied into the general system and blood is saved instead of being withdrawn. In a very exhausted state of the patient, it may be of service to attend to this." (Great Operations of Surgery, London, 1821, p. 58.) But Esmarch was so impressed with its importance, that he erected it into a system, and urged it upon the attention of every surgeon in the civilized world. To many the idea was new. In fact, to a considerable part of the surgical world Esmarch was the discoverer of an important truth. He deserves to be avowed as such, in requital of his pains to perfect, and to publish to the surgical world, a useful point, new to many of them. He is so recognized.

Antiseptic precautions in surgery are not new; but Lister published his views, as did Esmarch. Whether germs are essential to the theory or not, there can be little doubt that it is well to free a wound from coagula, and to wash it out with diluted carbolic acid or its equivalent. Then the subsequent free use of the antiseptic, by hindering decomposition without, tends to maintain vitality within the wound. These views have been enforced and brought home to the world by Lister, with the pertinacity of a Jenner or of a Morton. The world at large owes its attention to these points to Lister's announcements, and properly attaches his name to the antiseptic method.

Mere publicity is notoriety; but with merit it is fame; with originality it is discovery. To all these publicity is essential. He who keeps his

Thus put, however, the statement throws light on Jackson's prominence after the discovery. An unproved hypothesis in physiology, which was his whole claim, would usually be considered of little account. But Jackson knew the machinery of fame. As Wells by accident, so Jackson by his scientific relations, and through his friend and former teacher, Élie de Beaumont, got at once possession of the scientific rostrum of the French Academy of Sciences and other foreign learned societies. He also subsequently addressed Humboldt. He thus compelled the European world, even so far as Turkey, to listen to his exclusive statement that the whole was his. In the mean time, however, there was in Boston a scientific jury of the vicinage. When Morton's statement at last crossed the water, the French Academy did what it could at that late day, and awarded to Morton the same honor and recognition it conferred upon Jackson. It could do no less. It could then do no more. But had the case been at the outset reversed, and had Morton made a suggestion to Jackson, does anybody doubt that the humbler Morton, and his suggestion, would have been by scientific precedent wholly absorbed and assimilated ?

All honor, then, to the inventor of the art of anæsthesia ! — for there was little science in it. He found the practice of ether inhalation an amusement of chemical lecture rooms and schools ; he left it the sovereign anodyne of the human race in its moments and hours of agony. He found ether stupor as hazardously uncertain as was the narcotism produced by

discovery comparatively to himself discovers, or uncovers, nothing. If he admits that he has done so, the world will scrutinize and suspect his claim.

The act of publication, indeed, adds little to the claim of Morton ; his impregnable position being that he elaborated and perfected a new art. But facts like the above go far to show that the failure of Jackson for four years to publish his alleged guess, of itself extinguishes any claim to its recognition during that time.

pouring down the opium *à boire* of Canappe; he left it as manageable and safe as the sleep that follows a dose of laudanum.

There is hardly an inhabitant of the civilized world but can remember some one of those nearest to him in whose experience the anguish of the knife or of disease, of birth or of death, has been assuaged by anæsthesia, perhaps converted into a pleasant dream. Yet he is willing to take this priceless boon as a gratuity from those whose sole patrimony it was, and who have been brought nigh to want that he might enjoy it. If the world should cancel a fraction of its debt, the family of the inventor could afford to be generous to the families of his former friends, who, without impairing his title to the discovery, contributed to his success.

Wells's sad story has been told. Morton fell with apoplexy, induced by a publication in behalf of Jackson, of a nature to prejudice a subscription then arranged in New York for his benefit. Jackson, it is to be feared, is at the present time hopelessly bereft of reason.

HENRY J. BIGELOW.

# ADDRESSES

## AND OTHER PAPERS.

## FRAGMENTS OF MEDICAL SCIENCE AND ART.[1]

In looking back upon the brief period that has elapsed since I had the honor to be an immediate member of your society, I am reminded of a number of general inquiries for the investigation of which time and opportunity did not always serve. I have thought that, in occupying your attention this evening with the consideration of some of the more prominent of these, I might here and there do something to level the path you are all soon to follow. I have added to these glances at science a few remarks bearing upon our art. I am aware that individual views are liable to be tinged by the fancy, or distorted by the immediate atmosphere of the observer; but I believe they may contain something common to the convictions of all. I offer no further introduction to the following remarks upon Medical Science and Art.

The inductive method is grounded on the knowledge furnished by the senses. It teaches that the senses supply to us our only true conceptions of external objects, and that real science consists in the progressive generalization of these conceptions. This position is now obvious and undisputed. But there was a time when a different belief was prevalent. It was once thought beneath the dignity of man to deal with the physical conditions of nature; and, partly because philosophers looked inward on themselves to gain ideas of intel-

[1] An Address delivered before the Boylston Medical Society of Harvard University. Boston, 1846.

lectual phenomena, it was supposed that a knowledge of the material universe might also be derived from some source within the mind. Philosophers, impatient of the slow progress of discovery, sought to stride at once to their conclusions. It is now difficult to believe that for a period of nearly two thousand years, ending with the time of Bacon, the learned world was engrossed with error growing out of these false notions. The philosophy of Aristotle, for example, based upon apparent celestial phenomena, taught in astronomy that the stars revolved in solid orbs around the earth; and in physiology, that *sensible species* or immaterial shapes came off from bodies, and, passing along the nerves, were physically stamped upon the brain; and during this long period these empty theories and wordy nothings were received as truth by the philosophers of Europe and the sages of Arabia and Persia. Until the close of the sixteenth century the philosophy of Aristotle still continued in the schools, and men talked of *intention* and *remission*, of *formality* and *individuality;* mere abstract ideas, having no prototypes in nature, the fictions of a tortured intellect, "the idols of the human mind, and not the ideas of the Divine mind."[1]

In explaining this protracted prevalence of error, it should be remembered that truth is difficult of access. It does not require patient investigation and laborious thought to frame a false system of philosophy, to deduce an ingenious theory from a few facts; but truth unveils herself to constancy alone, to persevering love, of which few are capable. Nor is it the cause of error to which man, once enlisted, clings with such tenacity; he clings to his own cause, his own philosophy, with the determination of a chief or the zeal of an adherent; pride animates and prejudice arms him; it is the cause of human passion. It is not then wonderful that there

[1] Novum Organum, Book I. Aph. 23.

are so few minds able to divest themselves of human weakness, to acknowledge error and abandon cherished fallacy, to love truth for its own sake, and to find in its discovery a source of elevated happiness. Bacon

> "Led forth the true philosophy, there long
> Held in the magic chain of words and forms."

The Novum Organum was published towards the end of the sixteenth century, its name being suggested by the Organon of Aristotle. It taught that science was "a knowledge of the world as God made it, and not as man made it"; that nature, to be known, should be studied in its works; that to obtain a knowledge of a stone, an animal, or a star, the philosopher should examine the objects themselves; that he should not shut his eyes and his ears in a vain attempt to divine their occult qualities. More than this, it taught that "the true but unattempted way" of discovering truth "constructs its axioms from the senses and particulars, by ascending continually and gradually, till it finally arrives at the most general axioms,"[1] "by intermediate steps";[2] "that we must add lead or ballast to the understanding to prevent its jumping or flying."[3] These were no startling positions; yet for two thousand years were men occupied with profitless speculation upon notions of the material world, drawn by some single hasty effort from the misty recesses of their own imaginations.

The inductive method also teaches that, if truth lies in facts, we have only to collect facts to discover it. But Bacon knew how ready the mind is to pursue some false light into the morass of error; "to start off to generalities that it may avoid labor";[4] that such "anticipations will be assented to readily, because, being deduced from few

[1] Novum Organum, Book I. Aph. 19.
[2] Ibid., Aph. 126.
[3] Ibid., Aph. 104.
[4] Ibid., Aph. 20.

instances, they immediately hit the understanding."[1] He says, that the pursuit even of truth in minute details confounds and distracts the understanding, which, "undirected and unassisted, is unequal to and unfit for the task of vanquishing the obscurity of things."[2] To insure accuracy, therefore, facts are to be written down and subsequently counted. In Bacon's own words, "We must form tables and co-ordinations of instances, upon such a plan and in such order that the understanding may be enabled to act upon them."[3] All this is now obvious and undoubted. False theory is not the error of our day, nor of our scientific community. But while in medicine the value of facts is recognized, possibly overrated, their application is a fertile source of error.

Open any medical journal of the last week, or of last year, and you shall find an account of some new, successful remedy; and yet another year shall obliterate this record, and substitute new methods equally infallible. There is error either in the facts or in the induction. Here is Bacon's quaint exposition of this fallacy: "It was well answered by him who was shown in a temple the votive tablets suspended by such as had escaped the peril of shipwreck, and was pressed as to whether he would then recognize the power of the gods, by an inquiry, 'But where are the portraits of those who have perished in spite of their vows?'"[4] We listen to partial or imperfect evidence. Impressed with an idea, we accept only the facts whose tendency confirms our notion. In the words of Bacon, "It is the peculiar and perpetual error of the human understanding to be more moved and excited by affirmatives than negatives, whereas it ought duly and regularly to be impartial; nay, in establishing a true axiom" (or law), "the negative instance is the most

[1] Novum Organum, Book I. Aph. 28.
[2] Ibid., Aph. 21.
[3] Ibid., Book II. Aph. 10.
[4] Ibid., Book I. Aph. 46.

powerful."[1] These natural tendencies of the mind, then, show the necessity of insuring accuracy by writing; "the understanding being as incapable of acting on such materials of itself, with the aid of memory alone, as any person would be of retaining and achieving by memory the computation of an almanac." "Yet meditation," says Bacon, and with almost equal truth might it have come from Louis, "has hitherto done more for discovery than writing, and no experiments have been committed to paper."[2]

In its most general sense, induction is not only applicable; it is essential to the discovery of all law in nature. The student admits this, and yet at some time or other most of us have felt a certain undefined doubt whether the inductive method was adapted to the wants of medical science. A recent able and elaborate work on medical philosophy tells us that "physiology is not deducible from anatomy; that the knowledge of pathological phenomena does not flow from the knowledge of physiological phenomena."[3] In other words, that all we know, in each of the medical sciences, is the direct result of observation in that science; that there is no inference, no action of the mind upon the observation. And yet you shall elsewhere learn that it is the duty of great laws in science to predict results of new combinations. Such a law, to use Bacon's expression, "points out new particulars," a property he alludes to when he says, "Our road is not along a plain, but rises and falls, ascending to axioms and descending to effects";[4] in other words, rising to general laws from comparatively few data, and descending to new facts which these laws indicate.

There are certainly anatomical facts which point to facts in physiology, just as the discovery of the venous valves,

[1] Novum Organum, Book I. Aph. 45. [2] Ibid., Aph. 101.

[3] Bartlett, Philosophy of Medical Science, p. 99.

[4] Novum Organum, Book I. Aph. 103.

made by Sylvius and completed by Fabricius, foretold to Harvey their function in the animal economy. Here was undoubtedly an inference upon the existence of these valvular pouches; and a similar process of inference has led to the discovery of other facts in each of the medical sciences. How far then is the method of Bacon, which is generally supposed to admit of no speculative action of the mind, applicable to our science? and what is the analogy between the laws of our science and those of other sciences, — between a law, for example, of Louis, that tuberculous deposit exists in the lungs, if anywhere, and the laws of optics, which measure the velocity of the ray of light, as it travels many thousand miles while the eye winks, and tell us that the retina receives from every violet ray 727,000,000,000,000 of undulations in a second? What is the relation between the statement that Peyer's patches are diseased in typhoid fever, — a law absolute and immutable, but telling us of nothing new in the future, true only of itself, narrow in its tendencies, and individual in its relations, — between such a law and one which penetrates the mysteries of the future, which unerringly predicts the event of the conflict of unappreciable atoms, or speaks of the earth and stars, and assigns them their position in space through all future time?

A great discoverer is commonly a great genius. And yet the student has a vague suspicion that the observer with his note-book is a dull man; that the process of induction does not require ability; that statistic results, apart from observation, are the work of laborious and slow minds, — of industry which plods, of intellect which never sparkles.

These are some of the unsettled positions and indistinct impressions I would attempt to define, in clear outline, if possible without fatiguing your attention with unnecessary generalities.

And first, How much of medical science is drawn from facts by the process of induction, and how far are we able to anticipate this process, and to foretell certain facts by means of others? To predict in science the results of new combinations, we must be in possession not only of former results, but of the machinery which has produced them.[1] A common loom and a piece of cotton cloth being supplied us, we can foretell that linen or woollen thread will be woven by the same loom into a similar fabric. So, when the mass of a heavenly body is given, with the mechanical attraction of gravitation and the forces previously acting upon it, we can foretell its position at any future time. The rule which refracts the ray of light being given, we can calculate the results of any future combination of lenses. In the same way, if the tendencies of polar force, which exhibits opposite properties in opposite positions, are our data, we predict the effect of many untried combinations of magnetic or electric currents. But place a sheet of paper in the hands of a man ignorant of the process of paper making, and he cannot foretell what materials are capable of being made to assume this density; nor before the properties of gravity or of refraction were known could the philosopher predict anything of their effects. We can prophesy only after we understand the machinery which is at work. Now the only forces in the material world of which we possess this sort of knowledge are three, known as mechanical, chemical, and, in a more limited degree, polar force; the first of course including, among other sciences, hydrodynamics, optics, and acoustics. In ascertaining, therefore, how far these three forms of force are exerted in the animal economy, unmodified by any other, we shall determine how far the medical sciences are capable of predicting one of another.

In anatomy, the valves of the veins and the structure of

[1] See Appendix A.

the joints point directly to their uses; and if final cause in medical science be synonymous with function, it is their mechanical final cause which leads us from Anatomy to Physiology. Again, explain to an engineer the system of the circulation, and ask him what will be the tendency of obstruction of the aortic valves, he will show you that there must be "backwater," — a reflux of the fluids into the channels which deliver it into the left ventricle. And in fact there is this reflux of blood upon the lungs, producing local congestion, with its symptoms, in many cases of chronic cardiac disease. The optician tells you that the crystalline lens throws an inverted image upon the retina. A medical tyro will infer that opacity of the lens will obliterate this image; or that perforation of the thorax will be followed by collapse of the lungs. Here physiology points by the aid of mechanical force to pathology.

Again, no man carries in his head the whole extent of auscultatory detail without the acoustic principles which show why these phenomena take place. Induration obscures percussion, and, other things equal, conducts sound. Pathology thus directs us to truths of semeiology, still by our knowledge of mechanical force. And in a symptom well known as acidity of the stomach, pathology by the aid of chemical force points to the appropriate therapeutic agent. Surgery abounds in extemporary mechanical remedies to which pathology directs it. It is obvious that these sciences are not independent one of another; and for this reason, it can hardly be said that "our knowledge of pathological phenomena does not *flow from* the knowledge of physiological phenomena." On the contrary, facts in one of these sciences are frequently suggestive of facts in another; they lead to *hypotheses*, which I shall attempt soon to show bear no unimportant part in scientific progress. We are not compelled in the cause of medical science to divest ourselves of all experience that has not come to us in medical form. Our previously acquired knowledge of acoustics or hydraulics will in some degree serve us when their principles are involved in medical science.

Still the facts to which we are thus pointed are not decisive, because they are liable to be modified by another mechanism of which we know nothing. There are *vital* forces at work which counteract the most obvious tendencies of the material particles of the human fabric. What prevents the arteries from being dyed red, or the body from falling to the ground, or in short the whole mass from decomposing? It is vital force, whose power to hinder the most obvious effects of other force must, till we comprehend its nature, render all prediction in vital science fallible.

There are but few sciences in which we have detected the machinery which is the immediate cause of their phenomena; and although, in the words of Bacon, "It is rightly laid down that true knowledge is that which is deduced from causes,"[1] many sciences like ours are made up merely of aggregated facts, without reference to the manner of their production. Laws of phenomena are the sum and expression of knowledge already acquired; they open no new region of knowledge. Why do we know that lymph is and will be common on the tonsils and in the air tubes? Because we have observed it. But what does this tell us of the intestinal canal, or other mucous surfaces, where it is comparatively rare? It tells us nothing; we know only what we have known. Our knowledge is limited by the fact; and with blind reliance we trust in nature's constancy, and in the accurate adjustment of its vast machinery. Far different is the science which studies the detail of the great machine, which understands its complex movements and detects its variations, which wrests from resisting nature

[1] Novum Organum, Book II. Aph. 2.

its great secret, and foretells, ages beforehand, the workings of its universal laws.

Yet have these laws of phenomena a great and undisputed value. The facts, in the words of Kepler, "are collected into one fagot," though no scrutiny has enabled us to penetrate their substance. Laws of phenomena detect and assert the similarity of facts, they point out their common element, and draw from each a thread by which they are suspended from a common centre. In time these threads are twisted into cords, which in their turn are woven into some great fabric. They distinctly state a proposition which is to be subsequently proved or disproved, and supply a series of equations from which the value of the common $x$ is finally deduced. In the instance, for example, of polarity, a force now in process of discovery, we thus trace the connection of the ray of the setting sun as it was reflected from the windows of the Luxembourg with the phenomena of crystallization, chemical affinity, magnetism, and electricity. Wild and straggling facts of unknown growth are here laid side by side. They are brought into the domain of science, and the wedge is at last entered which lays them open and reveals their hidden entity.

The chief employment of the medical philosopher is to establish these laws of phenomena, — to ascertain the frequency with which certain facts occur with other facts, — to point out the element most constant in a wide range of phenomena, — the very ends which the inductive method of Bacon, and the numerical method of Louis, its medical application, teach us to attain with certainty. Medical diagnosis and medical prognosis obviously grow out of rigid induction.

But let us note an important distinction in the present application of this return to diagnosis and to therapeutics. If we err in our principles of diagnosis, it is of comparatively little consequence.

If we choose to consider sore throat a necessary effect of the cause which produces the other symptoms of scarlet fever, or the eruptions essential to the exanthemata, when they are really only incidental to them, science alone suffers. The inductive method offers us the surest results we can obtain, even though these are uncertain. But if we err in therapeutics, it is not science alone, it is the patient that suffers. Suppose it is conclusively shown that, when a hundred patients are bled in a certain disease, fifty-five always recover, and that when these hundred patients are not bled, only fifty get well. And suppose we bleed our hundred patients, we shall be very likely to kill somebody who, otherwise treated, would have proved a useful member of society. Science gains her five per cent, but humanity loses a man or a woman or a child. Such treatment may do for armies, where one man is as good as another, but does not answer for individuals, by nature prone to overestimate their personal consideration.

The fact is, the diseases we compare, and the similarity of which we affirm, are very dissimilar. Every case of disease varies in its character from every other case of the same disease. It varies in its intensity, its complications, and its tendencies. It varies with the constitution of the patient, and with external influences. It varies in the rapidity of its march, and in the duration of each symptom. The same treatment therefore affects single cases very differently. But it is a singular principle in nature that differences tend to neutralize each other in the long run; that while individuals deviate, like the asteroids in their revolutions, equally above and below a fixed line, the tendency of the mass is to an average always constant. This principle equalizes the number of births and deaths, of male and female children; it makes the annual proportion of dead letters to other letters always the same in the English post office; and in exactly regulating the laws of mortality, it guarantees success to life insurance companies founded on proper computations. But it does not tell us the sex of the child, nor the length of any man's life, nor the chance any given letter has of being called for. Men vary above or below a certain healthy standard. If in some disease this standard is too high, it must be lowered, but in this process some one whose scale of mortality was already low will be submerged; yet we cannot tell who this individual will be until we know what constitutes vital force. No rule in therapeutics applies indiscriminately to any other than a theoretically fixed standard of disease. If we can arrive at such an ideal standard only by averaging the mass, the rule is applicable only to this mass; and so long as the practice of medicine is for the benefit of individuals, such a principle will be of limited utility to the physician. To give fair play to this equalizing tendency, induction should be based upon a broad range of facts. Narrow induction is the bane of medical science, and the physician who infers that nature will gain its equilibrium in three or five successive facts, and argues from them, might with equal wisdom, in a game of chance, bet upon *rouge*, because it has won but twice, while *noir* has gained three times.

But let no one argue for these reasons the inadequacy of the inductive method. It is ignorance alone that hinders us from availing ourselves of it. If medicine were an exact science, it would be not only applicable but necessary to therapeutics; and as science advances, and we approach nearer and nearer this stage of medical knowledge, induction becomes more and more indispensable. And even now the self-adjusting tendency of nature furnishes us truth in its relation to the mass. The inductive method is of undisputed value in determining, for example, whether a supposed remedy has or has not a value. More than this, it tells us very nearly what this value is. If fifty patients in a hundred have recovered from a certain malady under the use of carbonate of iron, while fifty in a hundred have got well without it, I decide this remedy to be nearly inert in this disease. If the proportion of recoveries under the remedy much exceed this statement, I infer that the medicine possesses some efficacy; if the number of recoveries is much less, I am equally sure it is injurious. And I am right in all these suppositions. But there is another quality of the inductive method, and I am not aware that it has been observed, which requires that the results derived from it, at least in therapeutics, should be of unequivocal numerical force. The inductive method speaks of coincidence, and not of cause. The lesion of Peyer's glands is coincident with febrile symptoms in typhoid fever, and so also is sore throat in scarlet fever; but we have only probable evidence whether either of these conditions is a cause or an effect. Now this relation is essential in therapeutics. We require that a remedy should seem to be a cause of convalescence, and not merely a coincidence. If with Hildanus I anoint the axe that made the wound, and fifty-five instead of fifty per cent of wounded knights recover, does the additional five per cent make me believe in the efficacy of the *unguentum?* Can I believe in the therapeutic agency of dead man's touch, or

> "Slips of yew
> Slivered in the moon's eclipse,
> Nose of Turk and Tartar's lips."

Reason is against it, in spite of any possible and obviously accidental cajolery of the inductive method. In the connection of remedy and disease, we must see a probable, or at least not impossible, relation of cause and effect; and whence shall we derive this evidence? It must be supplied by the mind of the observer, and based either upon previous general or medical experience; or else upon the evidence of the immediate experiment, which must for this end be of overwhelming force. To be applicable even to the mass, the evidence should be of weight; and it has been shown that unless the evidence be conclusive, and hold good of all the individuals upon whom the experiment is tried, we have no right to apply to individuals that which is true only of the mass.

We can follow no indiscriminate rule in therapeutics. We can only pause and weigh the indications, and decide each case upon its own requirements. It was a common saying of the late Dr. Baillie, "Learn your profession well, and practise it on rules of common sense";[1] and it cannot be denied that in the therapeutics of the present day the physician must rely to a great extent on the resources of his judgment. And what is judgment? It is the faculty which God has given man to supply the place of certain knowledge. Because invading pneumonia must be bled, will you bleed the poor victim already lingering on the borders of the grave? Judgment is the act of common reason; it is a logical decision based upon the evidence of facts; and is this faculty impossible to you? Shall not your hundred cases of fever, analyzed, combined, weighed, sifted, in the wards of a hospital, be to you at least as the "experience" of a hundred cases scattered among the engrossing occupations of twenty years? Do not struggle with the crushing incubus, distracting you with its monotone, that judgment and experience come only with age. Is medical science the only one beyond the reach of active intellect? Is the mind to be depleted, and the vital force exhausted down to the comprehension of the vital science? But I am encroaching upon ground I intend to occupy toward the close of these remarks.

I have purposely omitted till now any reference to another form of induction, which involves the principle without

[1] Observations in Medicine, Marshall Hall, chap. ii.

involving the machinery of the inductive method. I mean the induction which goes on in the mind, which forms and shapes what is called *hypothesis*. And let not this name, suggestive of unsoundness and instability in science, startle the severer disciple of the statistic school. I shall attempt to show that hypothesis, in some form, is almost essential to the discovery of scientific truth. It is forced upon us in our examination of the lower and more obvious details; it is supplied by genius in the higher discoveries of science.

I am aware that this position is not recognized by many philosophers, especially in medical science of the present day. Bacon did not admit it. But the position of Bacon was peculiar, and in one respect resembled that of these medical philosophers. He knew that unfounded theory, gratuitous assertion, had been a stumblingblock to all preceding science; that it had mired men deep in error. Inventing a new method, which contradicted in so many points all former systems, — "founding a real model of the world in the understanding, such as it is found to be, not such as man's reason has distorted," [1] — anxious to convince men, in the cause of science, that groundless theory was error, — he attached to facts a too exclusive value. He taught that the only path to scientific truth was through the successive generalization of facts. "We must not imagine or invent," he says, "but discover the acts and properties of nature." [2] And in his anxiety to establish the one position, he undervalued the other.

And yet an expression now and then occurs, which seems to show that he was aware of the necessity of some suggestive principle of the mind. Thus he says, "After having constructed three tables of preparation, . . . we consider it useful to leave the understanding at liberty to exert itself, and attempt the interpretation of nature in the affirmative;

[1] Novum Organum, Book I. Aph. 124. [2] Ibid., Book II. Aph. 10.

. . . which attempt we are wont to call the liberty of the understanding."[1] And again: "The real order of experience begins by setting up a light, and then shows the road by it, commencing with a regulated and digested, not a misplaced and vague course of experiment; for not even the Divine will proceeded to operate on the general mass of things without due order."[2]

Newton, who came soon after, seems to have had the same instinctive dread of an hypothesis. "Hypotheses," he says, "whether metaphysical or physical, or occult causes, or mechanical, have no place in experimental philosophy."[3] But to Newton hypothesis was unproved or false hypothesis. In his own words, "Whatever is not deduced from the phenomena is to be termed hypothesis." Unless we thus interpret him, his practice is at variance with his assertions. What was the theory of gravitation, before it was demonstrated, but a great hypothesis? "The first thought, we are told, which gave rise to his Principia, he had when he retired from Cambridge, in 1666, on account of the plague. (He was then twenty-four years of age.) As he sat alone in a garden, he fell into a speculation on the power of gravity; that as this power was not found sensibly diminished at the remotest distance from the centre of the earth to which we can rise, neither at the tops of the loftiest buildings, nor even on the summits of the highest mountains, it appeared to him reasonable to conclude that this power must extend much farther than was usually thought. 'Why not as high as the moon?' said he to himself; 'and if so, her motion must be influenced by it, perhaps she is retained in her orbit thereby.'"[4] And the final calculations, which

[1] Novum Organum, Book II. Aph. 20. [2] Ibid., Book I. Aph. 82.

[3] Whewell, Philosophy of the Inductive Sciences, vol. ii. p. 438, and Scholium at end of the Principia.

[4] Whewell's History of the Inductive Sciences, vol. ii. p. 158.

proved that the force of gravity actually retained the moon in its place, were not made till 1682. What was this improved truth, during this long interval of sixteen years, but an hypothesis? We have positive evidence that many, if not all, great discoveries in science have been thus preconceived before they were demonstrated.

Copernicus says: "Then I too began to meditate concerning the motions of the earth; and though it appeared an absurd opinion, yet since I knew that in previous times others had been allowed the privilege of feigning what circles they chose, in order to explain the phenomena, I conceived that I also might take the liberty of trying whether, on the supposition of the earth's motion, it was possible to find better explanations than the ancient ones of the revolutions of the celestial orbs. Having then assumed the motions of the earth, which are hereafter explained, by laborious and long observation, I at length found"[1] in it a satisfactory explanation of the apparent motions of the planets.

What led Kepler to the discovery of the great laws which built the structure of astronomy up to the law of gravitation? It was a conviction of the existence of some appreciable and exact relations between the distances and times and forces of bodies which revolve about the sun. In his own words, "The motion of the earth, which Copernicus had proved by mathematical reasons, I wanted to prove by physical, or, if you prefer it, by metaphysical."[2] In 1619, he says: "What I predicted two and twenty years ago, as soon as I had discovered the five solids among the heavenly bodies; what I firmly believed before I had seen the harmonies of Ptolemy; what I promised my friends in the title of this book (On the most Perfect Harmony of the Celestial

[1] Whewell's History of the Inductive Sciences, vol. i. p. 369.

[2] Ibid., vol. i. p. 408.

Motions); what I knew before I was sure of my discovery; what sixteen years ago I published as a thing to be sought; that for which I joined Tycho Brahé; that for which I settled in Prague, and for which I have devoted the best part of my life to astronomical contemplations; — by the will of God who inspired me, and who excited in my mind an insatiable hunger, at length I have brought to light, and have recognized its truth beyond my most sanguine expectations." [1]

Davy did not plunge the wires of his battery into a promiscuous mass of inorganic compounds. His theory was that certain alkalies were compound substances, and he proved his theory in decomposing them. Jenner, while yet a student of medicine, founded his theory upon the assertion of the simple peasant girl, who incidentally remarked, when small-pox was mentioned in her presence, "I cannot take that disease, for I have had cow-pox." From that time the thought was ever in his mind; and when John Hunter said to him, in the words of encouragement, "Don't think, but try, be patient, be accurate," — he did try. Ten years afterward, he disclosed his now well grounded hopes to his friend Edward Gardiner, and in 1798, after an interval of twenty-eight years of labor, he published his pamphlet, and announced to the world his theory and its proof. [2]

It is useless to multiply instances. Every great discovery in science is preceded by a theory, a definite form of belief, a proposition, which facts afterward disprove or verify. Not only is this hypothesis constructed; but all lawful means are used to prove it true, and to reconcile discrepancies. In his investigations of the orbit of the planet Mars, Kepler labored thus to reconcile two theories. As he said of himself, "I considered and reflected till I was almost mad," —

[1] Kepler, Harmonices Mundi, p. 178.

[2] Baron's Life of Jenner, vol. i. chap. iv.

not perhaps without reason; for how intricate to the unastronomical is that confusion, which, resolved into well ordered truth, led Kepler to exclaim, "How ridiculous in me! as if libration in the diameter might not be a way to the ellipse!"[1] It reminds one of the German authoress, who exclaims in equal perplexity, "A thought has almost hammered my head in two; namely, that the future does not come towards us, does not lie before us, but streams from behind over our heads."

But facts are not to be perverted. Their use is to test, to prove or disprove, not to confirm theory. The error of former science, the error of recent medicine, was not that hypotheses were made, but that they were constructed to be proved; that truth was warped and misapplied; that facts were prostituted in the cause of ignorance and prejudice. Philosophers made a show of listening to the evidence of nature, while they aimed to prove a verdict, which was signed and sealed before the trial. Such, in our science, were the "inflammation" of Broussais, the febrile theory of Cullen, the stimulating system of Rasori, and many another theory, which first stated a proposition, and then collected facts to support and confirm, not to test it.

And is there any evidence that great discoverers have rejected their own elaborate hypotheses because they were false? When Newton first calculated the force of gravity upon the moon, he found that his results placed this body about two feet from its actual position at the end of every minute, and for this difference of two feet in the immensity of space he at once sacrificed his cherished theory. Years afterward, when it was mentioned at the Royal Society that Picart had proved a slight error in the estimated length of a degree of latitude, Newton was present. "He went home,

[1] Kepler, Astronomia Nova. Plurium amnorum pertinaci studio elaborata Pragæ, 1609, p. 285.

took out his old papers, and resumed his calculations. As they drew to a close, he was so much agitated that he was obliged to desire a friend to finish them. His former conjecture was now found to agree with the phenomena with the utmost precision."[1] His hopes were at last confirmed, and his hypothesis became a truth.

An inextinguishable love of truth led Kepler again and again to remodel his hypotheses, when they failed to satisfy the results of observation. In his own figurative words: "While I thus triumph over the motions of Mars, and prepare for him, as for one conquered, the prisons of the tables, and fetters of equations, it is rumored here and there that victory is of no avail, and that war has broken out in full force. For the enemy, left at home as a despised captive, has broken all the bonds of the equations, and the prisons of the tables. The fugitive would have leagued with his rebels, and driven me to desperation, had I not, when the veterans were routed and dispersed, at once sent into the field new forces of physical reasonings; and, having diligently learned where the captive had concealed himself, put myself without delay upon his track."[2]

Thus did he elaborate no less than six hypotheses upon the motions of the planet Mars, each rejected after tedious calculation, before he hit upon the assumption which accorded with the observations. Such were the attempts which led to Kepler's laws, — the great discovery of the age, — repeated suppositions made, to be compared with facts, and at once abandoned when their fallacy was shown.

Kepler was not alone in his theorizing tendencies. Singularly communicative, he has given us the story of his struggles after true conceptions. He says, "If we not only pardon Christopher Columbus, Magellan, and the Portuguese, when

[1] Robinson's Mechanical Philosophy. Astronomy, p. 94.

[2] Astronomia Nova, p. 247.

they narrate the wanderings in which they made their discoveries, but should lose much pleasure in reading were these omitted, let me not be blamed for following the same course in this work." [1] But such mental efforts precede the discovery of every law in science. Every discoverer forms his hypothesis and tests it by the truth; if the facts are numerous, the inductive method, with its tabulating machinery, offers the surest and the shortest test; if, on the other hand, the facts are few in number, especially if a law of cause is being tested by laws of phenomena, which then bear to it the relation of simple facts, I doubt if philosophers commonly have recourse to Bacon's tables; but the process still embodies the soul of the inductive method. It is induction with its tablets in the memory, and analysis far more subtle than the gross elaborations of material tables, but subject to the imperfections of the memory. In proportion as the facts are numerous, or extended through a long period of time, impressions are distorted and effaced, and results become inaccurate. It is this induction of the mind which accumulates what is called medical "experience"; and it is the multiplicity of facts which makes it so inaccurate. Apart from the results derived from the experience of others, medical experience is preceded by hypothesis. Unless the observer has no aim or object in his experiments, he wishes to ascertain something; the frequency of a symptom, or the effects of a remedy. His first few experiments give him a leaning to one side or the other, inappreciable though it be, or even disowned by himself. This is his hypothesis, and he goes on to correct or verify it.

All individual experience in life is summed up in hypotheses of future probabilities. By original experience I mean that which is not communicated to us by others; the philosopher has his hypothesis of the laws of the mind; the burnt

[1] Argum. Sing. Capit. Astron. Nov.

child has his equally stringent hypothesis of the action of caloric.

In a word, hypothesis in its wide sense is based upon experience; it is the sum of past knowledge aggregated, with a view to its bearing upon future knowledge. From the wildest theories of Kepler, to which he was pointed by some hand invisible to other eyes, down to the most inevitable results of accumulated facts, all is hypothesis in its bearings upon the future and the unknown. I am aware that such a view leads to the acknowledgment of an hypothesis of cause based upon experience; but if we are sure of anything, if we know that a material mass will feel the influence of gravitation, are we not infinitely more certain of the truth founded upon all we know of constant and seemingly necessary precedence in the material and the immaterial world? [1]

[1] Does hypothesis form any part of science? An obvious comparison of those who are ready to admit its value in the construction of science, but would reject it from science itself, likens hypothesis to a *scaffolding*, which aids in the construction, but is no part of the edifice. A simile which seems to me to touch the truth at a greater number of points makes hypothesis the *cement* of the structure. It must be of a certain sort to unite the facts, and with it the structure stands. Broussais, or any other philosopher who laid his facts in weak or bad hypothesis, insured the integrity of his tower only so long as he could strengthen its weak points, avert external force, or conceal its defects; it was Broussais, and not the cement, that held the materials together, and in time they fell. But adequate hypothesis binds the facts, and the structure stands in the impregnable strength of truth; the hypothesis then becomes part and parcel of the scientific edifice. More than this, the mind may take cognizance of the law of gravitation, or of refraction, abstractly, as the more important element of science, just as in the walls of Rome the eye is here and there arrested by the imperishable cement which projects from the wall, and seems to be its chief material, while the bricks have been honeycombed from its interstices by the corroding wear of time. When a late suspicious hypothesis thus appears in the respectable character of science, writers do not commonly feel called upon to constitute themselves a scientific police, and exercise the ungrateful prerogative of detection. They are often content to publish in general terms the doubt-

Hypothesis is drawn from few facts, and applied to many. It is experience of the past pointing to the future. But as there are some men who buy their experience in life dearly, who can take no hint, whose unyielding intellects are not impressed by the contact of occasional or inconsiderable truth, so there are minds in science whom no flash of revelation can arouse. The ability to detect scientific truth upon slight indications marks the genius of the observer. Dulness may detect truth, as the uneducated peasant stumbles upon a rich vein of ore; but the true discoverer studies the dip and succession of the strata; his quick eye detects the "lead blossom" which the metallic salts have nourished, and he sinks his shaft upon the mineral.

Do not suppose that a mind like Louis's ever piled up medical facts, useless to instruct his followers without some intention, expressed or unexpressed, of investigating them in some especial point of view; and if he thus amassed but ten accurate cases of typhoid fever, is it possible that the common lesion should have escaped his notice? No; it became in his mind the hypothesis, which the tables of Bacon then tested and confirmed. In observation of details, hypothetic laws of phenomena or of cause are thus forced upon our notice. It is the nature of the mind to recognize them. If they are imaginary, subsequent induction will demonstrate their fallacy. And while the perception of these simpler laws is inevitable, I would ask whether, in the discovery of more complex laws, the paucity of facts does not compel the assumption of tentative hypotheses, based upon slender evidence. Could the laws of Kepler, of the theory of gravitation, or of luminous undulations, have been evolved by the

ful character and false pretensions of "hypothesis"; which, however, then much resembles "treason" in the epigram, —

> "Treason does never prosper, — what 's the reason?
> Why, when it prospers, none dare call it treason."

machinery of any set of tables? I think not. There were not facts enough to accumulate the common element in quantity sufficient to make it obvious. Its nature was only suspected; it was taken from elsewhere; it was supplied by the mind; its powers were tested, and it was found to account for the phenomena.

The ready detection of this common element, it has been said, distinguishes the genius of the observer. It is talent of a high order. It is a power which at one effort embraces a wide range of knowledge, whose glance takes in the whole; it has a breadth of view which seizes and distributes details in all their vastness; it perceives similarities in the remotest facts; it intuitively grasps their hitherto unknown relations, and unites them in the bonds of obvious, though startling truth. It is the true wit of science, akin to one of the high characteristics of active intellect, which sees and combines dissimilar ideas in new and sudden relations.

All great observers have possessed this talent for the perception of remote analogies. Of Bacon, who probably did not appreciate its value, Macaulay has said: "He possessed this faculty, or rather this faculty possessed him, to a morbid degree. When he abandoned himself to it without reserve, as he did in the 'Sapientia Veterum,' and at the end of the second book of the 'De Augmentis,' the feats which he performed were not merely admirable, but portentous, and almost shocking. On those occasions we marvel at him, as clowns on a fair-day marvel at a juggler, and can hardly help thinking that the devil must be in him." [1]

The mind of Newton, sensitively alive to the slightest suggestion of nature, endowed with an exquisite scientific tact, seized and followed up its merest intimations. Through long ages she had hinted to philosophers in the falling leaves of autumn; in despair she had cried to them in the tumbling

[1] Macaulay's Essays, p. 285, American edition, Philadelphia, 1852.

rocks and roaring waterfall; but, toiling with the barren abstractions of theory, they heeded not her voice. In the falling apple Newton read her wish, and said,

> "Malo me Galatea petit, lasciva puella:
> Et fugit ad salices, et se cupit ante videri";[1]

and he followed her and knew her mystery.

There is another faculty which contributes to that of detecting relations, and is perhaps necessary to it. It is that of forming in the mind distinct conceptions. Men of scientific genius have been often noted for their powers of invention in the immaterial and material world. Discoverers in physical science have not unfrequently betrayed in their youth poetical or mechanical tastes. And there seems to be something more than a fanciful analogy between these apparently remote attributes. Both call new powers into being; poetry embodies sentiment; both animate matter. Both are gifts of nature, and are characterized by a power of combining material representatives of abstract ideas. By mechanical taste, I do not mean a taste for the use of the implements of art, but true mechanical genius, which is often impatient of the drudgery of manual labor. It makes its combinations in the mind, for the pleasure of the effort, and passes from one to another, perhaps regardless of their ever attaining perfection in a material form. Herschel has said, that "almost all the great combinations of modern mechanism, and many of its refinements and nicer improvements, are creations of pure intellect, grounding its exertion upon a moderate number of very elementary propositions in theoretical mechanics and geometry."[2] The mind of the inventor, as it combines

[1] Kepler quotes these lines, and adds: "I apply to Nature these lines from the song of Virgil. For, as I approach her, she plays her wanton freaks, and steals away as I am upon the point of seizing her, and eludes my very grasp; yet never ceases to invite me to possess her, as if delighted by my embarrassment." — Astr. Nov., p. 283.

[2] Discourse on the Study of Natural Philosophy, Part I.

the cams and levers, suggests on a small scale as many new relations, and rejects as many useless combinations, as that of the discoverer of the great laws of the universe. Such genius has a facility in placing conceptions distinctly before the mind. Kepler says, "In the year 1595 I brooded with the whole energy of my mind on the subject of the Copernican system." Newton said he made his discoveries "by always thinking about them. . . . I keep the subject of my inquiry constantly before me, and wait till the first dawning opens gradually, by little and little, into a full and clear light." But there is an active process going on in such a mind. It separates at a glance a complicated union into its elements, perceives what is essential to it, and again unites these elements, arranging what is necessary and rejecting what is useless to the new fabric. It is the struggle for clear conceptions, the tendency to embody abstraction, the effort to associate ideal relations with some probable material form, that leads such a mind to new combinations and new discovery.

I have tried to show that it is not the ability to sum up the common elements of facts arranged in tables, nor to verify hypotheses, which adapts a mind for observation. I will add, that it is not the mere power to make a theory. The theory must be of a certain quality, — a probable, if not a successful one. And it is remarkable that discoverers have been convinced of this probability by the cogency of their own reasonings, when they were unable to impress their convictions upon others. Columbus was as sure that he could discover a new world, as that he knew how to poise the egg upon its apex. The subject of vaccination was so distasteful to the companions of Jenner, that they actually threatened to expel him from their medical society if he continued to harass them with so unprofitable a subject.[1] Who but the

[1] Baron's Life of Jenner, vol. i. p. 48.

inventor of the atmospheric railway would have supposed it possible for an engine running forty miles in an hour to seal hermetically a wide crack in a two-foot tube with tallow? McAdam found it far more easy to grind his broken rock into the road than his convictions into the public mind. Such facts led Sydney Smith to say, "that man is not the discoverer of any art who first says the thing, but he who says it so long, and so loud, and so clear, that he compels mankind to hear him."[1]

But while facility in forming probable theory is distinctive of scientific genius in the mind of the true philosopher, the love of truth is steadfast and predominant. No ingenuity of reasoning, no parental affection for theory, no human passion, turns it from the contemplation of reality. It never shrinks from the untold labor of investigation; it is hard upon the tracks of truth, and stanch in its pursuit.

Bacon's tables and notes lead to the construction of hypothesis, but are more frequently the machinery by which its accuracy is tested. In either light the inductive method is a routine process, and does not require the hand of the master. Bacon himself knew that no high order of intellect was required to apply his system. He warned men "that it was such as to leave little to the acuteness and strength of wit, and indeed rather to level wit and intellect."[2] And in another place, "that it leaves little to their superiority, since it achieves everything by the most certain rules and demonstrations."[3] The intellectual effort lies in making the hypothesis. Truth is hid in the facts, like the fossil in the solid rock. Cuvier detects its existence and knows its value; some Laurillard chips away the stone and exposes it.[4]

Let me not be misunderstood in this attempt to place theory

[1] Edinburgh Review, 1826.
[2] Novum Organum, Book I. Aph. 61.
[3] Ibid., Aph. 122.
[4] See Appendix B.

and facts in what I conceive to be their true relations. Medical science is a science of phenomena, and laws of phenomena, which in the progress of knowledge always precede laws of cause, must be accumulated gradually.[1] This accumulation is the work of the inductive method. Intellect, if it cannot be invested in the mechanical labor of induction, will always find its occupation in guiding and directing this process, — in laying out the road and pointing to the truth. But in many sciences the labor of direction and the labor of experiment fall upon the same individual; the head and the hand belong to the same person. In medicine especially it must be so. The astronomer and chemist have their measures of space and quantity. The rude workman gauges his straight line by a ray of light, but we have no standard of the fulness or the hardness of a pulse, the color of a tongue, or the force of vesicular expansion. It is only by long study that the student can establish in his mind the

[1] Medicine perhaps resembles in its present scientific position the science of animal organization, thus referred to by Cuvier. "Speaking of theories in general, he said, a little before his death, 'I have sought, I have set up some myself, but I have not made them known, because I have ascertained that they were false, as are all those which have been published up to this day. I affirm still more; for I say, that, *in the present state of science, it is impossible to discover any*, and that is why I continue to observe, and why I openly proclaim my observations. This alone can lead an author to the discovery of that fact on which he can build a true and general theory. . . . This fact,' added he, 'is perhaps of little importance in itself; but with regard to theory, it will become the principal fact, the key-stone to the arch. Therefore it must be sought. Science must march; but we must take care that she does not march in a retrograde direction, as she has sometimes done, and as some naturalists lead her at present. We ought to labor, not with the object of supporting a theory, — because then the mind, being preoccupied, will only perceive that which favors its own views, — but with the object of discovering the truth; because the truth will be deduced from true theories, and true philosophical principles, — the truth being, in itself alone, the whole of philosophy.'" — Memoir of Cuvier, by Mrs. Lee, p. 145. New York, 1833.

unit of comparison, the accuracy of which qualifies him to interpret what he sees and hears. Observation alone qualifies him to observe; observation alone qualifies him to theorize.

Nor do I underrate the value of facts, as such. A large proportion of our science is made up of facts as unexplained as the action of mercury or of quinine, and we must accept them as they are. Such knowledge is essential to bring us to the point from which Harvey and Bell, and Laennec and Louis, took their flight into unexplored regions. These men were as familiar with medicine as Newton and Kepler with astronomy. But facts are not the end of science, and you are not to amass them blindly. Have a purpose in your investigations; let it be either of self-education, of verifying for yourselves what is already established, of forming an hypothesis, or of testing one. Do not think that impartiality in observation requires that a fact should stand alone, — should offer no indication of the existence of any other fact. Rather endeavor to find some true relation between a symptom and its immediate cause, between a sign and any alterations of structure or of function, between one disease or lesion and another. Here, if I may say it, there seems to me to be a difference in the tendencies of medical knowledge in this place and in the French school.[1] The connection of medical phenomena is there, if possible, determined. Every fact is labelled with its scientific value. There, a true relation is, if possible, indicated; here, if possible, it is evaded. The details of a medical case may be narrated or recorded promiscuously and without order, or methodically, to illustrate its bearings upon certain points. Either history will embrace all the facts; but while one supplies only the crude material, the other shapes the block and designates its place in the future edifice, and leaves to

[1] See Appendix C.

future science only the labor of adjusting it. The ill digested observation is in fact comparatively useless. Medical discovery has generally been the work of individuals, who had their hypotheses and have analyzed facts in some especial relations, and not of societies, who have collected them indiscriminately. But if any discovery is ever to be thus made, if observations thus accumulated by different individuals are ever to be collected and studied together, especially when we remember the difficulty and almost impossibility of analyzing a wilderness of medical facts matted and felted together into a dense and tangled mass, let us be ready to advance the labor in our humble spheres, at least in showing what points our observations are intended to illustrate, and in adopting a methodical and condensed arrangement which shall facilitate their future comparison.

And is it not probable that some of our common diseases have been as well investigated as they can be by the unaided senses? and is it worth while to complicate records, in amassing scores of duplicate specimens of typhoid fever and of phthisis? I do not undervalue the wholesome influence upon our profession of a school of rigid science, much less its influence upon the cause of medical education. The latter interest compels the repeated inculcation of the simplest principles; but let us recognize what is done for the attainment of these ends, and distinguish it from that fulsome repetition of undisputed truth which satiates interest and deadens zest for science. What more can we know of the pathology of these diseases, unless through the aid of the microscope, of chemical agency, or some other new means? And if some new form of force shall be detected in the animal economy, will not the incompleteness of our tables compel us to observe our facts anew with reference to relations now unsuspected?

I cannot believe that I am alone in these views. A part at least of our medical community will recognize a reaction from false theory, which now, as in the time of Bacon, tends to facts, — to facts repeated, — facts almost independent of their bearing or application. It is sufficient that facts are accumulated, hoarded in some dusty volume, and the knowledge that we possess them seems to satisfy us. But these facts are not the rare and choice specimens they were in the infancy of the numerical method; they have often been multiplied, till they are cheap. I question whether something might not be done to increase their value, and make them more available to medical science.

The possibility of attaching a too exclusive value to facts does not imply that a wide acquaintance with scientific detail is incompatible with the highest power of generalization. On the contrary, it is essential to its exercise. Only the laborious acquisition of successive groups of facts enabled such men as Newton and Cuvier to bind and harvest them. But do not content yourselves with their possession. Study their relations, and endeavor to unite them. Science aims at principles, and not phenomena; laws, and not facts. If Bacon condemns the "sublime and discursive" intellect, which "compares even the most delicate and general resemblances," often "catching at shadows," he warns us, in the same sentence, against subtle minds, "the steady and acute disposition which catches at nice distinctions," which "fixes its thoughts, and dwells upon and adheres to a point through all the refinements of differences."[1] Do not lose sight of your great object in the absorbing interest of details.

Few have the ability and the good fortune to make discoveries in science. Most of us must be content to learn what others have added to it. But we may all contribute our humble share in disseminating what we conceive to be just views, and in assuming for medical science and for ourselves

[1] Novum Organum, Book I. Aph. 55.

a right position. But let us recognize this position as it is. Our science is lamentably imperfect. We know next to nothing of cause in medicine; and it may well be asked, if the analysis of cause is not at present beyond human power. It is unquestionably difficult. We have few of the facilities enjoyed by the votaries of other sciences. Facts must be resolved into their elements before they can be combined in a new form; in the words of Bacon, "Experience must be broken or grinded, and not whole, as it groweth."[1] The components of our new fabric, material or immaterial, whether rays or rags, must be separated and disintegrated, before we can unite them into the spotless tablet of truth. In the science of life, every known form of force is inextricably interwoven with forces we either do not recognize; or of whose mode of action we are ignorant. Every fact is a compound fact, of most of whose elements we know nothing. Again, the astronomer's observations yield constant and unvarying results; medical phenomena are ever disturbed by unknown agencies. The astronomer has his unerring measures of degree; the standards of the medical philosopher are uncertain, and vary with different observers. The astronomer's facts repeat themselves after a determinate interval; the chemist occasions his at will; but the pathologist can only wait for promiscuous phenomena, whose occurrence is often amenable to no known influences.

Have I seemed to limit too narrowly the range of our professional usefulness? Will it be said, that I am treacherous to the cause of medical science, in confirming, by the evidence of an adept, what was already suspected by the uninitiated? The dignity of our science will not be diminished by a recognition of its real abilities. It is its actual condition, and not the avowal of it, that can alone add to or detract from its

[1] Preface to Natural History.

real character. If our science has advanced little in comparison with some others, it is because it is built upon them, and because its problems are combinations of the most difficult and unexplored of their laws. But if it is among the least advanced, it is among the most important. It wields many of the physical conditions of human existence. It has averted physical calamities which would by this time have destroyed ages of since aggregated human life. Were it for its single power of controlling sensation, our profession would be necessary to the civilized world. But we can do far more than this. The physician can foretell the duration of most acute diseases, and, apart from the accidents of life, he promises health. He alone can judge, from a wide combination of symptoms, of the actual condition of the patient. He condemns without appeal. He can sometimes arrest disease, and can often modify symptoms, or mitigate their severity. In its true form, our science is already indispensable to man.

And here and there a gleam of light penetrates the gloom which enshrouds it, and seems to promise the dawn which is to guide our steps. There is a class of remedies which the philosopher regards with untold satisfaction. They have been called specifics, and are few in number. It may be said, that an emetic mechanically irritates the stomach; but a sudorific carries us a step further in our sway over the animal function; and when we are able to say that quinine will prevent the regular recurrence of an intermittent chill and heat, that mercury will dispel the disorganizing pestilence which has invaded every tissue in the system, have we not here facts in the undoubted effect of material atoms upon inappreciable agencies which tell us that we are approaching the fountain head of vital action? Is not this a breach in the barrier which divides the palpable from the impalpable?

The great philosopher of the seventeenth century informs us: "They have in *Turkey* a *Drink* called *Coffa*, made of a *Berry* of the same name, as black as *Soot* and of a *Strong Sent;* Which they take, beaten into powder, in *Water* as hot as they can *Drink* it. This *Drink* comforteth the *Brain* and *Heart*, and helpeth *Disgestion.*" [1] Two centuries later, the civilized world breakfasts upon coffee, and drinks tea; because, says the great chemist of the nineteenth century, "*Theine* and *caffeine*, their peculiar principles, are in all respects identical, and supply the human system exactly as many atoms of nitrogen and carbon as it requires to manufacture *taurine*, the essential constituent of bile." [2]

May we not assert that this is more than progress, that we have at length struck the path, and that such facts are "blazes" upon the trees which shall enable us to thread this scientific wilderness?

I will detain you but a little while with a few equally general considerations bearing upon medical art.

And, first, I would have you take a wide view of medical science. The distinctions of medicine and surgery, and many others, are arbitrary, and there is little in the intrinsic character of disease to warrant such dividing lines. Surgery, literally, the labor of the hand, in its restricted sense, manipulates. It deals with primary effects. Medicine deals with secondary effects, the symptoms of obscure and uncertain lesions. And here is a superiority of surgical resource, that it applies itself directly to the lesion. It wields mechanical force, — the form of force with which we are best acquainted. Medicine acts indirectly. It knows little or nothing of the forces with which it deals. It often makes its thrusts in the dark, and waits for daylight to

[1] Bacon, Sylva Sylvarum, cent. viii. 737.

[2] Liebig, Animal Chemistry.

show whether it has disabled its friend or its enemy, the patient or the disease. Yet are medicine and surgery not distinct in science. Inflammation in its different stages, tubercle or malignant growth, are intrinsically the same, deep in the viscera, or salient upon the surface. Modified by the tissue they occupy, widely differing in their symptoms, scirrhus of the breast or of the pylorus, tubercle of the lung or of the ankle joint, are identical to the pathologist; and I would impress upon you, that it is only by recognizing such pathological unities that we can advance in our knowledge of morbid action.

Do not identify surgery with the knife; with blood and dashing elegance. Distrust surgical intrepidity and boldness. If such epithets have any meaning, they are in bad taste and tend to give the student a wrong impression of scientific excellence. War has ever respected science; why should the votaries of science themselves disturb its quiet paths by the harsh jargon of the battle-field? What are brilliant achievements? The right subclavian artery and the innominata have been often tied with success, and the patient has always died. Boldness in battle implies voluntary exposure of one party, while it threatens danger to the other. In surgery, the bold operator does not hazard his own person, but that of the patient is perhaps none the less endangered. Science never hears of the ten or twenty quiet sufferers who fall victims to the publicity of an exceptional escape from surgical intrepidity. There are cavities in the human frame like the chamber in the legend, to open which was death. The mind clings pathetically to its human habitation, for the possession of which the immaterial and material world are ever striving. Let the surgeon beware how he hazards the result by officious interference. Surgery is not operative surgery. Its province is to save, and not to destroy; and an operation is an avowal of its own inadequacy.

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True boldness is that which a sense of competency maintains. Weigh your ability, and decide whether you are competent to a responsible position. Do not confound with the question of ability that feeling of repugnance which every young man has to undertake an untried duty. With a well grounded confidence, justice to yourselves demands the sacrifice of vague doubts and nervous hesitation. Endeavor to know in medicine what is to be known; and while you save yourselves much of the embarrassment which arises from a want of confidence, you will spare yourselves the necessity of dissimulating ignorance. There was a time, and that not far distant, when the grave and professional air was a necessary part of our professional attainment; when an expression of profound sagacity hung as a veil before the mysterious recesses of the mind; and an air of deprecating merit seemed to conceal unknown depths of wisdom. A good physician generated an oppressive atmosphere, which stifled vivacity and animation. His speech was oracular and final; and as he listened, his surcharged countenance expressed, like that of the bird of wisdom, a severe and unblenching appreciation.

Such was, and sometimes is, the mask of ignorance; but there was much in the position of bygone generations of physicians which justified pretension. The medical man was surrounded by those who leaned upon his art with blind reliance, and exacted from him superhuman skill; and he assumed the infallibility thus spontaneously offered. Such a false position is not ours. We owe it to those who have exhausted their best energies in our cause that there is now something to be known for which a severe and professional demeanor is no longer a substitute. The physician may now discourse on medical subjects honestly, and hopefully; and the offspring of his knowledge, the positive amelioration of man's physical condition, justifies him in avowing the inadequacy of his art, without fear of derogating from its dignity, or of impairing confidence in himself. I well remember my surprise, when a medical student, hearing one who is eminent among us proclaim, in answer to some medical question, "I do not know." It was the ignorance of knowledge. Such downright, avowed medical ignorance is rare; still, it is worth while to learn what is to be learned, if only to avoid the error of those who, rightly believing there is much they do not know, pretend to know much that cannot be known.

It was said by a recent medical journal, in celebrating a late physician, that he possessed "an intuitive knowledge of his science." It may be safely affirmed that no other physician was ever similarly gifted; and yet some such insight is popularly attributed to our profession. A man assumed to be thus endowed by nature will tell you, with decision, that in his opinion this patient will have pneumonia. Another, less gifted, will say, "Here are combined the season, the exposure, the fever, the chills, and to-morrow we shall probably have the physical signs." Both may have rapidly reviewed the facts, but the knowledge of the first is immeasurably less to be relied on. I do not underrate a peculiar talent possessed by some physicians. A diagnosis is eminently an hypothesis, often built of necessity upon few indications. One mind will elicit, sift, and combine the evidence much more rapidly than another; but the power of arranging and communicating, if need be, the steps of the process, does not diminish, on the contrary it adds to, the accuracy of the result. If such a man is unable to state clearly the grounds of his belief, it is because his conceptions are indistinct; and just in this proportion is his diagnosis, based upon the evidence of these conceptions, less sure. But one who thus jumps to a right or wrong result will seem to many, and is likely to suspect himself to be, a man of penetration, — of penetration which has the air of divination, — and sometimes not unjustly, in view of the intellectual chaos to be wrought upon. It is a quality which captivates the vulgar, who are fond of paradox. There is a pleasure in wondering, in seeing a juggler's trick; a perverseness in the human mind, which delights to believe impossibilities. The actual desire of people to be deceived has become classical; and to respond to this, in the words of Johnson, "There is in human nature a general inclination to make people stare; and every wise man has himself to cure of it, and does cure himself."[1]

If the admiration of ignorant or weak minds is an object of your ambition, minister to this vitiated and uneducated taste; encourage credulity; invest your art with technicalities; exhibit your results, and studiously hide your methods. But if you desire to place your science upon a level with other sciences, aim with Bacon "to make wonders plain, and not plain things wonders";[2] lay it open to the world, and strip it of the repulsive garb of false pretension. Common expediency at least teaches this. The day is fast going by when the intelligent and the instructed attribute to the physician superhuman sagacity. The physician is now often asked for his premises by people who think themselves possessed of sufficient logical abilities to follow him to his conclusions; and it is because the patients of this generation insist upon being told why, and not what, that the despotic sway of our professional ancestors is gradually escaping from our grasp. If you ever acquire in these days a reputation for infallibility, it will be after you have shown how you are infallible. All this is in accordance with the spirit of the age, which rules by enlightened reason, and not by ignorance, and persuades by the authority of facts, and not by its own authority.

When, therefore, you examine a medical case, neither shake your head with the negation or the affirmation of pro-

[1] Boswell, 1769. [2] Preface to Natural History.

fundity, nor indicate by your countenance the perplexity of overwhelming thought; but enter upon your duty with even an unprofessional cheerfulness, content to use the finite powers which God has given you. Spread out the facts; show which way they point. Do not say what your opinion is, but why it is; give the evidence and all its bearings; push the diagnosis to its full extent; but remember there is a point at which the imperfection of our knowledge bars advance, and beyond which all is surmise and uncertainty. It is a common error, especially among students, to suppose that the physician must always arrive at some decision with regard to the character of a lesion or disease. It is not so; a diagnosis is often uncertain. The evidence points equally in two directions, and in such a case ignorance alone asserts impossible knowledge.

Most of you have long since observed that scientific excellence is not always the nucleus of extensive medical practice. As devotion to science insures scientific eminence, so he who omits no opportunity to add to the number of his patients, who makes this the one object of his life, will, if he plays a moderately skilful game, insure to himself a practice entirely disproportioned to his scientific merit. And among the qualities which contribute to this end I will mention two, both laudable, and neither exclusively applicable to our art. I refer to that general good feeling which obliges people, and to the knowledge of men which rules them. Great eminence in science occasionally dispenses with these qualifications, but is often combined with them.

Science alone is inadequate to the duties of common medical practice. When the body is diseased the mind falters and the invalid looks for sympathy; for heart as well as for head; for the philanthropist and not the mere philosopher; and this difference will often condemn the man of science to yield the race to his inferiors in intellect and attainments.

Eminence from this source is not entirely independent of scientific acquisition, and from its nature is little open to abuse. But the power which accrues from a readiness in detecting the vulnerable part of human character may become in the hands of the unprincipled an engine of incalculable evil. In our art it is the just vocation of this superiority to secure to its possessor the confidence which is essential to the relations between himself and his patient. But this never requires the physician to pretend to do that which he cannot, to cure incurable diseases, to exaggerate their real gravity; and when the standard of expediency is no longer the welfare of the patient, but the pockets of one who, not devoid of scientific skill, is destitute of moral sense, and does not scruple for money to disguise truth and fabricate error, the deception strikes at the very foundation of the moral fabric. Law shields society from the violence of brute force, but no law protects it against the encroachments of brute intellect. The medical charlatan approaches his victim under the friendly and familiar mask of a noble art, only to discover the crevice in the armor with which the ceremonies and relations of society invest its members. He alarms or flatters prejudice, or wiles from human weakness some inviolate trust, only to secure his prey, while he extorts the gain which is his one object. And shall opportunity be thus voluntarily ceded to the unprincipled?

The question is no longer of the sagacity of those who are deceived. If law cannot protect society against the insidious approach of ill directed will, — if the unstable arm of public opinion is its sole defence against intellect that knows no moral code, that even fails to give the presumptive pledges of good conduct which in its sober senses society rightly exacts from those who are to lift the sacred curtain of domestic life, — if public sentiment alone guards public safety, — it is no negative or passive duty that devolves on individuals.

The experiment in therapeutics I choose to try upon myself, the willingness with which I abandon myself or others to the investigations of one whose motives must be questioned, no longer concerns me alone. In my humble sphere, and by my example, I am sapping the wall which protects society and private life from the invasion of those of whom we know little but their ability, which gives them power, and their disregard of common truth, which would make them willing to do infinite mischief should it serve either their interest or their inclination.

Content to exert a healthful influence within the immediate circle of your art, do not waste your breath in exposing error beyond the limits of real medicine; in holding up to indignation the heartlessness which supplies straws to the dying man, and tortures him with false hope until his palsied grasp has yielded its last coin; still less in pointing out the fallacy of those medical pseudo sciences which last a few short years and die of inanition, which rapidly replace one another, — with nothing in common but their friends, vociferous in their constancy to each in health and strength, but in its waning years quietly deserting it for some more profitable alliance. These fungous parasites of science are the natural food of weakness and credulity; a necessity to the vitiated taste of the more cultivated, or a luxury to vanity, which gratifies itself in detecting and appreciating what is obvious only to few. As well might you deprive such believers of their daily sustenance as displace from their minds their hygienic theory. With the sound and intelligent no such attempt will be needed; with others, none will avail. But in your own immediate art, scrupulously guard the barrier which professional convention has erected against the unsound in morals or in science. You cannot be too cautious in taking measures to advance your individual interest, which may be popularly confounded with those resorted to by the unprincipled. You cannot reprobate too strongly the motives of those who pretend to do what they cannot, who associate the skilful practice of your art with false pretension; or the still fewer, who would keep for their own advantage what they would be thought to have discovered for the relief of suffering humanity.

Do not aspire to the notoriety which deals in secrets, and takes out letters patent for the common offices of Christian charity. Humanity revolts at this shallow artifice of those who cannot gain the eminence ever accorded to superiority. If art is sometimes thus prostituted by those who feel no interest to maintain its dignity, thank God there is an inner temple, beyond whose precincts no sacrilegious selfishness has ever penetrated. Science radiates truth, like light, upon the world. The contemplation of the order and harmony of nature, the intercourse of truth, warms the heart, as it enlarges the intellect, and elevates man into a sphere where self is sacrificed. Great discoverers in science have been ever philanthropic; that they have shed their knowledge upon the world, as freely as they have devoted their best days to its pursuit, is a fact so universal and infallible, that he who now attempts to conceal his pretended discovery exposes to the intelligent, with his own selfishness, the fallacy of his pretensions.

Lastly, do not lose sight of your science in your own intercourse with art. Science is knowledge; art is its application. Science is of the head; art is of the hand; and the physician who obeys the indication of a sign exercises a faculty possessed in common with the brute. Science is often independent of art; in the natural order of events, art precedes and leads to it, while science in its turn repays the debt with new applications of established truth. Nor is utility, or immediate subserviency to the well being of man, any test of the character of scientific discovery. High scientific truth is often of limited application, while a gross invention of art, like printing, or an accidental discovery, like the specific action of Peruvian bark, has proved of incalculable benefit to our race. But, were science of no avail to the physical condition of man, while art continued to endow human life with comforts and luxuries, science would still remain an incomparably higher object of pursuit. In its widest sense, knowledge, it is the labor of the intellect, — as far above the crude productions of the artisan as the mind is above the material mass it inhabits. But the strivings of the philosopher who yearns to serve his fellow man are not thus paralyzed. The pursuit of science contributes to the physical endowment of the race; and beyond all other knowledge, beyond all human labor, ours aims at utility, the great end of the philosophy of Bacon. Its experiments are those of "fruit," as well as "light."[1]

Art becomes science; the isolated fact becomes a scientific fact in its relations to the rest of human knowledge. Strive to detect and establish this relation; and possession, as it rewards you, shall confer untold obligation on your fellow man.

You linger now at the starting point of your career; and as you gaze upon the broad and dim expanse, every feature in the distant landscape dwindles to its just proportion; but as time rolls on, and you descend into the plain before you, and your horizon narrows, that little object in the distant outline will stand out in bold relief, and grow upon the sky as you approach it, until it fills your range of vision, and shuts out the view. Indolence, the routine of art, perhaps the demands of hard necessity, may confine many of us within narrow spheres, and turn us from the pursuit of knowledge. But in the struggle and turmoil of active life, do not forget your debt to science, which ever toils in quiet, unremittingly;

[1] "Experimenta fructifera . . . lucifera." Preface to Natural History.

heedless alike of its own transitory interests, and of the world around; its highest aim, year after year, to add its new contribution to the sum of human knowledge; thus promoting by its example the best interests of our profession, and content to find its happiness in a tranquil intercourse with the great truths of nature, and the manifestations of unerring sagacity.

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## APPENDIX.

### A. — Page 181.

The power of predicting in science depends, first, upon our belief in the stability of causes now in action. For example, we know that east winds prevail here in April, and we believe that they will continue to do so. Copper crystallizes in four-sided pyramids, and we see no reason why it should not always thus crystallize; but we are more certain of the future occurrence of the last phenomenon than of the first, because the facts on which we base our belief are more rigorous and numerous. This belief is faith in the constancy of nature, strengthened by cumulative evidence. It predicts a repetition of phenomena already observed, and of no others.

But there is another sort of knowledge, which predicts phenomena not yet observed. It is the knowledge at once of immediate cause, and of that quality in the material which is essential to the experiment. Thus, when it is shown that a certain die strikes, in a malleable mass of copper, a four-sided pyramid, we can foretell that any crystalline form may be impressed upon any malleable metal by modifying the die; so when we know that gravity attracts masses inversely as the squares of the distances, or that refraction bends the ray according to a ratio of the sines, always constant for the same medium, we are enabled to predict the results of new combinations of different quantities of matter at different distances, or of different rays passing at different angles through different media.

## B. — Page 201.

"One day M. Cuvier came to his brother to ask him to disengage a fossil from its surrounding mass, an office he had frequently performed. M. Laurillard was the only person to be found on the spot, and to him M. Cuvier applied in the absence of his brother. Little aware of the value of the specimen confided to his care, he cheerfully set to work, and succeeded in getting the bone entire from its position. M. Cuvier after a short time returned for his treasure, and when he saw how perfect it was his ecstasies became uncontrollable; he danced, he shook his hands, he uttered expressions of delight, till M. Laurillard, in his ignorance both of the importance of what he had done and of the ardent character of M. Cuvier, thought he was mad. Taking, however, his fossil foot in one hand and dragging M. Laurillard's arm with the other, he led him upstairs to present him to his wife and sister-in-law, saying, 'I have got my foot, and M. Laurillard found it for me.' It seems that this skilful operation confirmed all M. Cuvier's previous conjectures concerning a foot, the existence and form of which he had already guessed, but for which he had long and vainly sought. So occupied had he been by it, that when he appeared to be particularly absent his family were wont to accuse him of seeking his fore foot." — *Memoir of Cuvier*, p. 53.

## C. — Page 203.

It is probable that a large proportion of the Paris medical world would agree with Rostan, who says, in a lecture upon Humorism: [1] "It is a question if the love of rigid induction in modern medical science does not tend to efface really valuable hints, which found their origin in the experience of observing men, because they are unsupported by registered facts." The rigid "numerical school" embodies a comparatively small part of French medical philosophers. In this place, on the contrary, medical science is or has been somewhat imbued with the exaggerated spirit of the statistic school.

[1] The writer's manuscript notes of a lecture at Hôtel Dieu, in 1842.

The numerical method tends to distract the mind from general laws; especially in medical science, where facts are complex, and therefore little suggestive of immediate cause. In its exaggerated form its practical working is to exclude, perhaps by habit, any considerations of cause or of unproved relations; it is suspicious of probabilities; and hesitating to draw the line between real and false analogies, it discards them altogether.

But that many of the disciples of the numerical school are not thus illiberal in their views of science will, I think, be conceded by those who are familiar with the writings of Barth, Valleix, Grisolle, or Fauvel, or who have had the good fortune to know personally M. Louis.[1] It will probably be allowed that the works of M. Louis, apart from their scientific merit, have to a certain extent remodelled the features of modern medical science, in inducing a general recognition of the value of accurate statistic results. But such results do not preclude the use of hypothesis. The act of taking a medical observation implies a succession of hypotheses. "Learn how to observe" means, besides the necessary education of the senses, "Acquire that medical knowledge which shall enable you to judge *a priori* of the correctness of a patient's statement, in order that you may re-question him if necessary, to learn enough to form, from a few signs and responses, an hypothesis of his disease, that you may direct your inquiries accordingly." The eyebrows, or the color of the hair, may have some relation to the brain or heart; but this is so improbable that in the present state of science it is considered unnecessary to study this connection. We select those relations which a hypothetic belief leads us to suppose the most important; and it is previous medical education that renders a man competent to form this hypothesis, that makes him competent to observe.

There is probably at the present time no greater pathologist than Louis; but such men as Andral and Chomel have arrived at equal scientific eminence by a different path. What difference

[1] I find the following in a pamphlet by M. Castelnau, who was, in 1842, *interne* of M. Louis, and a member of the Société Médicale d'Observation: "*La statistique* does not forbid either reasoning upon a single fact, or the application of the whole mind to it. It even counsels it. But it forbids premature conclusions." — *Lettre à M. Trousseau en réponse, etc.*

would be popularly made between their systems, — between the numerical method in its exaggerated form and that form of scientific belief in general use? If I am not mistaken, it is this. Both collect the crude ore, the locality and general character of which has been determined by previous theory. Both expose it for examination; the latter, as is most convenient, rejecting the baser material; the numerical philosopher, in tables, giving the exact proportion of each obvious, though comparatively worthless, ingredient; and if any native metal in a pure state happens to be thus exposed, it is picked out and preserved. This is a sort of mechanical analysis, and here the numerical method is supposed to stop. But the genius of a discoverer seizes the crude fact at this stage of the process, grinds it to fragments, and with the rapidity of thought applies to it a hundred different reagents, detects the slightest tendency to combination, — which he encourages by adding new elements, — and extorts by this chemical analysis every particle of valuable material.

The numerical philosopher will tell you, truly, that in such a process the observer will often mistake glittering combinations for the real metal; that he will present you only his own combinations, — facts of his own selection. Some one (I think Mr. Lawrence, in the Preface to his work upon Iritis) very justly remarks that every condensed medical case will be more or less colored by the views of the narrator; obviously for the same reason. The discoverer will reply that he is competent to the process only when he is educated to distinguish real from fanciful analogies; that the demands of science will not be satisfied by the small supply of native metal brought to the surface by the tables.

Whether medical facts in their present state are susceptible of this chemical analysis, whether the numerical method is adapted to the present requirements of medical science, and whether much of the foundations of medical hypothesis have not yet to be built, has been discussed elsewhere in this paper. It is my own conviction that M. Louis would be as ready as any medical philosopher to acknowledge the value of the intellectual power requisite for the higher range of scientific discovery.

## INAUGURAL LECTURE.[1]

GENTLEMEN OF THE MEDICAL CLASS: —

WE are assembled in obedience to a healthy custom. It is well that those who are interested in this institution should meet together once in the year to testify their good will to it, and to indicate by their presence that they feel an interest in its prosperity. We recognize here the guardians of the University, the flourishing condition of which is ample evidence of the fidelity and wisdom of their administration. Here are those who, at no remote period, were actively engaged in teaching the lessons of our art, indelibly associated with a pleasant period of our lives, and bound to many of us by claims to more than our regard. Some who look back as if it were yesterday to the time when, like ourselves, they stood at the threshold of our profession, — when they imbibed at this fountain the early teachings of our science, — come here to be reminded, by each recurring year, of the lengthening interval which separates them from a period which never can return, and to awaken its memories. Winter has assembled you from various distances and with various motives; animated by curiosity or impelled by duty; determined to accomplish an end, or yielding to a customary routine; but all imbued with a good and friendly spirit, and ready to unite with the well wishers of our institution to promote its best interests.

Occupying a relation to you, gentlemen, new to myself, and of the honor of which I am deeply sensible, there may be

[1] Introductory to the Course on Surgery, delivered before the Medical School of Harvard University, Boston, 1849.

a propriety in devoting an hour, usually allotted to considerations of a general character, to an exposition of some of the principal topics suggested by this relation; and it is my intention, with your permission, briefly to review our subject in its connections with science and with the community.

The institutes of a science are its settled principles; and if we consider the character of the phenomena which are presented to us in the study of surgery, and reflect how unappreciable are the agencies which constitute disease, we have good reason to be satisfied if there is anything in its comprehensive generalization so remote as to be called a principle, or so unequivocal in its character as to be considered settled. In surveying this subdivision of a great subject, let us avow that we still linger upon the lower steps of scientific progress. The phenomena of fever or of convulsive action bring us but little nearer to their essential cause. More than this, we are but little nearer to their material machinery. A man dies of tetanus, and in a large proportion of cases you can find no lesion of his nervous organism. Fever has been grouped into inflammatory, irritative, and hectic, because febrile symptoms tend to recur in certain groups characterized by one or more constituent symptoms predominant in intensity and duration. Perfect knowledge should demonstrate the intimate mechanism of each symptom; yet we possess no such knowledge. The inward fire is kindled, and the thrill and the restless play of an unknown machinery warn us of a never ceasing elaboration; but we stand without the edifice, and only gaze bewildered at the complicated manifestations of its exterior. We have only learned that certain occurrences are probable, but do not know why they are probable.

And leaving the symptoms, which are the result of lesions, for the lesions themselves, we are indeed nearer to the fountain head of morbid action. But here too the investigation of the simple fact, divested of its relations to proximate cause, is the boundary of our research. Phlegmon, and erysipelas, and ulceration, represented in color and in outline, in duration and transition, — scrofula and cancer, each uniting somewhat heterogeneous groups of very various phases, — these furnish subjects of what may be called the institutes or settled principles of surgery. That they are combinations of frequent occurrence cannot be denied; and we may concede that, from the constancy of their recurrence in a state of combination, they may be fairly inferred to have some common bond of union maintaining to them the attitude of cause; but we have not extracted or identified this common principle, and science falls short of its perfection, by the wide interval which separates suspicion from a certainty.

The broader generalizations have often reached a second class. Thus, having grouped the different symptoms of inflammation, we again unite the phlegmonous and erysipelatous varieties by whatever is common to them both; still it may ultimately prove that their discrepancies preponderate, that we have not yet touched their real point of sympathy or of difference, and that we misappreciate the actual value of characters which may prove accidental. It is a striking fact, that a writer of the Augustan age should have indicated the marks of inflammation as four, — "redness and swelling, together with heat and pain"; and that, till within a very recent period, medicine has added little to elucidate this fundamental process of disease. But medicine must ever follow behind chemistry and physiology and anatomy; it may urge, but can only follow their steps over the threshold of discovery.

Palliate it as we will, few pathological principles are entitled to that name. There is a broad line between material phenomena and their immaterial cause. The pathologist scrutinizes the gross tissue, subjects it to mechanical force and to chemical reaction; he disintegrates as much of it as will lie upon a needle's point; he bends the rays which emanate from only a small portion of this particle until the image of a single cell shadows a large portion of his retina; and still the surrounding fluid is reflected pure and crystalline. Far more impalpable than this hyaline fluid is some heavy air, and far more subtle still is light, and again, at an immeasurable interval, the vital force. Short of this point, our generation may surely rest satisfied; and content itself, for years of progress yet to come, with such investigation of material changes as exaggerated vision may afford, and such improved speculation upon them as may be made through the aid of collateral progress in the kindred sciences.

It has come to be questioned how far Clinical Instruction is essential to a course of medical teaching. Local interests or local exigencies have led to a discussion of the value of this method of imparting knowledge, and as seriously as if there were some doubt about it. Surely those who hesitate do not consider the difference between words and things; between the aspect of a man himself and such a detailed description of him as the police might give; between visible and tangible disease, and a written history of it. No doubt, an original fact and its description both gain access to the understanding; but there is a difference in the quality of the knowledge thus obtained. To value a possession, the mind must first have felt the want of it. Curiosity must first stimulate both its perception and its ability to retain. The mind asks a question and is then polarized for the reception of a direct answer; and it is balked and wearied by an irrelevant reply. Now every protracted description, especially a lecture, is of the nature of a series of replies to which no question has been asked. A whole audience cannot ask or be answered at one time, and the alternative is to distribute information in bulk, that each may select something which will approximate his purpose.

On the other hand, exhibit a case of actual disease, and every observer will put and answer in his own mind, and with the rapidity of thought, an endless variety of queries upon points in which, perhaps, he alone is deficient, and for the reception of which his mind alone is stimulated.

Another aspect is more important. Sensible qualities must be described by reference to acknowledged standards; and we can thus measure heat, and space, and weight; but not shades of color, nor the attributes soft and hard, nor the varying outline of a curve. In the same way, a personal examination will yield the qualities of an odor, a pulse, a tumor, an expression of the features, which pages of tedious description might fail to do. And the mind which painfully contemplates an abstraction will seldom fail, at such a moment, to arrest some tangible association by which the abstract quality is permanently fixed.

Clinical study is bedside study. Here the student closes and grapples with the malady of whose Protean forms he has as yet only read. Here he learns at once the language of disease and the language of suffering humanity; and while his scientific sense is educated, his kindlier feelings are also developed. He learns to listen patiently, to sympathize; he learns to re-establish a facility in the manifestation of that kindly feeling which is generally upon the surface in early youth, but which sometimes in the process of education gets embedded beneath a stratum of indifference and insensibility.

The dialect of disease is an especial object of clinical study. Is a fever settled? Is a cough seated on the lungs? Is there water on the brain? Such questions are as significant as if conveyed in the language of recondite science. On the other hand, there are propositions less intimately according with modern views. What is the cause of this? asks one. Is this a scrofula humor? Is it in my constitution? These, or even the vexed question of biliousness, may well perplex the votary of rigid science. Such querists suppose the physician to possess a truly intimate knowledge of the human frame. In the words of Sir Thomas Browne, two hundred years ago, "They foolishly conceive we visibly behold therein the anatomy of every particle, and can thereby indigitate their diseases; and, running into any demands, expect from us a sudden resolution in things whereon the Devil of Delphos would demur, and we know hath taken respite of some days to answer easier questions."

The language of symptoms leads us directly to the threshold of our science. The evidence afforded to the physician by signs and symptoms may contradict the positive assertion of the patient. But it is not on that account to be rejected. The rigid exactitude of Louis would not overrate the statement of a patient when it contravened a probability derived from previous experience. Disease has been observed for a great length of time to repeat itself in certain forms. Cancer of the breast precedes the affection in the axilla. But suppose a patient to insist that the reverse had taken place; it is quite evident that a fact so unusual must be well established before we can accept it. Nature, indeed, is under a tacit contract of probability always to do as she has already done. Her character for honesty of performance is established, and the burden of proof is on the individual to show, by collateral or some other especial evidence, that she is this time at fault.

It is then quite evident that, in questioning a patient whose testimony is not exempt from human fallibility, I must have some standard with which to gauge the accuracy of his statements; to compel him, as it were, either to conform, in his rendered account, to some one of a series of regular moulds of disease, which I alternately present to him, or to show good reason for not doing so. It is therefore necessary that I should be familiar with the standards by which I am to gauge his statements; and these standards are the result of my researches into the previously recognized order of nature. I have thus learned that nature has the habit of grouping certain symptoms together, which we then call by the names of individual diseases.

To illustrate this. If a man has certain symptoms of laryngitis, I examine him to ascertain if the lungs are the seat of a primary tubercular affection. If not, I abandon this hypothesis, and treat the affection as a local one. If treatment is again without success, I may form a new hypothesis, perhaps in favor of an aneurismal tumor pressing on the nerves of laryngeal motion, — a disease of which Mr. Liston actually died. Let it then be well established that in studying a case the mind is active; that it is not the time bestowed upon its examination, especially that it is not the protracted consideration with which a pulse is held and counted, nor the attention with which a tongue is scrutinized, that throws light upon the disease, but a previous and full knowledge of the usual combinations of symptoms which enables the observer to recognize any especial combination as one which has occurred before, and which has been before identified. On the other hand, it may be satisfactory to know that certain symptoms are sometimes united which have not been before observed together, and which the assembled faculty of the civilized world could not have been able to interpret.

There is a word in frequent use in connection with medical practice, the true value and import of which it is essential to understand, — the word *opinion*. It is used to indicate the sentence passed upon disease, and is popularly said to be *pronounced* by the physician. A man's medical opinion is quoted in the community in proportion to his combined force of character and professional notoriety. Yet these elements of popular position are often quite distinct from pure scientific ability, and it is important to separate them from it and to understand them. Scientific acquirement, which is sometimes quite a different thing from professional notoriety, should be the only standard of professional opinion, and would be so were medicine an exact science, or could medical opinion be at once tested. An opinion is, in fact, the result of judgment, and judgment must be informed and enlightened. Opinion now differs from that of former days, because science is now built up of many accurate facts, which must be known to form a ground of inference, and it is valuable just in proportion to a man's natural ability for judging, and to his knowledge of the rules of disease by which the case is to be tested.

Let us consider the process of forming a diagnosis, presupposing the observer to be sufficiently familiar with disease to identify with certainty any common union or succession of symptoms. If such combination actually exist in the case under consideration, the question is settled, and the diagnosis is made up from positive evidence.

But it more frequently happens that certain signs are wanting; that a part only of the usual symptoms are found, and that the case is proportionably obscure in its indications. A certain tumor often resembles many other tumors; and we find no obvious characteristics to identify it. Instead of looking further for positive evidence which cannot be had, the observer then avails himself of what negative evidence the case may afford, and makes what has been called an eliminative diagnosis, a diagnosis by exclusion. He considers what diseases are capable of presenting the actual symptoms before him, and, examining each in its turn, rejects or eliminates the less probable. A difficult case is thus brought, in general, within two, or at most three, probable diseases; time often supplies additional evidence which serves to complete the indications, or if not it is impossible to get nearer the truth. The comparison of symptoms which resemble one another, and especially of similar combinations, is called by the French the *diagnostique raisonné*, in which the question of similarities and of differences in the symptoms of disease is stated with reference to the application of the eliminative diagnosis in any especial case.

It is quite obvious that the observer must possess a knowledge of all the possibilities in a case before he can choose among them; that if he fail to identify a tumor by its positive signs, and is in consequence obliged to select among the entire range of lesions of this class, he must possess a comprehensive knowledge of all tumors, in order that he may invoke each in its turn and test by it the affection which is ultimately to be identified.

A rounded tumor of the cellular tissue, not peculiar in its appearance, was presented to Velpeau, who avowed his belief that it was a fœtal growth; in other words, that it was material belonging to the body of another individual, which was accidentally buried beneath the skin of the patient under examination. So remarkable an opinion excited much attention, especially when the extirpation of the mass verified the diagnosis. But examine the evidence upon which it was based. This tumor was completely destitute of sensation, and was invested with a most singular skin. All ordinary growths are susceptible of cutaneous sensibility. This tumor was then not likely to be a growth of any ordinary description. So far the evidence is negative. But a lock of hair projected through a fistulous opening from its interior. It was doubtless this lock of hair, not uncommon in fœtal growths, that laid the groundwork of a positive hypothesis, which the facts of insensibility and of peculiar skin, negative in regard to all other tumors, now confirmed. Add to this that the tumor was congenital, that it exuded an oily matter neither serum nor pus; while, to support the well known fact that such tumors often contain bone, there was a central density which might well be osseous. These phenomena led Velpeau to believe that the lesion was identical with a few others, of rare occurrence, which his wide study and tenacious memory had impressed upon his mind; and upon this probability the diagnosis was founded.

Thus the mind laden with a group of symptoms oscillates among the combinations with which our experience of the rules of nature has furnished it, attracted by resemblances, repelled by differences, again returning, in despair of finding better, to hypotheses which at first seemed to be untenable, until at last it settles where the probability is strongest. And it is the part of clinical instruction to indicate these journeys of the mind in words; to detain thought, which ever tends to hurry on and is loath to retrace its steps, while the obliquity of its original wanderings is made evident. And the student may be safely abandoned to himself when he is at once master of the few well beaten tracks of daily diagnosis, and familiar with the system upon which they are projected.

Before leaving the subject of clinical study, let us consider the value of the popular assertion that it educates the senses. How does it educate the senses? Is the eye of an artist who should chance to study medicine likely to be educated by the blush of inflammation or the red of hectic? Will the capacity of an average olfactory be probably developed by an experience of gangrene or of porrigo? Is the tactile sense refined by the wave of ascites, or the fluctuation of an abscess? Consider this very point of tact, by which the fluctuation of deep-seated fluid is detected. To doubt its existence will be cardinal heresy in the eyes of many, who consider it a leading attribute of a skilful surgeon. According to my own humble experience, fluid cannot be identified by the touch alone. A cyst may be so hard that it differs in its sensible properties from a solid body in translucency alone, fluctuation being entirely wanting. On the other hand, a solid fibrous tumor, especially an encephaloid growth, may offer a fluctuation so unequivocal, that no man from this sign alone would be justified in doubting the existence of subjacent fluid.

This must be obvious. Fluctuation implies displacement. The parietes of a contained fluid may be so tense and unimpressible that you can displace nothing; while, on the other hand, certain soft solid and elastic tissues may perfectly fulfil the required conditions. So it is with the blow of a blunt edge upon the scalp. The tissue of each side may rise in such a way that, while an inexperienced person would be quite sure of the existence of fracture of the bone when it did not exist, a skilful surgeon could only pause and doubt. Whence comes, then, the accuracy of diagnosis which in general is referred to tact, and which characterizes skill?

Leclerc, who wrote more than two hundred years ago, draws a line which in these latter days seems to have been lost sight of. He says: —

"How may it be discovered that the two tables of the skull are broken?

"By inspection and by reasoning.

"Are not the eyes sufficient alone, and are they not more certain than reasoning?

"Yes. But forasmuch as things are not always seen, there is often a necessity of making use of rational deductions, to find out that which the eyes cannot discern."

When probability is substituted for certainty, an informed judgment is our only resource.

In the kindred and beautiful science of auscultation, a new râle is learned like a new landmark; not by any especial development of the sense, but by a repeated act of observation and a corresponding effort of the memory. And wherever two or three of these landmarks can be observed an immediate inference can be made with respect to the condition of the patient. An experienced auscultator decides rapidly and at once; not because his ear is more acute, but because his memory is better stored, and he can thus assort and appraise more readily his hypothetic combinations. A skilful surgeon detects fluid, not because his tactile papillæ are more sensitive, but because his ready knowledge furnishes him with natural groups of symptoms, which now exaggerate and now discountenance the value he would attach to the indications of the tactile sense. Surgical tact, like social tact, is not only the delicate impressibility which apprises the observer of some manifestation in the individual with whom he is in relation, but it is a correct inference of its true cause and character, leading to appropriate action, and based upon a knowledge at once of collateral circumstances and of man's physical and moral constitution.

Operative Surgery is another department of our art. Here "Anatomy and mechanics," in the words of Boerhaave, "both better and more universally understood in our days, have laid the foundations and spun the thread of our reasonings; both of them sure!" In operative surgery we occupy more directly what is popularly considered to be the province of the surgeon. The surgeon in the mind of the public is associated with surgical operations; and his fame is in measure with the belief which the world entertains of the number or magnitude of the operations he has performed. Singular as it may seem, a surgical operation, even in the medical world, is apt to be looked upon with an undue appreciation; and even eminent physicians concede an unquestioned position to a skilful operating surgeon. So true is this, that for acquiring the notoriety which is a nucleus for surgical practice a surgeon had better sometimes be known as the hero of extraordinary operations which have proved unsuccessful, or even fatal, than as a follower of the usual routine of ordinary treatment.

This has always been true of the surgeon. In earlier times, when the art was in its infancy, the successes of the surgeon were more exclusively connected with manipulation than now. Besides, the art was confined to few, being in a measure hereditary, or transmitted from master to some favorite pupil. It partook of the exaggerated and exclusive spirit of alchemy, being admired rather than exactly estimated.

Much of this spirit of exaggeration still invests the science. Why is the amphitheatre crowded to the roof, by adepts as well as students, on the occasion of some great operation, while the silent working of some well directed drug excites comparatively little comment? Mark the hushed breath, the fearful intensity of silence, when the blade pierces the tissues, and the blood of the unhappy sufferer wells up to the surface. Animal sense is always fascinated by the presence of animal suffering. It is the trace in man of the emotion which the sight of blood, of laceration, or of death produces in the lower animals. But, beyond this, there is an arbitrary interest and an arbitrary importance attached to the performance of most surgical operations, in my view, disproportioned to their intrinsic merit. It is rare that supply does not respond to demand; and, in obedience to a general expectation, the surgeon is prone to foster and to encourage the undue appreciation which the public is ready to concede. The error, indeed, if it be one, lies with the community itself, which offers a sure market for surgical pretension; but the effect upon the professional world is not less to be regretted. From a habit of modifying his standard to an eager curiosity, a surgeon may easily lose his own standard, and fall into the mistake of exaggerating a case in the presence of those who are competent themselves to judge, — an error growing out of an habitual illusion, and entirely dissonant with his tact and good judgment upon other subjects.

As we have now perhaps reached the kernel of our proper subject, let us inquire, somewhat in detail, what is the actual and intrinsic merit of a surgical operation. I do not hesitate to avow a belief that the great majority of mere surgical manipulations require less skill and less manual experience than the nicer mechanical manipulations of daily industry, which excite little attention. This estimate does not include the three years of preparatory study, common both to the physician and the surgeon, but only the peculiar and usual training of the operating surgeon. Few who have studied our art in Paris can have failed to be struck with the number of aspirants singularly adroit in the various methods of performing surgical operations upon the dead subject still practising manipulations, week after week and year after year, but never destined to make their skill available, and who eventually sink beneath the surface in the tumult of competition, to be succeeded by others of equal skill. The operating surgeon should add something to mere dexterity of manipulation. "A surgeon," says Celsus, meaning an operating surgeon, "ought to be young, or at most but middle-aged; to have a strong and steady hand, never subject to tremble, and to be no less dexterous with his left than with his right hand; to have a quick and clear sight; to be bold, and so far devoid of pity that he may have only in view the cure of him whom he has taken in hand, and not, in compassion to his cries, either make more haste than the case requires, or cut less than is necessary, but do all as if he was not moved by the shrieks of his patient."

"These irregular operations," says Liston, speaking of tumors of the neck, "require, on the part of the surgeon, correct anatomical knowledge, prudence, coolness, decision, and some share of dexterity; qualifications only to be gained by practice and experience." Here is something beyond manual adroitness. I have noticed in Europe, where opportunities for comparison are frequent, that the crisis of an operation — when the wound gapes and the bleeding is free, and the end is not yet in view — sometimes induced in the operator a constitutional excitement and haste, a want of steadiness which threatened to hazard success, were the operation protracted beyond its natural and anticipated period. Fortunately, at this time difficulties are surmounted, and the end begins. This contrasts unfavorably with the physical immobility, the unimpressible steadiness, that may be relied on at a critical time, or with the self-possession which may be directed, at a moment's warning, to the quiet contemplation of some new exigency. I should place a constitutional or acquired imperturbability at the head of the qualities to be prized by the operating surgeon. Decision and self-reliance are next, and then a fertility in expedients. Bell describes an operator destitute of these qualifications as "agitated, miserable, trembling, hesitating in the midst of difficulties, turning round to his friends for that support which should come from within." "Although the chair of surgery has been, for seventeen years, intrusted to me," says the renowned Haller, "although I have frequently demonstrated the most difficult surgical operations upon the dead body, yet I could never bear to cut a living man, fearing that I might do him injury." With such evidence of its attendant excitement, it will be conceded that there is a fascination in a game where life is a not unfrequent stake, in the presence of a breathless multitude, or in the solitude of an appalled household. It is not wonderful that Wiseman wrote of "the nobility and dignity of chirurgery," and Hildanus of its "grace and splendor"; neither is it remarkable that surgery in these days should offer a resistless charm to the majority of students. And yet these attractions can be abated. It should be remembered that, with some operators, a natural insensibility, and even brutality, is a substitute for the simple steadiness of the humane surgeon. And besides this, there are shoulder joints and hips amputated, and extraordinary operations satisfactorily done by those whose names are not destined to outlive the number of the Journal which reports them, and whom accident or temerity has urged into an unwonted position. Again, the result of an operation is often no test of the skill invested in it. Nature is a great leveller, and among a hundred amputated limbs it would be difficult to distinguish the original result of consummate skill from that of only moderate ability. A traveller upon the Lakes tells us of a thoroughbred Indian, who, when a tree had fallen across his leg, took out his knife, cut off his own leg, bound it up, and paddled himself home to his wigwam on a distant island, where the cure of his wound was completed. Johannes Lethæus, having sent his wife to the fish-market, extracted from his own person a calculus weighing four ounces. Nature is the great surgeon, and art is at best but an assistant. It is also well to remember, that a dexterous operator might perform single-handed, and in a few weeks, a large proportion of the operations occurring in a large city in the course of a whole year; so that, as a question of mere expediency, based upon the frequency of surgical opportunity, it is profitable for the student to throw his labor into the scale upon whose preponderance his daily occupation will, for a long time, depend. Such considerations will not discourage genius, which is talent with a marked taste to direct, and a strong driving power to work it; nor should they dissuade those whose deliberate judgment may have determined them to pursue this art. It is, however, unquestionably better for most students to aim at being competent pathologists and physicians, than to devote a disproportionate time to the various methods of performing an amputation of rare occurrence. Besides, in estimating the true position of an operator, we are to weigh the contingencies of an operation, and not its regular and successive steps. It is quite obvious that a novice might attain exquisite adroitness in any given manipulation; but unexpected deviation of anatomy or disease, abundant and sudden hemorrhage, violence, syncope, the panic of bystanders, the lack of aid, are adventitious circumstances which call for distinct qualifications; and it follows that a patient is actually less safe in the hands of one who is not familiar with exigencies and expedients.

It has been proposed to separate the science from the art of surgical manipulation. This can never be; the involved interests are too great; and, although we meet in other walks of life presence of mind and ready concentration of the faculties to which are apparently intrusted equal interests with slighter guaranty, yet the helmsman or the engineer stakes his own life with that of the passenger, who confides not in his skill alone, but in his instinct of self-preservation. The surgeon risks nothing; and the patient confides in a character to which the lapse of time has testified.

Still, upon ground peculiar to the surgeon we arrive at another consideration of importance, — the evidence which in each case determines an operation. And here, again, is the field for the exercise of the higher faculty of sound discrimination. It is unnecessary to allude to instances in which the propriety of action admits of no doubt. Common sarcoma and common lipoma, in a healthy patient, are usually extirpated, and with permanent relief. Cancer, on the other hand, as inevitably returns at a subsequent period, and generally to prove fatal. In such cases, the contingencies on either side may be thus briefly stated. In default of excision, acute pain wearing the patient down, recurring and exhausting hemorrhage, the apprehension or actual existence of local disintegration with its accompanying calamities, which, together or singly, may render life a burden; on the other hand, a chance of a permanent local removal of these terrible local symptoms, with a chance of their local return, — a chance of not affecting the duration of life, with a chance of abbreviating it, — these are the difficult elements of the question which it often falls to the lot of the surgeon to determine. Human life is a question of deep responsibility. "You must die as you are, and an operation will give you a chance"; or, more exactly, "You can live but a few months in your present state, and with an operation you have an equal chance of sudden death and of permanent recovery," — this is a frequent and responsible alternative. To one man, life is inexpressibly dear. He would live a short month longer for himself, for his child, for his estate; while the defenceless woman, whose existence is embittered by disease which awakens a groundless but withering suspicion, would give a world to cast off her weary burden, and strives by sophistry to make the surgeon her executioner. Here the physician and the surgeon occupy a widely different ground. While the physician so adjusts his remedies that, if they do no good, they do no harm, the surgeon is unhappily compelled to see many a death accelerated, or directly caused, by his remedial agents.

Pain, but recently an object of insuperable terror, once prohibited many operations. The quivering and straining muscle, the deep groan of fortitude or the thrilling shriek of agony which resolution could not stifle, then invested surgery with a sad solemnity. In these days the surgeon has a lighter task. The rising vapor stimulates and stupefies the intellect, whose fantastic clamor may excite a not uncharitable smile; but the operator, with a conviction that alarms are goundless, lulls his patient to a quiet slumber. In other times, a fear of pain co-operated with a fear of death to resist an indiscriminate attack upon the stronghold of disease. In the annihilation of pain, let not an equal force be now brought to bear against vitality alone. The balance of surgical responsibility has been shaken to its centre by the extinction of an element whose preponderance may be truly said, in a majority of cases, to have turned the scale; and years must elapse before a standard of expediency can be adjusted. In the mean time, let the burden of proof lie with the patient; let the surgeon avoid operating when he can do so; and at least let him consider how far he would himself be ready to encounter, in his own proper person, the risks presented by each recurring case. Years too must elapse before the surgeon will cease, as he must ultimately cease, to be identified with pain; and, as years elapse, the anæsthetic will excite as little speculation upon mysterious agencies as the quill which now shields the individual from a pestilence. But it matters little that a great principle should cease to excite remark because it is of vulgar application. I care not whether the well worn story, fretted by hostile pertinacity, palls upon the ear. When the petty jealousies which opposed, and the obstinate consistency which still makes show of doubting, shall have been forgotten, — when we, with our estates and our institutions, shall be scattered to the winds of heaven, — when nations shall have been disintegrated, and their material wrought and rewrought into the organism of successive ages, — it will be remembered that the discovery which annulled the physical suffering of man was made at Boston, in America.

I wish, in this connection, to refer to another subject which is acquiring an increasing importance in our community. I allude to the practice of deciding questions of a purely medical and scientific character by appeal to a legal, and medically unqualified tribunal. A man receives a blow upon his watch or upon his window, and submits to a jury the following three questions: first, the fact of the blow; secondly, the connection between the blow and the injury received; and lastly, the extent of the injury. It is plain that the second question, of the causal relation of the blow to the injury, is in this case absurd; the effect of a stone upon a pane of glass is too obvious to be discussed, — it is a question of every-day experience. But suppose that a severe blow has been received upon the head, and that a man thus assailed has fallen dead. The connection between the blow and the ensuing death, though quite obvious, nevertheless trenches upon peculiar ground. It is customary in such a case to invite the opinion of an expert, who would not however hesitate here to recognize a frequent cause, and an equally frequent effect. But let us go a step further, and suppose the blow to have been followed, not by death, but by some derangement of the physical or mental functions. A man shown to have previously possessed less than an average share of intellect complains after such injury of an impairment of the memory. It is claimed for a sickly child, with many symptoms of diseased spine, and some time after receiving a slight concussion, that the disease is unequivocal. These are cases which have actually gone through the courts, demanding remuneration. An accident happens; a man receives a considerable jar; and if he subsequently experience obscure pain, or short breath, or epileptic fits, or any symptoms of which the proximate why and wherefore are utterly and profoundly inexplicable, he does not hesitate at once to accuse individuals, railroads, or towns, and to prosecute for damages. It is plain that, to establish his case, he must show the connection between cause and effect; between the stone and the broken glass; between a blow upon the shoulder and a permanent pain perhaps in the leg. Before whom is the question brought to issue? Not before a jury who have spent a lifetime in acquiring an intimate knowledge of the physical mechanism of the human body, and the causes and consequences of its derangement,—men who have ascertained that nothing in medicine is certain, and that, for the lack of certainty, every question must be decided, if at all, upon its probabilities, and who are accustomed to balance these probabilities. This intricate question is not thus brought to issue; but is laid before twelve average minds, taken at random from the common walks of life, profoundly ignorant of medicine, or equally imbued with prejudice, and who are to be educated in a few days upon points which most intelligent students, after two or three years' exclusive study, would avow themselves unprepared to decide. This is not a question of the rights of inert property, nor of the modifications of mechanical force, nor of abstract right and wrong, nor of a fact of occurrence, nor of any other subject which the general education of daily life renders men competent to settle; but it is a question of recondite and peculiar knowledge. And to submit such a question to most men is to submit the figures of the planet Neptune to an optician because he owns a telescope, or to refer the question of pregnancy to a jury of matrons.

Unable itself to draw any inference from medical facts which it cannot comprehend, a jury is theoretically supposed in informing itself of the opinions of physicians and surgeons to make an average of the results at which experts have arrived. Here, however, is another fruitful source of error; on the one hand, human testimony, especially in small communities, is not rendered less uncertain in an uncertain science by the insensible influence of conflicting medical interests; and on the other, the public at large is totally incompetent in any case to estimate the relative scientific value of medical testimony. There is also a tendency among juries taken from the mass of the community to side with the professedly oppressed. Wealth, incorporated or unincorporated, does not invite equal sympathy. Here is a bias. And in this refracted light medical opinions of unequal value readily neutralize each other. Probability, too often the substitute of certainty in medicine, is exaggerated; or still worse, it is enough in some cases to show that a symptom might possibly have followed an accident; and the burden of proof is virtually thrown upon the defendant to show that it actually did not. The defendant is then guilty until he proves his innocence.

Now almost anything may occur in medicine. The most fantastic possibilities actually do occur. For instance, a good sized crowbar was shot through a man's brain, and he recovered. Another patient had an excessively itching ulcer upon his thigh; whenever he scratched it, he experienced extreme tightness of the chest and dyspnœa, and only then. The father of Lord Cavendish had a pain in the left arm connected with a stone in the bladder, and the only knowledge which he had of the necessity of micturition was the recurrence of this pain. With such facts possible, and these are perhaps solitary instances of their kind, what can be absolutely denied? Now, let two or three doctors testify before a jury that, when a railroad car stops suddenly, it is barely possible that any passenger may be taken for the first time with an epileptic fit; and let an equal number of medical witnesses testify, on the other side, that it is indeed possible, but that evidence upon this point is altogether wanting; or let them avow, with John Hunter in an analogous case, that they "can give no decided answer," and the verdict, as in that case, will very likely go against the defendant, and this in default of any corresponding medical probability whatever.

It may be a matter of policy to compel a railroad to pay for every accident to life or limb, and so to remunerate a road for travel that it can also afford to insure the safety of its passengers. It is a very serious question, however, as a mere matter of expediency, how far a patient may prosecute his surgeon for malpractice. On the one hand, gross injustice and ingratitude are occasionally exhibited towards the surgeon. He is made to suffer for deformities which could not be prevented.[1] Besides, a patient residing in a thinly settled country who employs a local surgeon virtually says, "I have, on the whole, decided to place myself under your care; you may not have the experience or the opportunities of a surgeon in a large metropolis, but there is not time to send to a distance, and I cannot meet the expense of it; I am therefore prepared to incur the chances of recovery with such aid as you may offer, and on such pecuniary terms as are customary in this part of the country"; and he has no right subsequently to complain. On the other hand, the chance of being mulcted for gross inefficiency is a chief preventive of ignorant pretension. It is the only means of hindering certain practitioners from assuming duties for which they are not competent. These, however, are questions of practical expediency, differing widely from that of scientific right and wrong. Tested by the single standard of surgical truth and error, I believe injustice to be often done to individuals and to corporations; and if poisoning, infanticide, and analogous crimes have created a science of medical jurisprudence, I know not why surgical injuries do not demand an equal, perhaps a more extended science, of surgical jurisprudence.

[1] This resort to law has become so familiar, that it seems to suggest itself at once to every country patient who is dissatisfied with the deformity of a fracture or a dislocation. I am persuaded that patients often leave metropolitan institutions, where they have been treated with skill and care, who would in the country be able to make a strong legal case of a distortion which was inevitable under the best treatment.

Let us establish a position in relation to empiricism. It is usual to reserve feeling, or at least declamation, for those who are considered hostile to the interests of the true medical faith. And there is excuse for unfriendly feeling, and a reason for the antagonistic attitude usually manifested towards quackery by our profession. Those who occupy a firm position in established medical centres unquestionably encounter it more rarely, and feel its influence less, than those whose medical practice lies in thinly settled districts, or among less educated classes. The public opinion of large communities is very apt to be well ballasted by common sense; while in small communities, agitated by minor interests, medical, political, and religious faith are almost equally subjects of difference and change of opinion, and the interests of medical men are as often very seriously affected. It is, therefore, the duty of every medical man to discountenance quackery, the only question being how far and in what way this may be accomplished. Laws to repress it have existed at various times. Stowe, in his Chronicles, says, "A counterfeit doctor was set on horseback, his face to the horse's tail, the same in his hand as a bridle, a collar of jordans about his neck, a whetstone on his breast, and so led through the city of London with ringing of basons, and banished." The present French law is stringent against charlatans in medicine. Quackery has always existed; and yet, although barren of invention, treading in a monotonous round, a thousand times exposed, and as often presenting itself anew with the same threadbare pretences, it is always receiving the same encouragement.

Here are the natural bone-setters of 1579. "Here," says Ambroise Paré, "I determine to treat of those impostors who, taking upon them the person of a chirurgeon, do, by any means, either right or wrong, put themselves upon the works of the art; but they principally boast themselves amongst the ignorant. common sort, of setting bones which are out of joint and broken; affirming, as falsely as impudently, that they have a knowledge of those things from their ancestors, as by a certain hereditary right, which is a most ridiculous fiction; for our mind, when we are born, is as a smooth table, upon which nothing is painted. . . . God hath endued all brute beasts with an inbred knowledge of certain things, necessary to preserve their life, more than man. . . . For it is no more likely that any man should have skill in surgery because his father was a chirurgeon, than that one that never endured sweat, dust, nor sun in the field, should know how to ride and govern a great horse, and know how to carry away the credit in tilting, only because he was got by a gentleman, and one famous in the art of war."

Here is the hydro-practice of Petro, who flourished a short time after Hippocrates, and who, says Celsus, "as soon as he was called to a person in a fever, when the fever began to be a little abated, gave cold water to drink; and if it once raised a sweat, he pronounced the patient to be out of danger; if it had not procured that discharge, he gave still more cold water, and then obliged him to vomit. If it did not give way to these methods, he boiled water with salt, and obliged him to drink it, that, by vomiting, he might cleanse his belly. And these particulars" (I use the words of Celsus) "made up his whole practice; which was not less acceptable to those whom the successors of Hippocrates had not recovered, than it is to those in this age, who have been long unsuccessfully treated by the followers of Herophilus or Erasistratus. Nor is this kind of medicine not to be esteemed rash; because, if it has been pursued from the beginning, it kills more than it cures." What comment upon modern quackery is more dispassionate and to the point than this of seventeen hundred years ago!

Read the medicine of any people or of any time, and you find allusions to the contemporaneous growth of quackery, perhaps of elaborate efforts to repress it. The "Art of Chirurgery," published in 1663, contains nine folio pages of elaborate argument, to prove that wounds said to be healed by the "weapon salve . . . are cured by the help and assistance of nature alone," and which were written "in regard that there are many who have asserted the contrary." "Crollius terms all ignorant and simple that doubt of the efficacy of this medicament." Nine pages of logical argument is an opposition abundantly sufficient to reanimate any falling cause, and doubtless for a time invigorated this.

Medical quackery belongs to no age, to no country, and to no people; its elements lie in the human mind. It is as certain to take root and vegetate in any country or in any age where mind exists, as cancer is to affect the material tissues. Quackery is but an unsound modification of every science and of every art. It is a false pretence of ability, or knowledge. The science of medical therapeutics is especially open to it, both from its uncertainty and from the difficulty of verifying it. You can test a piece of iron, or a plan of ventilation; but give a remedy, and how shall you know, from a single case, whether nature or your physic cured the patient? You can only speculate upon various probabilities. "Medicine," says Celsus, "is a conjectural art, and the nature of conjecture is such that, though it answers for the most part, yet sometimes it fails." "God and nature," says Ambroise Paré, "do sometimes such things which seem to physicians and chirurgeons impossible." "This observation and some others," says J. L. Petit, speaking of hernia, "prove that cures which appear miraculous are due to nature more than art." If nature is conceded to have so large a share in therapeutics, you can decide the effect of a single remedy only by a deliberate inference upon a series of cases. But how difficult is this act of the judgment! To many men, one personal experiment is worth octavos of recorded evidence. "I grant everything," says one of these, "but I know that this cured me, and I think it will again." "And, indeed," adds a bystander, "if it agrees with his constitution, why should it not?" Personal knowledge of single cases lies near the foundation of all quackery. Again, the physician frankly avows the inadequacy of his art. The charlatan promises a cure, indorsed by the statement that he has had a precisely similar case. "When it was decided that the Lord Martignes must die, Monsieur de Savoy showed himself to be much discontented, and wept; and asked the physicians again, 'if for certain they all held him deplored and remediless'; they answered, 'Yes.' Then a certain Spanish impostor showed himself, who promised on his life that he would cure him; and if he failed to cure him, they should cut him in one hundred pieces. 'I swear to thee, by God, that before eight days I will make thee mount on horseback, with thy lance in thy hand; provided that no one touch thee but myself. Of this thou mayest be assured upon my promise. I have cured divers who had greater wounds than thine.' And the lord replied, 'God give you grace to do it.' Notwithstanding, two days after the said lord of Martignes died; and my Spaniard, seeing him in the agony, eclipsed himself and got away without bidding farewell to anybody." This is the second category of quackery, common to all ages and countries; except that, in these days, the cancer doctors and the water doctors find it unnecessary to "eclipse themselves and get away," inasmuch as the notoriety of a case which has proved fatal is pretty sure to bring another.

Other bias of deliberate judgment may be found in a love of change, of patronizing, of originating, and especially when a quiet and inoffensive person suddenly, and perhaps to his surprise, finds himself arrayed in the defence of some form of quackery which consistency obliges him to make his own cause. And, finally, the mind is often irresistibly swayed by the personal attraction and power of some representative of unsound doctrine.

Fully to appreciate the leaning of medical evidence demands capacity simultaneously to grasp a considerable number of details, often distributed through time, and also a fair share of intellectual capital to discriminate and to combine them. Now a mind well endowed by nature, and susceptible to stimulus from subjects connected with the daily occupations of life, and for which it has a natural aptitude, may have no taste for this especial subject, or knowledge of it, and so yields at once; or may be biased by any of the considerations already mentioned.

On the other hand, many minds cannot comprehend a logical necessity, and propound their belief quite as impressively as if they could. Expose to a person of this class a preponderating mass of probability, or an inevitable certainty, depending from a chain of evidence, and at the expiration of an hour you shall receive the answer, "Still the quack cured this man." "But," you reply, "nature, and not the remedy, cured him," — to demonstrate which you open another argument, and are again brought up by the original premises of your inflexible friend, that "the man was cured."

Such has been and will be the permanent nutriment of quacks, not of any one sect, but of all sects; not of any one year, but in all the past and in all the future. If these views be correct, quackery cannot be repressed by any exposition of the absurdity of a theory or set of theories. It is not its local or temporary manifestation that demands our notice. Its roots lie deeper, — in the defects of the human mind. Credulity and imperfect knowledge are the fermenting soil which nourishes a hundred different excrescences, modified by the local influences of disease or of national peculiarity. Every intelligent man must have his medical, political, and religious faith; and unsound and unenlightened minds, in a free country, will have equally theirs. You cannot abate quackery by anything short of government restriction. Let us not vitalize it by opposition. It lives by notoriety. Like cancer, it is inflamed and grows by injudicious efforts to repress it. Leave it alone. You cannot recall a patient strayed from your fold by exhibiting your displeasure. Maintain your philosophy. Your patient may return, but it is even then quite likely you will live to be many times deserted in behalf of quackery by the same profound logician.

The progress of true medical science cannot be impeded by the vulgar opinion of the unsound or uninformed. It is in this century steadily and rapidly progressive. Entwined with the kindred sciences of physiology and chemistry, it grows as they grow, at intervals sending forth an independent shoot. It is curious to observe the difference in the methods of its culture, at different times and in different countries; and to note how a few standard types of medical research have been repeated. Celsus divides the medical world into two classes. "There are those," says the Roman writer, "who declare for theory in medicine, and who look upon the following things as necessary: a knowledge of the occult and constituent causes of distemper; next, of the evident ones; then, of the natural actions; and lastly, of the internal parts." Among occult causes were included the purely theoretical, such as the four elements, humors, etc. Another class, who styled themselves empirics, admitted the "evident causes" as necessary, but "affirmed the inquiry after the occult causes and natural actions to be fruitless, because nature is incomprehensible." They held that "it is much better to seek relief from things certain and tried"; that "medicine was deduced from experiments"; that, for example, "some used a full diet in the beginning of a disease, others were abstemious; and that those grew worse who had eaten plentifully." "That these and the like instances daily occurring, diligent men observed attentively what method answered best, and afterwards began to prescribe the same to the sick." Here is the medical theorist, and here the experimentalist of all time. On the one hand, the humorist, the solidist, the Brunonian, and I know not what other disciple of false theory, ever volunteering and assuming the unproved *why;* and on the other side, the Hunter and the Louis, dealing with nature as it exists, cautious in assigning cause, inexorable in requiring evidence.

It is a little remarkable that national peculiarity should be so marked in its bearing towards medical science. "The Englishman, while still young," says Roux, after his visit to London, "is remarkable for a certain maturity of reason and of judgment, which, when we are about to teach him any science whatever, allows us to reckon as much upon the operations of his own thoughts as upon the simple exercise of his memory. Without being less qualified for labors of the mind, for the cultivation of the sciences, and conceptions of genius, the French youth is more impetuous, more distracted; his reason is more slow in coming to maturity; and when he sets about the study of the sciences it is necessary, for some time at least, that his memory only should be cultivated, and that few things be left to his meditations."

French medical science strikes a foreigner as a forced growth, a business overdone. There is less claim to originality in science, than constant struggle to assert it. Numerous scientific societies offer a market to novelty. Here is a mutual forbearance which listens patiently, on condition of being heard. A society or a train of followers thus becomes a rostrum for announcing the last remedy or surgical operation. It was complained that a gunmaker availed himself of the Academy of Sciences to give his wares publicity.

This long custom and facility of disproportionate announcement is a constant stimulus to the medical world, who labor with an assiduity little known in this country. Medical discoveries are generally but novelties, slight modifications in routine or method, and seem to be an inadequate remuneration for the great labor expended. On the other hand, this constant review of details produces a medical precision elsewhere equally unknown. In knowledge of the usual combinations of symptoms, in diagnosis, in pathology, the French are unrivalled.

The German mind is of a different stamp. Here is the same, perhaps greater, capacity for labor, guided by the most ingenious and recondite theories. From Germany we have embryology and the philosophical anatomy, originating, as if to stamp a current value upon the imaginative faculty, with the great German poet, Goethe.

John Farey, a practical engineer, and familiar with the history of mechanical inventions, in his testimony before a committee in the House of Commons, in 1829, expressed the opinion that "the prevailing talent of the English and Scotch people is to apply new ideas to use, and to bring such applications to perfection; but they do not imagine so much as foreigners." This is perhaps as true of science as of art. The general tendency of modern English medicine is not to new or subtle theory; neither have the majority of English medical writers any taste for dry and exact detail. Theirs is not the philosophy which excavates perpendicularly downward at the root of some isolated fact, to scrutinize in the ultimate fibril its microscopic point of contact with the hidden rills of science; nor yet that which toils on the surface, to note with unwearying fidelity the germination of disease, and to chronicle in every leaf the varying type of morbid action.

But there is a high intelligence and a large share of sound determination in the English medical mind. It is slow of admitting novelty, a little tenacious of opinion, perhaps of prejudice, and, ever leaning to the useful, to practice rather than theory, it is perhaps a little exclusive in its attention to therapeutics. But we are dealing with the practitioner as well as the pathologist, the man as well as the philosopher; and we recognize the cultivation of the higher intellectual faculties, and the balance of a strong common sense.

Louis and Hunter! the pathologist and the philosopher! The one stimulated by a passion for truth, the other impelled by genius. The labor of the one a vast and fragmentary system, sketched by the hand of a master, with here and there a thought, as of inspiration, which suggests the architecture of the whole plan. That of the other, a corner stone in the foundation, which art cannot improve, and for which no other can be substituted, which may be built over as the edifice is reared, but which will resist the wear of time.

Louis, singling out each function of the healthy man and tracking it through the labyrinth of disease, observing such experiments as nature itself might institute. Hunter dismounting the machinery of the whole animal world, ever suspecting new truth, forming new theory, and with a rapid sagacity organizing original experiment. "For, as in ordinary life," says Lord Bacon, "every person's disposition, and the concealed feelings of his mind and passions, are most drawn out when they are disturbed, so the secrets of nature betray themselves more readily when tormented by art, than when left to their own course."

Louis gauging phenomena by standards of color and form and dimension; Hunter seeking behind these phenomena to link them by some principle common to animal existence. Louis identifying occurrence, the when and the whether; and affirming truth upon this side of the verge of uncontrovertible certainty. Hunter seeking cause; ever contemplating the why; transcending proof to speculate in possibilities; summoning a thousand facts from the recesses of a vast mind, to cluster them about some shadowy uncertainty, until it is revealed as palpably as if demonstrated.

In a storm of prejudice and error, Louis stood passionless and inflexible, deep in the conviction that, amidst the flashing and meteoric sophistries of Broussais, the modest lamp of truth would arrest attention by its intrinsic beauty. His was an intellect not readily conjecturing, but sound in its discrimination between well known and recognized resemblances, and indefatigable in action. The intellect of Hunter was a gigantic mechanism in full play, capacious of a myriad of circumstances, cognizant of the loftiest and of the humblest details of the organized world. Rapidly transported to the confines of human knowledge, and there pausing, Hunter sat, as in that noble effigy which art has bequeathed to us, for hours consecutively contemplating the memory of facts beneath an ample forehead. It was then that faculties, at other times chained to the slow progress of experiment, or diverted to the exigencies of daily life, assumed their legitimate sphere, and strove with a noiseless and impetuous energy. Gazing into the misty future, suspecting affinity from resemblances as extravagant as beautiful, devising and executing almost simultaneously the *experimentum crucis;* ever laboring; soaring from experiment to abstraction, and nailing abstraction again down to the test of experiment; toiling at his art for the means of gratifying his enthusiasm for his science; — such was John Hunter; and if his books are hard to read, I question if the hardness be not the hardness of his facts, and their obscurity the depth of his reasoning.

From mind turn to matter, and regard the possibilities of human knowledge in our science. Who will assign a limit to man's future knowledge of chemical affinities? Reason indicates no barrier beyond which the analysis of inert matter may not be urged. The chemical eclecticism of the atoms of animal tissue will ultimately be traced to a point where chemistry yields its sway and vitality begins. The cell, the stage at which matter, stimulated by the vital force, first becomes sensible to the eye, is now being recorded in all its manifestations, as it yields to the mysterious influence which transforms it into the animal and vegetable world. Cancer and tubercle, lesions of the cell common to the whole animal kingdom, and terribly devastating to the human race, are upon the eve of being as far identified as a thorough appreciation of their ultimate form and a fair inference from the forces which animate them will warrant. Muscular force, which has now been shown to animate the simple cell as well as the ultimate element of the true muscular fibril, is as yet unexplored. Its key fact, the entering wedge, the starting point from which investigation shall proceed, remains to be recognized; and unless it lie in that acknowledged fragment of what is called animal magnetism, which is said to modify or annul muscular power, it is a labyrinth without discovered entrance. Yet there is nothing in the relation which this force bears to animal existence which ostensibly prohibits its eventual exposure. The nervous fibril of each muscle will one day be followed to its termination in the cerebral mass; and while the physiologist assigns fibre after fibre to the sensitive and motor functions, the intellectual philosopher will analyze the mental faculties, claiming for their few dissected elements whatever tract may then remain unappropriated. The solid and the fluid, the denser and the rarer air, chemical force, light, the muscular and vital force, the intellect, the individual, successively elude one after another of our senses, until apparent certainty becomes hypothesis, and conjecture in its turn fades into utter ignorance. Yet they all exist. The term material has relation only to the reach of human faculties. The interlacing evidence of all the senses attests their actuality; hypothesis allures us to give form and body to the slightest revelations of a single sense in that vast field which is conceded to be immaterial, and which lies where human imagination even can hardly follow.

Religious faith makes it a duty to avow this ignorance in conceding to infinite power the ability to act without material, and without place and time. To fix this point is simply to assign a limit to the reach of human understanding; and in the impossibility of doing this, it is neither a confession of an absolute faith, nor a disparagement of the attributes of matter and of mind, to run the boundaries of immaterialism close to consciousness itself; to class with the material not only the attributes of matter, but that machinery of the senses and of the mind which is subservient to the will; and in this way to extend the possibility of human comprehension, so that it may one day unravel much that is now invisible and intangible, exposing the subtle relations of matter and of electricity, of muscle and of force, of special sense and of intellect. Analogy would then suggest in these untrodden regions continuous stages in a system of transition from palpable to less material; the development of a lofty structure, at whose foundation man now toils.

It has been well said that, "if we are to have a correct philosophy of the human mind, it must come from physicians." As the surgeon deals with pathological processes which come into immediate contact with his senses, so the physiologist is nearest the mechanism of thought. Rays of light approach the earth, bearing the image of a distant star. They are woven and interwoven by human art, they penetrate the eye of the astronomer, to be elaborated in the mind, and sweep on with the diverging rays of human knowledge to illuminate the intellectual world. The physiologist claims the narrow isthmus which unites the luminous and mental ray, and lays his finger upon the machinery which effects the first step in the system of transition.

Analyze reason itself. The working of this complex faculty, divested of its adventitious circumstance and sifted to its simplest form, the syllogism, is but a recognition of equality or inequality, of identity in degree. Represent equality or inequality by units. Suppose the mind to deal with units of resemblance or of difference, and we have already invaded the science of number, — an intellectual operation which can be performed by a material mechanism with far more accuracy than by the intellect itself, and in which a unit of brass is more certain to register its due influence upon the dial, than is an abstract unit upon the tablet of memory.

A brief but grateful task remains. The office which I humbly hold has been occupied by those whose well earned name has conferred upon it dignity, and even lustre.

He to whose hereditary claim upon our respect, and to whose culminating and completed reputation we now yield a ready deference, but yesterday was toiling with an iron energy and unremitting will, bending to our science the best faculties of a long and vigorous life. Go to yonder amphitheatre, where the sufferer seeks in silent agony the last resources of our art; and in its wide facilities, its noiseless discipline, the absence of all ostentation, and in the calm severity which recalls the classic day of surgery, in a perfection indelibly stamped upon the organization of this arena of our science, study the impress of his ruling intellect.

Yours, gentlemen, is also the grateful recollection of one the echoes of whose voice have hardly ceased within these halls. The spontaneous language of regret that he should have withdrawn in the meridian of his abilities from a position which no one was better qualified than he to fill, is yet upon the lips of all who have at heart the welfare of this institution. For many years identified with its history, the warm advocate of whatever was advantageous to the Medical School of the University, deeply interested in your well being and receiving in return a ready and loyal devotion, the loss he has entailed upon you in resigning the Professorship of Surgery cannot well be overestimated.

With unfeigned distrust in my ability, with a deep sense of responsibleness, with an earnest hope of making this office in some measure useful to others, I enter upon its duties.

# SCIENCE AND SUCCESS.[1]

When, after a long and prosperous voyage, the good ship has made the land, and is skirting past the familiar objects of the shore, the passengers elated with the prospect of a speedy release, the officers no longer anxious, it is customary to devote an interval, as now, to an interchange of kindly feeling and of mutual good wishes. With your permission, I will endeavor to beguile our yet remaining minutes in attempting to convey to you my own impressions of the shore on which you are about to disembark, and something of the country beyond it. The history of late years has been instructive to those who, in pursuit of wealth or of a new field of enterprise or distinction, have courageously but unadvisedly invaded an unknown territory, without an adequate knowledge of the difficulties to be met, — with enthusiasm perhaps, and high aspiration, destined but too often to be wasted in misdirected effort or frittered in unprofitable industry.

Whether you are here in the fulfilment of a long cherished plan, the dream of earlier years, or whether by the trivial influence of some little circumstance you have been switched upon a new track in life, and whirled far from the scene of earlier associations, each of you is now bending earnest steps to a new field of labor, determined to convert his store of knowledge into a means of creditable livelihood, — to earn an honorable position in the place of his future adoption, and perhaps distinction in the world of science.

[1] A Valedictory Address delivered to the Medical Graduates of Harvard University, Boston, 1859.

No profession tends like ours to confuse the different phases of worldly distinction; moral excellence, for example, with medical attainment; intellectual ability or cultivation, with success in business. Let me at the outset explode any lingering belief that what is usually called eminence in science necessarily produces medical practice; or that large medical practice necessarily implies much in respect of medical science. Inquire in any considerable metropolis for the physicians in extensive practice. You will hear some of their names for the first time, while, if you ask about the practice of a man whose scientific name is a household word, you may find it often inconsiderable. The qualities of a good practitioner need no encomium of mine. Far be it from me even to seem to undervalue them. But I shall endeavor to show that the pursuit of medical science and the practice of medical art are often uncongenial occupations, which lead the mind in different directions; and that a taste for science is on one side of and separate from the qualities which insure an extensive business. It is true that there is no absolute incompatibility in these pursuits, for though Hunter left the dissecting table unwillingly to seek the necessary guinea, practical study must have been a congenial occupation to the mind of Sir Astley Cooper, who was eminently a practitioner. He himself told me that he rose at an early hour of the morning for scientific work, digested his morning studies afterwards, while he visited his patients and wrote out his results in the evening. The names of Brodie and of Lawrence are familiar to us as reaping largely and early in the field of science, while their medical practice was lucrative. In fact, the reputation which accrues from scientific distinction is justly more available than any other in inviting that confidence which in its turn leads to practice. But to develop and retain this practice, demands other qualities, — and I shall presently refer to them, — the possession of which may be sufficient to insure to some individual ignorant of common medical truths an extensive medical business, not indeed of the best class, but among people who are more or less intelligent in other matters. And one who possesses the practical and efficient industry here alluded to, by a familiar intercourse with disease, acquires a certain rule of thumb appreciation of it, which is his scanty scientific stock in trade.

Study is generally the chief occupation of earlier professional life, — if not at that period, never. It afterwards gives way gradually to practice; and this perhaps is the usual life of the physician. The man who gives himself up to science is very apt to be a recluse, impatient of interruption. The large practitioner, on the other hand, has barely time to read the newspapers, much less to follow the medical literature of the day or age.

In considering first the science, then the art of medicine, let us look for instruction, if there be any, not in the customary eulogy of an ideal excellence, but in such a consideration of our subject as might be suggested by an observation of daily life. We are most of us charlatans when we are sick. It is rare that an at once sagacious and prejudiced man dies, like Spurzheim for example, proof to the last against the incantations of our art. Let us then embrace this moment, while our faculties are yet unweakened by disease, with the mind unclouded and the eye tolerant of light, to view our occupation for a short time with a steady gaze, — its beauties, its defects, — not unmindful of the one, nor flattering ourselves in ignorance of the other.

We all know that medicine is a composite science, and that its advance is dependent, not only upon a knowledge of its elements, of symptoms of disease, and of the appearances of diseased parts, but also upon that of physiology, anatomy, and chemistry. To identify disease we must know health.

To repair the machine, we must understand its structure and its working. But the student of physiology or chemistry may insensibly wander far from the field of pathological research, absorbed or beguiled by phenomena, which are at each step less immediately applicable to his own peculiar science, especially to the details of his daily vocation. He may not only become bewildered in the interpretation of equivocal appearances, but his mark may be effaced by the next wayfarer in the same direction. On the other hand, let him linger nearer home, and the paths are worn and barren. Earlier explorers have left so little to reward his industry that the chiffonier in science, no matter how industrious, stores his basket with material of inconsiderable value.

Yet most of us must be content to accept one or the other of these alternatives. He who climbs the tree of knowledge is likely either to linger among its larger and unproductive stems, or to follow some inviting branch in its divisions and subdivisions till he finds himself far to one side, perplexed in studying a handful of its ever subdividing fibres, and his sky darkened by the crowding foliage. It is reserved for the capacity of few to grasp in a comprehensive glance all the relations of the outspreading branches, from the leaf to the trunk, — to discern the fruit, and to garner a profitable harvest.

It should not be inferred that he who has earned the highest place in scientific acquisition is most likely to make a great discovery, remarkable either for its novelty and brilliancy or for its utility. Knowledge is not always cultivated for the sake of its direct utility or immediate application, but sometimes only to extend the range of human comprehension, to enlarge the sphere of intellect. But intellectual ability in any direction rightly commands respect, whether, like that of Leverrier or of Peirce, it lays up facts and develops knowledge which may be turned to use in sailing over or measuring the surface of the earth, or in weighing its atoms, or in adjusting the complicated curves of mechanism; or whether it is simply an exhibition of gigantic and unfruitful capacity, like that of Morphy. It is, however, a mistaken zeal which would monopolize for the votaries of abstract science the larger share in fashioning the material world to the direct comfort and welfare of the human race; which always points to the alleged scientific pedigree, for example, of the safety lamp, as if it were not at every moment offset by the protean phases of India rubber, or of the sewing machine, or even of a common apple-parer; all of the plebeian birth of art, but all intrinsically involving a more complicated mental combination.

If you are ambitious for the fame of a discoverer, you will be solaced by remembering that the not untrodden paths which led to a knowledge of the circulation of the blood, of vaccination, and of the properties of ether, — discoveries which will bear the names identified with them to a remote posterity, — were open to the ordinary capacity, as well as to the ordinary cultivation of man. But beyond the requisite devotion or distortion of his daily life to an idea in the possible realization of which he believes, he who expects to draw the prize must have good fortune. In such lotteries there are many blanks. A witty friend of mine once said, that sweeping the sky for asteroids and comets was like sweeping the street for sixpences. A man might find one, but this good fortune does not explain why he should receive a silver medal also. We might almost dispute the justice of the lottery which seems sometimes to overlook the continued toil of cultivated genius to bestow a discovery of immense utility on some importunate laborer, whose chief claim was that he believed the prize was there, and that he was determined to possess it.

Indeed, a medical discovery may be made by some person of extravagant views in medicine, perhaps on the whole unskilled in disease and its treatment, a man of one idea, whose life may be collectively of more harm than good to the community; and yet while the individual may be justly appraised and ranked by contemporaries, or by those who know all his qualities, good and bad, the name attached to the discovery is an abstraction which posterity and foreign nations may honor with unqualified distinction.

We need not subject any real or alleged medical discovery to a cynical and cold-blooded scrutiny, but rather direct attention to the little that we may know or even care to know of an individual — of his life, or of his views of the rest of science — beyond the name which stands as the barren and algebraic exponent of recognition by the world of a received value.

Just fifteen hundred years ago, there lived a man of servile origin, who, his employment being mean, rendered it infamous. He was a worthless parasite, a vile informer, and afterward a tyrant, each moment of whose reign was polluted by cruelty and avarice, — a plunderer of temples, and, it is said, a ravisher of women. "This odious stranger," says Gibbon,[1] "disguising every circumstance of time and place, assumed the mask of a martyr, a saint, and a Christian hero; and the infamous George of Cappadocia has been transformed into the renowned St. George of England, the patron of arms, of chivalry, and," somewhat oddly, "of the garter."

There is another phase of scientific fame of which we sometimes hear, more closely related to the solid substance of intellectual cultivation, of large and laborious acquisition. Men who have studied are often tenacious of their so called scientific reputation; which I suppose to mean an acknowledgment by other men of similar pursuits of their degree of commendable attainment, and of the actual progress in

[1] Decline and Fall, chap. xxiii.

knowledge they may have made. This reputation is a more legitimate one. And yet you might occasionally suppose that there existed a monopoly of some nebulous and ill defined variety of greatness among the votaries of physical science; a superiority of sentiment which concedes little, for example, to the energy, the wide-spreading contemporaneous knowledge of the merchant, to the perfection which the practice of the law impresses on the higher intellectual machinery, or even to the wisdom of the statesman; while it is assumed that the investigator of a microscopic species or the finder of a new insect may expand at leisure and by right within his mystic circle.

You will also hear of a pure and dispassionate atmosphere of science, remote from the conflict and struggle of busy life. Without insisting that our own National Medical Convention is its exclusive and peaceful asylum, I have yet to learn that we have reached that ideal stillness when the passionless form of truth is simultaneously contemplated by two naturalists who have stumbled upon the same stone or fish or flower, or even that it hovers around the mutually impinging tubes of any two astronomers.

The wisdom and excellence of the world is not vested wholly in those with whose names and reputation you are most familiar, nor can we suppose that those of whom we know comparatively little have been shut out from all participation in the divine gifts to man.

The noblest part of the character of a whole contemporaneous people, the Indian of the Northwest Coast, is almost unwritten, save in the casual testimony of a visitor from a distant shore when the race was not as yet demoralized and asphyxiated by the invading wave of new and uncongenial forms, — a traveller whose own large intellect, whose sense of justice, and whose warm and generous impulses could elicit a like response from savage stoicism and reserve. We cannot suppose that Solomon monopolized the discretion of his generation, nor yet that Celsus, Galen, and Hippocrates were the only and best family practitioners of their respective dates. There is a machinery to fame. It is one thing that a quality should exist, and another that it should come to be known. In civilized centres, talent and attainment generally make their mark; but sterling sound sense and excellent medical acquisition may be sown through many a village, unambitious and unobtrusive, while, on the other hand, men upon whose medical judgment you might justly hesitate to rely may by adventitious circumstance or a thirst for notoriety or gain be urged into a conspicuous position.

Briefly, then, immediate usefulness is but a collateral object in the pursuit of science in its higher aspects. We rather look to the exercise which the latter gives the human intellect, and the field which it lays open for the progress of the mind. Science explores, points out the way, invades and annexes new districts, suggests their capabilities, although much in their loftier and remoter regions may be at the time unproductive territory. But the flood of industry soon pours in, selects its productive spots, and tills the soil or digs the gold.

Knowledge generally advances by slow steps, and the supervision of its progress is allotted among many individuals. The almost useless iodine, or lunar caustic, or the curious collodion; the daguerreotype, and at last the stereoscope, which conjures to your fireside the living apparition of every image created by God or man; a common adhesive strap in the hands of a New Hampshire surgeon, and an apparatus of fracture extension for which no European potentate could at need command an equal substitute; the old familiar ether bottle on the shelf, and anæsthesia; — all these are examples of this subdivision and gradual growth. Then let each contribute something. If utility does not demand great intellect; if gigantic feats of intellectual force do not insure utility, the prizes fall to industry; and sometimes to a tenacious — I had almost said insane — pursuit by each of what may seem to others a chimera.

But I hasten to the more attractive theme of art; of therapeutics and of daily life; the field of practice, where, in the imagination of the student, the laurel wreathes the surface and the gold embarrasses the soil.

Referring you to the abounding annual harvest of medical introductory and valedictory literature for the reiterated inculcation of honorable motive and profound learning, and yielding to no one in a just appreciation of the importance of holding constantly in view a standard of attainable perfection, I shall venture, perhaps in humble imitation of those divines who seek instruction from the contemplation of man in his imperfect state, briefly to speak of medical practice as it sometimes is. And, first, of the power of remedies; meaning, of course, that therapeutic region which is still open to discussion, with sedulous respect, at the same time, for the fixed and imperishable boundaries of that domain which therapeutic art has distinctly and forever subjugated.

It was a singular reflection upon the career of some physicians of great eminence, fifty years ago, that their lives might have been, on the whole, productive of more harm than good, I do not say to the happiness, but to the physical welfare, of their patients.

How is it that the treatment of disease has varied so widely from one epoch to another, and that diametrically opposing methods have been successively approved? How does it happen that inside of certain general limits there is no fixed standard of therapeutic infallibility, or even excellence? or that among physicians in large practice anywhere few persons know or care exactly what are the therapeutic views of any one of them, — whether he may deem it proper, during the progress of a typhoid fever, to administer a whole dispensatory, or whether he allows the patient to go on without remedial interference? One of these systems is the better, and if so, which, and why is the truth not hailed by acclamation?

Again, let a medical jury of conceded weight and position be selected, each to dictate, without the knowledge of the rest, some therapeutic course for a particular case. What a farrago should we have of calomel and opium, of gum-water and ptisans, of "favorite medical prescriptions," all possibly compatible with the recovery of the patient, and some of them promoting it, but more of them unquestionably retarding it!

The therapeutics of England, of France, of Germany, and of America, probably differ much more widely than the diseases do, both among standard and written authorities and among the mass of general practitioners; partly because one remedy often does as well as another, both being superfluous and neither positively injurious; and also because even when there is a real necessity for active interference, the patient has no guaranty beyond his own personal belief that his physician shall either entertain or adhere to any standard views in science. In other walks of life, people can judge of work. In the other learned professions — for example, at the bar — there is a public tribunal where a standard of right is upheld and the advocate is tested; but the medical man both argues and adjudicates in private, being himself examining counsel, jury, and judiciary, and the patient relies upon him alone. More than this, people have their private preferences. Suppose your roof should leak, and that a carpenter, when sent for, should make a diagnosis and then stop the hole; and that at another time you should in like manner send for a different mechanical practitioner, who, on hearing of the anasarca which pervades your house, should fumigate the entries and introduce agreeable preparations into the *primæ viæ*, promising to call again next day. If the rain should then cease and your house be soon dry, I am not sure that you would all prefer the first inelegant prescriber, who merely stopped the leak, especially if the second were a sanitary engineer. Thus it is that, because people are not qualified themselves to be judges of a lesion, they must sometimes accept on faith, and be as well content with the one treatment as with the other.

Practice is business. Pardon me if I treat this somewhat homely subject in an informal manner. From Sir Astley Cooper down to "old Dr. Jacob Townsend," whatever else of truth or error, of honest and learned labor or of arrant deception, may go with it, large practice depends much upon industry and regularity and assiduity and long-winded steadiness of purpose, — qualifications which give success to business. I do not speak of a scientific nor of a desirable reputation in any sense, nor of the respect of educated men, nor of that of the intelligent world; but of a practice which in a metropolis may be as large and possibly as lucrative as that which is attracted by the most popular medical fallacy or nostrum of the day. A step further. Only throw overboard honesty, abandon the truth, and the practitioner must have a singular want of business faculty, relating to a subject about which people know so little and of which they ask for so much as they do of medicine, if he fails of tolerable pecuniary success. In fact, this is one of the few modes of getting money by unblushing false pretences of which the law does not in the United States take cognizance.

On the other hand, though such medical practice may come quickly, it is also liable to go quickly. Weathercocks whose equilibrium has been easily disturbed will turn again at the next breath from any other quarter; and in this way the practice of pretenders and of the medically incompetent tends, in various degrees, to that rapid rise, culmination, and decline, which in all ages characterize the traffic in nostrums.

With honesty of character and purpose, there accrues a better sort of practice and one of more enduring nature, — a practice sprung from the business habits which are necessary to it, and which are sometimes even its only claim. Yet, added to these, we may now observe a great variety of less objectionable attributes conducing to the same end. Perhaps the practitioner honestly deceives himself. Does he believe he is successful, for example, in our autumnal fevers, which never stop for treatment? Then, as he persuades himself, is he engaged in a hand to hand combat with disease, in which victory rewards only superhuman efforts. Is he good for a chronic case? Then is he fertile in expedients, assiduous, and long suffering.

Among the highest qualities distinctly collateral to science, and which conduce to practice, an acknowledged rectitude and firmness of general purpose, usually called character and principle, stand first; and then the social attributes, a ready and genial sympathy, good feeling, all in themselves essential or conducive to perfecting the obvious and intimate relations in which you stand to the members of the human family. Again, as collateral to medical knowledge we recognize as legitimate instruments of success a cultivated intellect, force of will, some knowledge of the world, not in its objectionable sense, but rather a knowledge of what men want both at the time and on the whole, and with it a readiness to serve them, and an understanding how to do it, kindliness, tact, or more largely judgment, and so on without end.

Thus it is that practice accrues alike to the medical man in Paris whose toil has lifted him to some lofty eminence, —

a man known mainly, it may be, as the occupant of a distinguished office, and whose name is only an illustrious abstraction to most of those who call for his professional services,—and to the excellent physician of the country village, whose attractive helpmeet may have won his practice, a practice which again may be determined even by the meeting-house he goes to.

The exclusive practitioner, whose only aspiration is to enlarge his daily round; who divides the world into two groups, the first his patients, and the second those who are not his patients; who watches like a shepherd over his own flock, and lest they should stray gathers to his fold, as opportunity offers, the lambs of other shepherds; who is always ready with a prescription,—and it has been well said that the comprehension of disease is in inverse ratio to the belief in prescriptions, —such a practitioner not only teaches a lesson in his fidelity and regularity, but something also of more importance. He appreciates the length of time nature sometimes requires to do its work, and just as the dial measures the passing hour, by tangible intervals of space, so he materializes, by the art of the apothecary, months of time, and pharmaceutically marks their daily progress. The epigastric tympany which afflicts the maid of Erin chained to her laborious routine, or yet that evil demon of the sewing girl, the stitch begotten of the stitch, these are maladies rarely to be exorcised in a moment. But let some salutary discipline alternately with therapeutic duties beguile the tedious convalescence and justify improvement, while you inculcate the necessary diet and fresh air, and the dyspepsia and the spasm will forthwith abate. So in grave disease, when the excito-motors of the mind are polarized, when the sensibilities are tense and vibrating, people must do something commensurate with the occasion. The treatment of the patient is then in part the management of friends. The active inflammation demands depletion and evacuation, but the patient's mind also, as well as that of the friends and sometimes of the neighbors, must have a vent for capabilities pent up and condensed. All this we learn much of, in following the daily rounds of the mere practitioner.

And we have gained a valuable lesson. But in addressing vicarious remedies to the mental, for the benefit of the physical system, let us not confound the two. There is great need to discriminate distinctly what is done for the disease. Because just as in a necessarily doubtful diagnosis a positive man will be right once in several cases, and the wrong guesses will be forgotten both by himself and other people, so in therapeutics he who prescribes for everything will, with nature on his side, so often see the patient getting well, that he must inevitably attach importance to his remedies. If it be necessary for the patient's welfare to occupy his mind, let the practitioner be careful not to deceive himself in this respect, to the danger of his scientific sense and of his whole judgment. "You may talk in this manner," says Dr. Johnson, "it is a mode of talking in society, but do not think foolishly."

It should not be supposed that this current of remark can have an injurious tendency. No patient will believe it possible that he himself can come within this category, or if he think he may, it is because he is a philosopher; and if so, he will thank us for any appropriate remedy for his ailments, whether bodily or mental.

Let us not deceive ourselves. Heaven knows that it is difficult, in any calling, to maintain an ideal equilibrium of perfect right. It was a pardonable confusion of professional ideas that once escaped an excellent friend of mine in the remark, "I cannot make this patient fewer visits, for my family needs all I earn." It was, on the other hand, a Spartan trait in one of the most unblushing but successful pill venders of the day, and one which shall preserve his name inviolate, that he could exclaim, "God forbid! Indeed I gain my money in that way, but no friend of mine shall take my pills!"

Few young men escape the ordeal of a hospital life, or of a protracted attendance upon hospital service, at home or abroad, without having sacrificed to some extent their nicer appreciation of the claims of the individual to the engrossing interest of disease. It is a paradox that a medical student, with a recondite medical knowledge laboriously acquired, may not be wholly qualified to deal with common and familiar cases of sickness, that he may still have something to learn and something to unlearn, and yet it is so. He has hitherto treated disease. He is now to treat men and women.

As in general practice, so in a specialty, organization and business faculty vitalize medical proficiency. Specialties belong to large communities, or for a shorter time to smaller ones. An educated man, by a successful specialty, may become a skilful one, in concentrating his sphere of observation. And yet the local disease occasionally suffers for the want of an adequate appreciation of its relations to the condition of the whole system. And another objection to special studies lies in the tendency they beget to exaggerate particular lesions, and to protract a case with unnecessary treatment, without which the patient might do as well, and perhaps better. How often is the sponge probang officiously and uselessly intruded into the throat! You might suppose, of late years, that all the diseases of the viscera had finally intrenched themselves at the fauces and the os uteri.

Permit me to add here a word or two of promiscuous advice. Our time is brief, and I will not detain you with a reference to quackery, which is best let alone. It is a perverted but frequent growth, drawing its food from the unsounder organisms which cannot be prevented from existing in every large community. Nor yet will I refer to your general behavior towards patients, for nothing can be simpler than the observances commended in the last code of ethics of our American Medical Association, which advises physicians to "study in their deportment so to unite tenderness with firmness, and condescension with authority, as to inspire the minds of their patients with gratitude, respect, and confidence." As this was printed in 1857, I can refer you to no later prescription to inspire these simultaneous emotions.

Do not think I have treated this whole subject either lightly or irreverently. Yourself the invalid, with what expectation do you anticipate the daily visit! Beguiling the tedious hour, satisfying the restless and perverted judgment, soothing the irritable caprice, harmonizing the unstrung intellect,—thus only can a master of his art guide you through the hour of danger, strengthening the frail tenement against the passing storm, and then, if need be, repairing it for your comfortable habitation.

In therapeutics there is a series of material agencies or remedies which, skilfully directed, arrest and neutralize certain diseases, as if their coexistence in the human system were materially and mutually incompatible. At the opposite extreme there lie a group of maladies for which art can do little. Between these extreme categories there lies an infinite variety of imperfect and perverted function, which may be generally influenced by competent interference for the better, or by incompetent and solemn meddling for the worse. It would indeed be little loss if that system of prescription of which the dispensatories are the exponents were reduced in bulk by nineteen twentieths, but it would be equally a disastrous day for mankind if our actual accumulation of sound medical and surgical therapeutics were stricken from the page of human wisdom.

If you go into the field, armed with a detailed and thorough knowledge of lesion and disease in all its phases; of surgical expedients; of the few specific remedies, and of their uses; of the miraculous power of air and exercise, and proper food; of the applicability and agency of stimulus; of local and general depletive measures; of applications cold and warm, stimulant and emollient; of counter irritation; and perhaps of a dozen of the most efficient drugs, not specifics,— these are more than you will be likely to require for a considerable period and a common practice, and with them you will do as much service to your patients as you would be likely to effect with an entire apothecary's shop, and with prescriptions two inches and a half in length.

If I have been fortunate in clearly expressing my convictions, no one for a moment will suppose that the science of medicine necessarily or intrinsically involves anything of unsoundness, or that its true practice is uncongenial to a straightforward simplicity of character. It would ill become one who is surrounded by the brightest examples of professional acquirement, in a medical community characterized, if by any eminence, by a high standard of honorable conduct, not only among the elder but among its rising members, to leave, by negligence or by imperfect statement, any false impressions of our true relations to science, to each other, or to the community. Equally unpardonable would it be, if, in attempting to dispel the refracting atmosphere which hovers about our art, I should seem to imply that it is vulnerable to attacks from those who live by inculcating the medical delusions of the day, and whose practice always aims at concealing their ignorance of the actual characters of disease under a cloud of therapeutics.

If any incidental conclusion has been especially elicited from the views which have been briefly presented, it will have struck you forcibly that the public at large are wholly incapable of judging the relative merits of medical practitioners. They may indeed recognize some general distinctions, of prominent position, extensive practice, conceded eminence; they can identify the man who best persuades or satisfies them, to whom they may intrust themselves because of his general force and weight of character, or of his moral excellence, or of his fidelity, or it may be from a mere affinity, because they like him. But at what tribunal accessible to the public does the usual physician testify to his scientific knowledge? What can the sick man know of his knowledge of disease? Do you trust to his general good judgment in other matters? As well might you rely on the professional ability of a lawyer or of a merchant who has a tolerably well balanced mind. If it is true that no quality is so essential to sound medical practice as a sound judgment, it is still further true that an enlightened judgment in medicine is as necessary as an informed conscience in morals; for it matters little that a man's convictions are logical or honest, if they are based upon benighted or erroneous premises. They might as well be those of a conscientious New Zealander as of a merely conscientious practitioner of medicine, if he feels it his duty to pursue a course which is conducive neither to your comfort nor to your safety. The hygienic safety of the public lies in the sound and thorough education of the medical student; in the adequate support of medical schools; in seeing to it that the best institutions of medical learning, each in its own community, shall be so far well nourished that they shall not dwindle and degenerate, but that they shall possess the vigor without which they cannot hold their way with the onward march of solid knowledge.

The question for the public is, Will you admit within your confidence, to navigate the household ship in time of peril, responsible to no one but himself, with no eye of scrutiny upon him, one who, not knowing what the exact nature of the danger is, seeks to engross equally your mind and his own by a routine of incessant effort, putting the helm first up, then down, and so compelling the good ship to struggle at once against the tempest and an officious, or to say the least a futile interference? Or will you rather rely upon one who undertakes to know, first, all that can be known of the conditions of disease, and who then endeavors to discriminate, among remedial measures, which are of sure, which are of probable, and which are only of possible salutary influence? The broad foundations of an ample scientific structure must be laid, at an early period of life, in a sound medical education.

Let us avow with pride that our lot has been cast among a people sensitive to the importance both of science and of art. If their just munificence has lately testified to a high estimate of one whose reputation is known wherever science has been cultivated, whose capacious intellect and whose genial temper are familiar to us all, and who has deserved largely of our own community in opening attractive and new paths in natural science, where the expanding intellect may gain health and vigor, and by which the boundaries of human knowledge have been borne onward and extended,[1] — if the claims of science have been listened to, — an equal liberality is at this very time responding to the exigencies of our own art, at the appeal of one who knows its actual requirements, the honored patriarch of our noble calling, — himself ever a bright example of its learning and its virtues, whose right is undisputed whether to sway the judgment or to lead the hearts of the community, whose elevating influence radiates

[1] Louis Agassiz.

both from his own and from a transmitted excellence, briefly though it shone amongst us.[1] Let us emulate this doubly bright example, and, cherishing a memory identified with all the more exalted aspects of the healing art, let our institution bear within its walls to a remote posterity his name, joined to that other, which ever kindles our loyalty and affection.

[1] James Jackson, Jr.

## MEDICAL EDUCATION IN AMERICA.[1]

Having on former occasions said something of Medical Science and Medical Art, I propose here to offer a few practical considerations on Medical Education, with reference both to its daily use and to the progress of medical knowledge.

I am well aware that he who inculcates in general terms a high standard of knowledge, and bids God speed to progress, has a far more grateful task, in the approval of others, and possibly of himself, than he who stops to confront it with any consideration of its relative utility. But in an age of science, like the present, there is more danger that the average medical student will be drawn from what is practical, useful, and even essential, by the well meant enthusiasm of the votaries of less applicable sciences, than that he will suffer from want of knowledge of them; and I am quite aware that I may not hope for the favorable consideration of some of my friends, when I say that, if there is any idea which I particularly desire to present distinctly in these remarks, it is that of utility in medical education.

The zealous devotee of less serviceable science, to whom the world is indeed under obligation for often inadequately requited labors, whether in extending or in merely cultivating the domain of human knowledge, may well be pardoned the conviction that such science is worthy of pursuit for its own sake; but he should guard against the fallacious belief that it offers quite as good an investment of time for the student dependent on his profession for support, as if it had

[1] The Annual Address read before the Massachusetts Medical Society, June 7, 1871.

an immediate and determinate practical value; and especially against a nebulous feeling that there is a savor of earthiness in the pursuit of knowledge which is likely soon to be worth something.

The lapse of centuries has removed the amulet from the physician's sanctum, and the stuffed alligator from his ceiling. Astrology, astronomy, and even natural history, are known to have no immediate connection with pathology and therapeutics; and as the area of our science expands we shall not only continue to eschew error, but shall leave to one side more and more of real truth pertaining less directly to it, still utilizing and incorporating its valuable results, and still finding an ample field of study beyond the compass of any one individual. If, on the other hand, it is fair to inveigh against a quackery which makes plain things difficult, buries principles beneath details, occupies the mind with mere therapeutic measures and routine, and attracts by persistent activity, I venture also to question that enthusiasm which mistakes novelty for value, and, overlooking much that is useful and practical, appropriates with eagerness whatever comes authenticated by recent alleged discovery, or flatters by a suggestion of exclusiveness in its pursuit.

Let us think carefully, then, before exacting from adult students collateral acquisitions which in practice they will not need, and will actually soon forget,— especially as much that is strictly medical is profitless, or nearly so, to the medical practitioner. When, a student in Paris, I listened to a lecture upon the plague, or upon the ligature of the posterior tibial artery, it reminded me of my fencing master, who was giving equally useful instruction how, in case of attack by more than three men at once, to place your back against a tree, and, drawing a rapier, dispose successively of each.

And yet there is a limit to this line of argument. No student or artisan is the worse for an outlook upon kindred arts and sciences which help him to establish the true relations of his own, which will supply him with additional facilities and light for its pursuit, and with that training of his intellectual powers afforded by a systematic variation in their exercise. Let us concede, then, a certain latitude to the study of medical science, testing it rigidly and constantly by its applicability to subsequent medical pursuits, and especially by a frequent consideration of the question, how far it shall occupy the student's limited time, to the exclusion of what to him is more important.

Two classes of the profession at once claim our consideration: those who are to do the daily work of medical attendance only, and those who may be expected to contribute something to the development of medical knowledge. For each of these a course of education is to be provided, such as will not rise above the proper requirements of the one nor fall below the just expectations of the other; or, on the other hand, we may, with more economy, aim to devise a single system suited to the education of a body of students, not only as routine practitioners, but as something higher.

It is plain that the mass of work must be performed by the exclusive practitioner, who has been educated with the view of turning his acquirements to immediate practical account, and whose business so occupies him that he contributes comparatively little to the absolute advance of knowledge. Let us consider first just what the community should expect of this man.

It has often occurred to me, that, if steam power should be substituted on common roads for horse power, collisions would be of hourly occurrence. It is as often the beast who turns out as the driver, and I hold that, as a rule, outside of surgery and other surface work, it is the disease which turns for better or for worse, and not the physician who turns it. Disease often advances with a dignity of progress not to be sensibly swayed to one side or the other by the interference of the physician. The balance of healthy function is disturbed; for a varying time the disturbance increases, and for another varying time it diminishes, until the balance is restored. A discourse, which first attracted public attention here to the fact that it is useless to try to cut short certain kinds of disease, justly called them self-limited, because, if not limited by their own inherent tendencies, they assuredly are limited by nothing else.

But let us not forget that, when we are able to limit the duration of disease, as we can that of fever and ague, or, more completely, of syphilis, then it will be no longer, as now, self-limited, but subjugated and controlled. And this may be the future of any disease, not excepting tubercle and malignant affection, the failure and the exuberance of vitality, and even old age itself, provided only the chemist will manufacture, as of late he promises to do, the vital spark. So that, even if a large majority of fevers, epidemics, and the more serious derangements of structure or function, are as yet little controlled by anything which the physician prescribes, we are neither to doubt of future progress nor to lose sight of accomplished results.

An accurate and well defined knowledge of undisputed therapeutic principles and details should be exacted from every practitioner claiming to be properly qualified. He should know how to treat, and of course how to identify, all common injuries and diseases, so that health shall be reestablished in the shortest time, whether by interference or by a resolute refusal to interfere. And you are to provide fifty such plain and competent men for one who knows more.

Look at the reverse of the picture, — at a practitioner deficient in respect to the quantity or the quality of his education, — accomplished in the right direction, it may be, but also learned in the wrong, — who tells a patient he is bilious, and refers every pain in the side to the liver, — who cures rheumatism with colchicum, and scarlet fever with belladonna, and, when a straw may break her back, handicaps Nature with a six-drug prescription, — who treats cancer of the lip with ointment till a gland swells and the patient is lost, paints with iodine every lame knee, cauterizes every inflamed throat, and cannot set a broken elbow: an industrious, driving, and perhaps thriving, but professionally incompetent man, — incompetent not because ignorant of the labyrinths of modern chemistry and physiology, but because he does not know the plain rule of thumb practice in modern medicine and surgery, — because he yet lingers in the paths of exploded error, or turns like a weathercock to the last advertisement of the apothecary or journalist. Such a practitioner you do not want.

Whatever else, then, it may or may not do, a medical school should aim to give a plain, sound, solid education, without error, if without ornament.

For, in the first place, you cannot do better. It is the highest average development of which the mass of the material you are dealing with is susceptible, in view of the character of its preliminary education and of the accepted three years' term of study.

In the next place, you need not do better. If you can supply the country at large with medical men thoroughly competent in all common medical matters, able first to identify and then to treat properly the local diseases and lesions, thoroughly imbued at once with the simple and broad principles of necessary therapeutic interference and with its detailed routine, and free especially from the entangled mass of therapeutic prejudice, error, and deception bequeathed by earlier art, you have raised up a class of students superior to those now graduating from any medical college in the land, and have sown seed from which individual ability and individual industry will develop a growth far beyond the average of the present day.

But there is another consideration. The excellence of the practitioner depends far more upon good judgment than great learning. Other things being equal, the best practitioner is the man of soundest judgment. With good judgment added to industry and fair ability, you can make an excellent practitioner out of a man of moderate medical acquirement, provided only it be of the right sort. But without good judgment, for which education is no substitute, if you fill the mind of the student with chemistry and physiology and drugs as leading ideas, the chances are that he will apply this collateral imperfectly applicable knowledge wrongly, and that he will have to forget and abandon much of it before he gets it down to a medical working level.

If any one who hears me will consider to whom among his acquaintance he would prefer to intrust himself in such common cases as make up the mass of medical practice, if only assured of a kindness and business fidelity which shall secure him a pleasant and regular attendance, he will, I think, decide in favor of some one not originally distinguished for large conventional acquirements, who was not prominent at graduation, but who, beginning quietly, has grown and ripened with experience, — of some one not the eminent and learned reader of medical books, acquainted with every theory of fever, who will analyze him for urea, register him with a sphygmograph, keep a thermometer in his armpit, and generate ozone in his apartment, but a plainer sort of man, — whose diagnosis is accurate, whose wide practical experience and sound judgment have taught him not to harass disease with uncertain or conventional remedies, whose active interference is cautious and discriminating, whose mummery is beyond doubt harmless, — in short, of one who never loses sight of general principles, who stimulates, depletes, derives, or narcotizes when he is sure the malady requires it, but does neither when he is not sure, and scrutinizes with great caution the contradictory results of "favorite prescriptions."

While abroad recently, I visited in consultation with a distinguished foreign practitioner an American child fatally affected with diphtheria, whom he was treating with continued small doses of copaiba, which produced an obviously prostrating though unintended catharsis. His argument was, that the child was like to die, that the friends required that something should be done, and that somebody had recently reported a number of cases all terminating favorably under this treatment. I said to myself, How much safer would this child have been in the hands of an average Massachusetts physician, who would have kept steadily in view the importance of economizing and supporting its strength! What this learned and distinguished medical philosopher lacked was judgment; in the practice of medicine, if we do not set the landmarks of judgment firmly, learning may displace them disastrously.

We are speaking of practitioners, of the working men peremptorily demanded by the community everywhere, and whom medical schools are expected to furnish. In the education of these it should be the aim to develop good judgment by a reiteration of undisputed facts in their simplest expression, and by a constant reference of these facts to such broad principles as can be demonstrated beyond reasonable doubt. The teacher should keep constantly in mind the use and application of the student's knowledge. He should never lose sight of the fact that everything in medical instruction is to be made wholly subservient to the prevention and proper treatment of disease. Indeed, and more precisely, Therapeutics is the single leading idea, to which no inconsiderable part of modern medical education is secondary, and even tertiary, if I may say so. To know the remedy, you must know disease, and this is Pathology; to know disease, you must know health, and this is Anatomy and General Physiology; and, lastly, to separate the ultimate particle from its friends and its affinities and cross-examine it, is Chemistry in its widest range. But every step of this progression leads farther and farther from the original object of medical education, which is Therapeutics. It is all more or less desirable as knowledge, if you can have it all; but if you cannot, you must choose what is essential to the practitioner, and especially you must consider what he can hold; and the mass of medical students cannot, or do not, hold much at the end of three years' study.

I do not conceal from myself that it would be desirable to raise the average level of medical acquirement, skill, and capacity, the world over. There can be no doubt that a certain amount of incompetency, in our profession as in others, escapes through its graduating machinery, stamped with the tower mark of the colleges. But we must not confound a want of opportunity with its neglect. The question is, Exactly what measures will best promote a better education? You cannot turn out medical men with the uniform perfection of Ames shovels or Springfield muskets. The popular and specious cry for raising the standard of medical education comes often from those who know little of its difficulties, and it is notorious that those who clamor loudest accomplish least. The Vicar of Wakefield said he "was ever of opinion that the man who married and brought up a large family did more service than he who continued single and only talked of population." I am equally of opinion, that, in medical education, he who conscientiously seeks to enlighten his pupils, availing himself of the best means within his reach, does more to advance medical science than he who devotes his time to criticism and declamation upon the curriculum.

The latest new medical journal, which calls on us to "lay down all jealousy, modesty, and reserve, and come boldly to the rescue, and by our united labors and best efforts seek to build up medical science in our midst, to the great elevation of the professional standard, as well as to the ultimate good of our community," and then, in a case of cerebro-spinal meningitis, proposes to administer, in the course of eighteen hours, "an ounce and a half of calomel, one ounce and a quarter of sulphate of quinine, and two ounces of bromide of potassium," suggests the value of much of the criticism put forth on this subject, both in public and private, and to which inexperienced persons are disposed to listen.

These remarks are not intended as a plea for mediocrity. It should be remembered that our present system of medical education, imperfect as it may be, produces men eminent in science, and furnishes able teachers as well as distinguished practitioners. Most eminent men are in a large degree self-made, and have pursued their subject from the attraction before them, and not from a stimulus behind. The material out of which philosophers are made is largely supplied from their own intrinsic and determined will. Genius is talent with a strong driving power, whether versatile in all directions, or more profitably guided by taste or circumstances in one direction. You cannot create this talent nor compel this taste. You may, indeed, give it opportunity, but you cannot force it.

Nor does scholarship, in its common acceptation, insure medical eminence. In the classes graduating from our universities, the more cultivated scholar, by reason of his talent or training and power of application rather than his acquisition, is indeed apt to average well afterwards in the paths of literature and in the professions, but he by no means monopolizes the honors or the active work of life, especially in the medical profession. On the contrary, his brilliant career often terminates early, through no other fault of his own than that he has relied mainly on the work of others. He has studied Latin, Greek, and mathematics, not for an ulterior object, but because they were prescribed; and when left to himself, stimulated neither from within nor from without, he may become as ineffectual as a ship or a horse without a master. Your medical school should not be arranged for his benefit alone.

But it may be urged that perhaps the key-note of the student's mind has not been struck; perhaps natural history or applied science might have developed a capacity for and a power of devoted study to which grammar and geometry have in vain appealed. There is much truth in this view, and much has been recently done in recognition of it in the undergraduate department of our own University, always active in the vanguard of intelligence and light, — never more alive to the progress and the demands of the age, never more full of vitality, efficiency, and promise, than at this moment. Much has been effected by allowing to the student a latitude in the choice of his studies.

But something yet remains to be done. Few young men are competent to make their own unaided choice. Few medical students take up a subject — for example, physiological or other chemistry, the microscope, or any of the less immediately applicable or more attractive branches — with the knowledge how to apportion it properly with reference to a sound and well balanced medical education, or to what they will afterwards need as practitioners. It is here that supervision is especially requisite. And a wise guidance implies tact and patient discrimination, and aims at what in adult education, at any rate, is more important than mere acquisition, and that is acquisition for a definite and useful purpose. In encouraging motive, it develops principles of action and character, conduces to that enduring and strenuous effort in one direction which makes the reputed college dunce — who has dragged through his collegiate course in the last half of his class, persistently wasting his time with gun, boat, base-ball, novels, poetry, anything but the prescribed studies — a useful, hard-working man; which in the affairs of life puts the boy who has been a persistent thorn in the side of his tutor far ahead of one whose deliberate standard of excellence has been the tutor's approbation instead of his own. The horse difficult to break makes the best horse. Backbone, unbending though it be, is better material to work upon than a compliant "mush of concession" to the last man or the last thing. In fine, a determined and intelligent purpose is the surest basis of all adult education. Opportunity comes next, and lastly organized system.

In these remarks we have been drifting toward the recognition of a fact always to be kept in view, that the period of the medical student's real curriculum begins with his graduation, when he is set free and left mainly to himself.

Practically speaking, the medical student in this country then first begins a course of study varying with the characteristics and habit of his mind, with his power of application, and with his opportunities. To one, a year or two of faithful labor in Vienna or Berlin or Paris is an actual extension of his previous three years' term; to another, an equally laborious though slower observation, an analysis combined with book study of cases occurring in his own practice, lead in the main to the same result.

The schools and colleges graduate every year a horde of young men, born to privileges of education, who settle away into insignificance, while the whole land is full of heroes who have fought their way to usefulness and eminence, to high positions in the state, in the professions, in the arts, and in trade, by sheer force of will and determination. To these last you must give opportunity; and you fail in the administration of your trust, if you do not arrange every part of your machinery to facilitate their progress.

Of two medical classes educated to the same standard, in the same community, the numerically larger will yield the greater product of wheat, as well as chaff. No medical school in this country, however disinterested its Professors, can afford on any ground to lose sight of the size of its classes, which are at once its seed and its fertilizer. If any school has not chosen to improve the quality of its teaching in proportion to the increase of its students and pecuniary receipts, such example affords no argument against these remarks. They might be superfluous, had it not been speciously maintained to be absolutely bettér to turn out a few graduates educated to a certain standard than a larger number not educated quite so well. The aim of any reform in medical education, in this country, should be to educate to a higher standard a number of students at least equal to that of the present. If, in order to the better accomplishment of this object, some radical change in the existing plan of medical teaching be demanded, great care will be required lest the new system should prove exclusive or impracticable to the many.

With these preliminary remarks, let us rapidly review some of the various topics of accepted medical study in relation to a higher standard of medical competency.

Observation is a word in frequent use in connection with medical study. The secret of profitable observation is not only to observe accurately, but also to know precisely what to observe. When Nature is on the witness stand, you may not ask her leading questions, yet you must ask her something. If you say to a student, "Here is a bone, observe it carefully," he may inspect it intently like a dog, and to as little profit; and if, like the brute, he is cut off from previous and transmitted learning, he will be likely in the end to add quite as little to the sum of knowledge. But if he considers it in relation to other bones, to its muscular mechanism, to its joints, or the manner of its formation, if he compares, discriminates, and infers, it will be profitable observation. Intelligent observation, the work not only of the senses, but of the mind and for a purpose, is based upon previous knowledge.

In medicine it is indeed important to study facts in the authenticity of actual occurrence, and to keep the mind free from words and book learning as substitutes for these. Let the student rest upon experiment, and not on authority. Teach him to doubt until he has collected his own evidence and made his own deductions, but give his mind something to do, as well as his eyes. Show him exactly on what points you desire him to doubt, to experiment, and to infer. All profitable observation is to test theory, or, in other words, to settle doubt, — whether about the substance of a child's marble, the existence, form, or meaning of a protuberance on a bone, or the identity of terrestrial forces. It cannot be too strongly borne in mind that "observation" should have a very definite purpose and direction.

Again, the geometrician, wishing to make his proposition clear, states it distinctly before proceeding to prove it. The juggler, on the other hand, wishing to keep you from understanding what he does, never tells you beforehand what he is going to do. Let the student, therefore, begin with a clear understanding of what you are proposing to demonstrate. Show him the map before you travel over the ground. Give him his concise abstract hypothesis before you demonstrate it to his senses or his reason. Then let the demonstration follow quickly, the dissection upon the anatomy, the clinical teaching upon the so called didactic teaching.

A perfect system of instruction would accomplish this, and in Anatomy you accomplish it by modern illustrated book anatomy, to which the student may devote himself with far less reservation than to modern book pathology. There is no excuse in these days for deficiency of anatomical knowledge. If a little of the enthusiasm which formerly found expression in the production of elaborate preparations of the arteries, and in gigantic hearts of many colors, now equally expresses itself in the attractive fields of chemical manipulation and the microscope, the change is not objectionable; it need not interfere with the acquisition of a branch, the increased modern facilities for whose study render a knowledge of it compulsory, and which, moreover, underlies all the rest.

The gross anatomy of the viscera is of such transcendent practical value in relation to all disease, that every student should be able to make with perfected skill a common autopsy of the healthy subject, attesting familiar knowledge of the outlines, the interlocked masses, and the economical packing of its organs.

To know the anatomy, I will not say of the bones, but of certain bones and of certain joints, is essential, not only for the welfare of the patient, but for that of the practitioner himself, — it may be in saving him from an action at law, often well grounded, for malpractice. Every practitioner should have this knowledge at his fingers' ends, to the sacrifice, if necessary, of the multifidus spinæ, the cutaneus of Wrisberg, the chorda tympani, or the two legs of the diaphragm. A student's anatomy, for whose details a practical surgeon, a pathological anatomist, and I would even add a physiologist, should vouch by concurrent certificate, would stand at least upon the basis of utility.

The dissecting-room — a school for manual dexterity as real to the surgeon as a workshop is to the carpenter — is not propitious to intellectual effort. It would be no injustice to the student rigorously to require from him an exact knowledge of the bones, and of the principal muscles, arteries, and veins, before dissection, if only as a preliminary exercise in accurate study and investigation. There is no danger that he will here lose sight of facts in words. Anatomy thus acquired, and in half the usual time, is retained immmeasurably longer; and, with a previous knowledge only waiting verification, frequently recurring opportunity will invite local practical study. On the other hand, the student who waits to be inspired by the impartial allotment of the demonstrator's hat will be very apt to abandon his negligently divided fifth, when he discovers for himself that anatomy enters at the head with effort, and not at the hand without it. A solid groundwork of anatomy, never acquired if not acquired at the outset, is the most satisfactory investment of the beginner's time.

I once heard a member of this Society express a complacent satisfaction that his business lay in curing disease rather than in studying its anatomical changes. But where anatomical change exists, one might as well ignore the mechanism of a damaged watch as to undervalue the importance of such a change; and the more accurate the knowledge of it is, the better will be the diagnosis. At some time in the distant future, through observing the bronzed patch, or the hyaline cast, we may invoke a specific remedy for the renal or supra-renal lesion which they indicate. But until that remote day when all diseases can be so identified and arrested, any appreciable change of material tissue must point the way to better therapeutics.

No single branch of education is more essential to the medical student than Pathological Anatomy, the corner stone of medicine. And yet it will hardly be credited that, while its study is a matter of only secondary importance in some of our colleges, chiefly perhaps the want of opportunity, for many years a distinct professorship of that branch existed in Harvard University alone. Here we early saw the value of knowledge resting on a surer basis than that of pulse and pain and deranged digestion. Indeed, it is not too much to say that the comparatively exact standard of medical knowledge in this immediate community for the last thirty years has been largely due to the accurate and disinterested observer who for nearly a quarter of a century has occupied the College Chair of Pathological Anatomy.

Pathological anatomy is important to the practitioner, and especially to the surgeon, because it is so often practicable to identify a morbid growth by its gross appearance, rather than by its aspect under the microscope.

I remember the heresy, years ago, of a laborious, sensible, and unostentatious country observer, who said that he had been able to find very little in morbid cell growth which he did not also find in healthy tissue. If any change has marked the character of investigation in this direction during the last ten years, it is a recognition of this fact, and in study of the arrangement of the particles rather than of the particles themselves, of the section rather than of the cell.

Let me, to illustrate my own convictions, transcend for a moment the limits of strict induction. I recognize two underlying formative forces in the machinery of the human fabric; one which transforms the cell and raw material into the perfected tissue, and another which distributes and moulds that tissue to the outline and proportions of the human body. Without the latter force we have the amorphous fat, bone, or cartilage, glandular or uterine tissue, which are examples of the so called homologous and comparatively innocent growth, or tumor; while without the former we have the untransformed cellular and other raw material of heterologous growth, whether malignant or benign. The innocence of a benign growth, connected with the fact that its peripheral cells do not interfere with their neighbors, points to their dependence upon some governing force inherent in the whole mass, a force to which each cell is subordinated; while the principle of "malignity," by which a neighboring tissue or distant gland is pervaded and supplanted by new cells, equally points to an independent existence in these last. In my own mind the growth of an innocent tumor is associated, by an analogy too close to be purely fanciful, with a centralized or monarchical government, and the independent tendencies of the cells of cancer and its congeners with the self-ruling elements of a modern commune.

All this points to a distinction between similar growths, based rather upon lesion of their inappreciable forces than of any structure appreciable to the eye. And the same train of thought may be applied to the isolated cell, of which two, apparently similar, like seeds or eggs, may develop a widely different maturity; one cell benign, of a reproduction slow though progressive, tolerant of its neighbors, and altogether unobjectionable as a citizen; the other fomenting evil, insidiously supplanting its neighbor, a fungus in the rapidity of its increase, deteriorating directly or indirectly the whole system, which it involves at last in a common ruin. And yet these cells may be positively undistinguishable. If chemistry finds identity in its allotropism, pathology equally finds diversity in its isomorphism.

Modern science, after laborious examination of the wide range of growths which occupy the fields intermediate between innocence and malignity, has in general terms advanced the incredible statement, that "epithelial" cells aggregated in little chambers of interlacing meshes may be classed as cancer, with a tendency to recur widely, while growths composed of cells juxtaposed without this chambered tissue have a tendency only to local reproduction; but as this rule is far from having a practical infallibility, modern science hedges, in avowing that a competent observer may devote two or three days to the examination of a small growth, and yet fail to discover some minute portion of exceptional tissue which at a subsequent time may dominate the mass and overrule its previous tendencies.

To the practical surgeon, to whom rules with such exceptions have little value, the great question with regard to these morbid growths is the possibility or probability of their recurrence. The philosopher's stone of the histologist is a distinction between innocence and malignity, divested of which ignis fatuus science may seem to the explorer to have lost a part of its charm. But the experienced surgeon or pathologist will settle this question with great certainty, with only a little occasional assistance from the microscope, and without the elaborate refinements of modern science. Such is the lesson to be kept before the mind of the student, — the clinical utility of pathological histology.

No subsequent experience or observation can, indeed, ever call in doubt a microscopic appearance once correctly observed and recorded. But its classification according to presumed affinities is as changeable and uncertain as groups in clouds or the kaleidoscope. The large labor absolutely necessary to keep pace with modern, and especially German science, in this direction, has a value to the student in directing his close attention to the material of disease; but he may readily devote to these attractive studies a disproportionate amount of time, and, above all, lose sight of the relation of his labor to its result. Although the observation of diseased tissue conventionally involves the philosopher in theories of its relations and significance which the lapse of every ten years seems to subvert and replace, it is difficult to persuade the student of morbid growths under the microscope that the present year does not represent the culmination of a perfect science, and that the last new doctrine does not embody the final and enduring truth.

Another consideration, in reference to this subject, is the fallacious connection between names and things. A growth, for example, whose clinical history, whose tendency, and whose microscopic structure were thoroughly understood ten or fifteen years ago under the arbitrary name of "fibro-plastic," and then of "recurrent fibroid," now appears in the new rôle of "fasciculated sarcoma," with little added to our practical knowledge of it; and the same is true of "necrosis" and "osteo-myelitis"; yet the student who is laboriously admitted to the new name believes he has discovered a new thing, and that his previous knowledge represents a conservatism past which the current of science is rapidly sweeping.

In pathology the student has reached the kernel of his subject. He may well gaze with admiration at the magnificent array of valuable facts, both medical and surgical, old and new, here spread before him as the basis and solid foundation of his future practice and his future progress, — striking, when compared with those of former years, for the absence of any induction which does not follow close upon the premises. Here lie the gist and body of the student's three years' work. With the invaluable material thus collected for strictly medical study, in such works as those of Niemeyer, Aitken, Holmes, or Billroth, there is no danger that he will devote a disproportionate period to that accurate investigation which alone makes it possible to treat disease intelligently, and which implies a successive study of one disease or small group of diseases at a time. Specialty in practice unfortunately tends to encourage hyperpractice and ignorant practice, — prolonged, useless, damaging, — in which the practitioner may deceive himself, perhaps his patient. It narrows therapeutic view, substitutes local for general measures, and dwindles to ever changing instruments and methods. Not so with special study in pathology, which, if of facts and not of theory, and proportioned to the student's time, is so much the better according as it is the more accurate and elaborate.

The medical Pre-Raphaelites of the old so called numerical system, whose proselytes did not hesitate to pay a large price in time and labor for its angular results, were in error only so far as they prized this dry and exact method as an end of medical study, rather than a stage of accurate investigation. In reality, Pre-Raphaelite efforts are valuable chiefly as marking a progress leading to equally accurate, but far more comprehensive generalization. Such laborious study and mathematical exactness were essential to the subsequent excellence of the highest art. Without it you might have the tolerable drawing, the harmony of color, and the occasional good composition of modern pictures, but nowhere the combined perfection of all these qualities which distinguished the great masters of a former age, in whatever school. You cannot have the great generalizations of painting, history, or natural history, of science ethical or material, of medical science, whether in theory or in practice, without a previous accurate knowledge of detail. And this is to be acquired while the student is a student. Laborious and careful study must precede what looks like careless handling, but which is really a masterly and free perfection.

With a generalization of detail, with a selection in each particular case of what is essential and a simultaneous rejection of what is not, with sweeping and comprehensive rapidity, a master of his art will give you a mere silhouette of diagnosis and treatment, with a single broad light and shadow, every part proportioned to the rest, which may be far more accurate and more to the purpose than the labored, conscientious work of a less skilled man. But in the seeming inspiration of a moment the master has given you the concentrated and digested skill of a life of careful study and practice.

And, to pursue the simile, if the advanced practitioner, who has arrived at his second and broader therapeutic manner, should come gradually to believe that the treatment of an old doctor is better for the patient than the diagnosis of Young Philosophy, he may be pardoned for still forgetting that he would stand on a yet broader basis if he were master of every modern truth of pathological anatomy and pathology.

The student's work is mainly with facts of empirical association. Proximate cause in medicine leads to treacherous ground, which, unless in matters of mechanics or of pure chemistry, it behooves both student and teacher to scrutinize with doubt and hesitation.

The proximate relation of symptoms and disease to contagion, infection, and miasm ; the smells and dirt that are unhealthy, details upon which depend important sanitary measures ; whether albuminuria is due to an original change in the blood; the relation of urea to convulsions; the proximate cause of pyæmic symptoms, — are problems concerning which no certain proof has been adduced. They are as likely to be settled ten years hence in one way as another, and are therefore to be held before the student with reservation.

But remoter and empirical cause may be profitable study. The assemblage of human beings as a cause of disease, the probable correlative equivalence or significance of the wide range of dissimilar symptoms differently affecting the sexes, and which pathologists have at times grouped as hysteric or mimotic, are examples in point, leading to broad therapeutic views and away from harmful interference.

Some cynical person might aver that, when an affection is curable, it is taken out of the province of the physician and handed over to the surgeon, the ophthalmologist, the dermatologist, or other specialist, and that the physician, bewildered by the intractable assemblage of signs, symptoms, and overgrown viscera alone left to him, driven to desperate expedients, is compelled to drug his patients, and even their friends, in self-defence. But we cannot set too high a value on modern therapeutics in its best form, — the science which brings alleviation, and occasionally secures the arrest of disease, which is the ultimate aim of our art.

There is a materialism, productive of error, which leads to a belief that we so far understand the physiological action of drugs as to feel sure, for example, that three grains of hydriodate of potash will produce a certain three grains' worth of effect, not merely upon the ultimate condition of the patient, — which it is well known we can sometimes do, — but upon his intermediate machinery. Phosphorus, it is said, supplies brain substance; but literature is probably better fertilized with roast beef and sherry wine than with fish. We can better judge of the effect of aloes, juniper, or tea on the intestines, kidney, or brain of the next man by knowing how it affected the last man, than by any reasoning upon the metamorphoses of vital chemistry. The student who expects to influence disease because he understands how a drug passes through the visceral cells, will get into a habit of therapeutic reasoning and action very likely to damage the man or woman who owns the viscus. For him, the established rules of art are safer guides than the speculations of science.

On the other hand, we are not on this account to lose sight of general therapeutic principles, when they can be clearly established. Students incline to lean upon prescriptions. But except upon the conquered ground of syphilis and intermittent, of pain and similar well recognized instances of effect, I believe that a practitioner would do better with broad therapeutic views than with all the prescriptions of the best medical writers.

The skilful surgeon, who startled his pupils by daubing an ulcer with ink from his pen, treated his patient not slightingly, nor with indignity, but with a simple application of sulphate of iron, of tannin, and of a principle.

New drugs find their greatest consumption in small communities, where the vernier of therapeutics, disturbed by medical journals, is not at once righted by the inertia of medical opinion, and where the practitioner is consequently more liable than elsewhere to lose sight of general laws in the routine of practice.

In no pursuit of life is the judgment more distinctly called upon than here; and we should learn this to our cost, did not the power of nature stand up against the lesser expedients of so called medication. The action of the medical attendant is so constantly based upon imperfect indications, — he so often finds it difficult to decide between a general and local treatment, — the question is so often, "How much and how long?" — so often whether to treat the body or the mind of the patient, or the convictions of his friends, — whether to do something or to do nothing, and, if nothing, how to do it with harmless form and circumstance, — he so frequently invokes his science hopelessly, — his science is so overcast by error inculcated with the authority of learning and the experience of former time, — indeed, his approved modern authorities are so often fallacious, — that it is no wonder the best judgment should frequently be at fault.

To what conclusion, then, may fallacious judgment lead? Would that it were possible, after providing ample teaching in the magnificent array of undisputed facts of modern pathology, to add to it sound instruction in the comparatively limited field of the best modern therapeutics, and then to endow, as more important than any other office of tuition in the healing art, a professorship of common sense, of which, indeed, all science has been said to be only the highly organized result!

What shall we say of the Materia Medica, that wonderful armory of therapeutic warfare, catalogued in the dispensary, emblazoned for exhibition by the apothecary, the obsolete weapons of the savage, harmless or envenomed, the clumsy artifices of the Middle Ages, the Chinese armor, specious to the eye, the stink-pot, potent to the sense, side by side, without invidious preference, with the improved expedients of later art furnishing the modern expectant with the wooden guns to enforce delay, and the more active practitioner with the trusty breech-loader?

"Favorite medical prescriptions," blowing hot and cold at the same time, at the same disease, — shooting promiscuously at friends and enemies, with general good intentions, like friendly regiments meeting in the dark, — what is such a book, but the panacea, on a large scale, of that good physician who accumulated the residuum of his bottles in a common receptacle for use in difficult cases?

What precocious wisdom in the letter written (the lines ruled above and below in pencil) by the young Prince to the Duke, his tutor! "My lord," he says, "I would not have you take too much physic, for it doth always make me worse, and I think will do the like with you. I ride every day. I am ready to follow any other directions from you. Make haste to return to him that loves you."

The judicious Sir Henry Holland somewhere ventures to doubt whether a single prescription, containing an ingredient for each symptom of a complicated disease, against which it is especially levelled, may not perhaps sometimes fail of producing its whole intended effect. I should boldly aver that it may.

And yet there is a clinging reverence and love for the memories, the associations, the superstitions, connected with these mysterious agencies, so largely identified with the health of the human family and the pockets of the medical profession.

In an address before a learned medical society to which I have the honor to belong, a distinguished friend of mine once stated that, if all the medicines in the world were thrown into the sea, it would be better for the world and worse for the fishes. Unfortunately, we all thought he said *physicians*, and very properly rose in a body to hurl back the startling insinuation. He was happily saved from universal execration by remembrance of his stanch and lifelong devotion to all that is honorable and true in our profession and in the world.

The matter of prescribing, in every-day practice, stands thus. First, does the disease, on any ground, require a prescription? Secondly, does the patient? If the former, let the prescription convey with the word the blow; but if you prescribe for the patient, and not for the disease, the prescription, then an empty word, a *vox*, if need be, should convey also a *præterea nihil* of undoubted innocence. Materially embodied in a bottle or a bath-tub, as an epithem, a measure, a restriction, the *præterea nihil* is not unfrequently the weights and scales of convalescence. Whole theories have been built upon its supposed action. The essence of some of the most successful species of charlatanism, the emergency for its employment in a visible form, occurs at every turn;

and the teacher should see that it does no mischief, either to the patient, or to the science of the practitioner.

Opium, narcotism, anæsthesia, consciousness benumbed, the nerves quieted, — what can the physician do without a therapeutic principle to which half his long prescriptions owe their chief, if not their only efficacy? And yet it seems but yesterday that I was called upon to justify the newly discovered anæsthesia, as if in common defence with the lightning-rod and the umbrella. In a surgical practice of twenty-five years, I have never intentionally given a patient, unless by his own choice, any unnarcotized pain, nor have I allowed a patient to die a death of pain when opium would lull him into his long sleep. I share the responsibility of this with the surgeon who walked about the battle-field distributing morphine to those who were hopelessly wounded, and with the soldier of Ambroise Paré, who did more. It has been said, that to cut the nerve of a lame horse's leg is like cutting telegraph wires to stop a war; but it does more, in preventing the wear and tear of pain upon vitality. It has been my lot to see a friend, to whom, at the end of a painful and hopeless malady, when the hour of death seemed to be near at hand, I had given morphine largely, awaken twice with a week's new life, due to eighteen or twenty-four hours' deep sleep and continued exemption from pain. Short of engendering a habit, it is better for the patient's strength and life to sleep with opium, than to lie awake with pain for the want of it; and I do not apologize for remarks, trite though they be, which are no digression from the subject of the education of those the great business of whose life will be to relieve pain and suffering, whose sheet anchor, whether in life or at the hour of death, must be narcotism in some degree or form, and deprived of which their profession, if not their prescriptions, would be comparatively a farce.

A full-blooded Latin prescription, the unabridged edition, such as we find in English books, is perhaps the curious single relic of its early history clinging to our art. And yet it is important that the student should acquire so much of Latin, or at any rate of the principles of that language, as shall enable him readily to understand the general character and construction of the Latin names of his therapeutic agents.

Latin is the accepted language, the world over, of much of the nomenclature of medical science. *Maranta* in Boston is *maranta* in Paris and in Calcutta; and so with the products of chemistry. Years ago I read a learned and protracted controversy upon the therapeutic properties of the cow-parsnip, terminating in the important admission that the controversalists praised each a different cow-parsnip, whose rival claims to commendation added fuel to the dispute, but presented insurmountable obstacles to its conclusion. If the world is agreed upon a single name for a drug of any sort, let us adopt it; and the world seems to be agreed upon the Latin name. But it is a separate question whether a teaspoonful should, of necessity, be a *cochleare*, or even whether the name of a drug once indicated should be susceptible of the terminations of declension. Business is but business. The merchant's price current does not say "*of* cochineal," "*of* jute." However incongruous to the classic sense, and although the innovation might for a time console and encourage conventional ignorance, I would agree that the mystic ℞ should be accepted as merely a signal to the apothecary that a prescription is to follow, and that such Latin and English names as are unmistakable should be promiscuously intermingled, without regard to case, as if the whole were Anglicized, and especially that subsequent directions should be expressed in English.

Chemistry and Physiological Chemistry, like anatomy or like surgery to the purely medical man, though not daily weapons in the combat with disease, are yet an essential part of a liberal medical education. Although we may not look to the chemical philosopher who has invested a large intellectual capital in these collateral branches of study, nor yet to the zealous advocate of the expansion of all human knowledge, for an impartial estimate of what may be profitable to the three years' medical student, we must avow that no intelligent modern practising physician can afford to be ignorant of the great principles which underlie these sciences. He cannot be expected to manufacture Epsom salts, any more than the modern disciple of Izaak Walton can be expected, as formerly, to make his own rod; yet he must know their capabilities. The practical chemistry of the physician will probably be confined to a simple routine of the microscope and test tube, and to breeding harmony and peace in long prescriptions; yet it may be fairly expected from the average student of the present day that he shall know something of waste and supply, of assimilation and excretion, something of the analyzed products of disease, and, more than this, that he shall himself be able to conduct a simple investigation for their detection.

But it is useless to the medical student to know that every four grains of urea excreted correspond to five tons lifted through one foot; and I believe further that, as surely as the manufacture of steel is one thing and the repairing of watches another, so chemistry and physiological chemistry will every day be more and more recognized as distinct branches of study, and the results which they furnish to medical science in the shape of rules and signs to identify disease and remedies to arrest it as another distinct line of study, — each separated from the other by the limited capacity of the human mind, which can grasp a part, but not the whole, of human knowledge, — by the limit of life, which is short, — and by the indefinite expansion of either of these branches of study, which may be sufficient for the best powers of the average man for the whole of his best years.

And so of experimental physiology, which leads toward uncertain ground for students, for whom the results of large and well attested medical experience are the safest teaching, and to a most questionable habit of mind leading to experiments on patients.

Mercury as a prominent specific, and opium, may perhaps be viewed as entering wedges of discovery in therapeutic science, inasmuch as it is more probable that they act chemically upon material particles than upon anything so immaterial as vitality. The history of the cryptogam and of the parasite of skin disease, of the grape, of the potato, of wheat, and of the silkworm, points to the hypothesis of a material cause of disease, of a derangement of the machinery this side of the impalpable or even of the invisible, — to chemical combinations of remedy with disease, resulting in harmless products replacing noxious ones, — or, in the case of germ life, to combinations fatal to its existence. But we may carry the theory of tangible or visible machinery too far. When the philosopher avers, because the air is full of dust, that therefore some floating germ probably causes cholera and scarlatina, yellow fever, plague, or cerebro-spinal meningitis, it should be remembered, although we conventionally return to dust, that we do not spring from dust alone. Dust does not make monstrosities, or cancer, or tumors; nor is inflammation dust. It remains to be shown whether miasm and infection are often more palpable than are hereditary gout or constipation in the spermatozoön which transmits them. We know nothing of vital force. Chemistry may, indeed, create a quasi protoplasm, but it gives little assurance that it can go further in this direction. The Pygmalion of modern chemistry may with infinite skill form his statue, but the proved facts of modern science promise little to his prayer that it may live. The mason may construct a house, but there is little hope that it will ever be animated by an added vitality of spontaneous generation, or by life begotten in other than the usual way.

The attractive field of physiological chemistry leads through speculations like these, until it reaches a point of wild and fanciful hypothesis which twenty-five years since would have startled the sober disciple of rigid induction. The reaction of the present day is from induction to theory. As the soil throws out alternate crops, each springing from the material which the last has left behind, as the religion of the masses alternates in the lapse of years between apathy and excitement, so does the scientific world, held back for a long period by the monotonous fetters of indisputable fact, seek that liberty of the imagination whose attractiveness even Bacon well knew and recognized. Such theory has undisputed value. The hypotheses of minds like those of Faraday and Huxley may represent a value to science hardly to be overestimated. But with the student of medicine, whose time is limited, the question must ever be one of its economical distribution. To the utilitarian, disparagingly asking, "What is such hypothesis good for?" Tyndall replies, with Dr. Johnson, "What is the use of babies?" I venture to answer, "To make men in twenty-one years." Light that will become fruit in twenty-one years has just that value, and no more; and hence its pursuit may be a thriftless investment of the medical student's time.

In this country the question is, What is the most profitable investment of time, capital, and labor? and the teacher of the art of healing has no more right to employ the time of the ignorant student disproportionately in the pleasant and seductive paths of laboratory experimentation, because some of these may one day lead to pathology or therapeutics, than a guardian has to invest the money of his ward in stocks or securities of equally uncertain prospective value to him.

How few facts of immediate considerable value to our race have of late years been extorted from the dreadful sufferings of dumb animals, the cold-blooded cruelties now more and more practised under the authority of science!

The horrors of VIVISECTION have supplanted the solemnity, the thrilling fascination, of the old unetherized operation upon the human sufferer. Their recorded phenomena, stored away by the physiological inquisitor on dusty shelves, are mostly of as little present use to man as the knowledge of a new comet or of a tungstate of zirconium: perhaps to be confuted the next year, perhaps to remain as fixed truth of immediate value, — contemptibly small compared with the price paid for it in agony and torture.

For every inch cut by one of these experimenters in the quivering tissues of the helpless dog or rabbit or guinea-pig let him insert a lancet one eighth of an inch into his own skin, and for every inch more he cuts let him advance the lancet another eighth of an inch; and whenever he seizes with ragged forceps a nerve or spinal marrow, the seat of all that is concentrated and exquisite in agony, or literally tears out nerves by their roots, let him insert it still one eighth of an inch farther, and he may have some faint suggestion of the atrocity he is perpetrating when the guinea-pig shrieks, the poor dog yells, the noble horse groans and strains, — the heartless vivisector resenting perhaps the struggle which annoys him.

My heart sickens as I recall the spectacle at Alfort, in former times, of a wretched horse — one of many hundreds, broken with age and disease resulting from lifelong and honest devotion to man's service — bound upon the floor, his skin scored with a knife like a gridiron, his eyes and ears cut out, his teeth pulled, his arteries laid bare, his nerves exposed and pinched and severed, his hoofs pared to the quick, and every conceivable and fiendish torture inflicted upon him, while he groaned and gasped, his life carefully preserved under this continued and hellish torment from early morning until afternoon, for the purpose, as was avowed, of familiarizing the pupil with the frenzied motions of the animal. This was surgical vivisection on a little larger scale, and transcended but little the scenes in a physiological laboratory. I have heard it said that somebody must do this. I say it is needless. Nobody should do it. Watch the students at a vivisection. It is the blood and suffering, not the science, that rivet their breathless attention. If hospital service makes young students less tender of suffering, vivisection deadens their humanity, and begets indifference to it.

In experiments upon the nervous system of the living animal, whose sensibility must be kept alive, unbenumbed by the blessed influence of anæsthesia, a prodigal waste of suffering results from the difficulty of assigning to each experiment its precise and proximate effect. The rumpled feathers of a pigeon deprived of his cerebellum may indicate not so much a specific action of the cerebellum on the skin as the more probable fact that the poor bird feels sick. The rotatory phenomena, once considered so curious a result of the removal of a cerebral lobe, were afterwards suspected to proceed from the struggles of the victim with his remaining undamaged and unpalsied side. Who can say whether the guinea-pig, the pinching of whose wonderfully sensitized neck throws him into convulsions, owes this blessed momentary respite of insensibility to the action of an unexplained special machinery of the nervous currents, or to a sensitive-ness too exquisitely acute for animal endurance? Better that I or my friend should die than protract existence through accumulated years of inflicted torture upon animals the intensity of whose suffering we cannot fail to infer, even though they may have neither voice nor feature to express it.

If a skilfully constructed hypothesis could be elaborated up to the point of experimental test by the most accomplished and successful philosopher, and if then a single experiment, though cruel, would forever settle it, we might reluctantly admit that it was justified. But the instincts of our common humanity indignantly remonstrate against the testing of clumsy or unimportant hypotheses by prodigal experimentation, or making the torture of animals an exhibition to enlarge a medical school, or for the entertainment of students, not one in fifty of whom can turn it to any profitable account. The limit of such physiological experiment, in its utmost latitude, should be to establish truth in the hands of a skilful experimenter, with the greatest economy of suffering, and not to demonstrate it to ignorant classes and encourage them to repeat it.

The reaction which follows every excess will in time bear indignantly upon this. Until then, it is piteous to think how many poor animals will be subjected to excruciating agony, as one medical college after another becomes penetrated with the idea that vivisection is a part of modern teaching, and that, to hold way with other institutions, they too must have their vivisector, their mutilated dogs, their guinea-pigs, their rabbits, their chamber of torture and of horrors to advertise as a laboratory.

The direct and efficient medication open to the surgeon contrasts strongly with that upon which the physician leans, and which is grounded on the uncertain indications furnished by pulse and tongue, temperature and digestion. His therapeutic *armamentarium* compares still more strikingly with the limited remedial resources of medical art.

The practitioner recognized as a surgeon because he professes a knowledge of surgical lesion and disease, or because he has popularly identified himself with the far inferior province of operative surgery, can indeed do little, compared with the great recuperative force of vitality in its silent and never ceasing work among the atoms, establishing the cell outposts of a new territory, and collecting and manufacturing the raw material into the completed tissue, until the work of repair is perfect. Compared with this, it is a feeble effort of skill that cuts off a tumor or a leg, lays a fractured limb straight, replaces the fragments of a broken joint, or that fails to do so. Yet nowhere has the healing art conquered so large a domain as in surgery, nowhere is progress so rapid, and nowhere is the importance of principles so forcibly presented to the student. And these principles lead back to precise rules. Thus, if a common ulcer, in default of local cause, is treated according to its condition, by stimulant or soothing measures, here are principles; and if the student is acquainted with measures, he at once commands all the resources of his art. Without these principles, he perhaps applies a "wash," with the simple faith which impels him to rub mercurial ointment on every induration. Such views find their special application in surgery, which deals largely with mechanics and surface work, and therefore admits of much precise knowledge susceptible of a generalization of highest value to the student.

Much abused as it is, I sometimes think that a wholesome fear of the law of the land is not a bad stimulus to well-doing in surgery. The medical practitioner, accustomed to standing by, with the solemn conventionalism, the routine and implements and parade of art, and impressed by the familiar fact that medical disease pursues its unabated and independent course in spite of what he does, gets insensibly to feel, if he does the best he can in a case of surgery, that no one will recognize defects in surgical result. But all the world professes to have an opinion on a distorted limb. Many medical lesions can wait until the practitioner, like a lawyer, refreshes his knowledge; but broken thighs and elbows, wrists and ankles, will not wait, and every physician should know how to treat skilfully what is liable to be badly treated.

Lastly, I believe that much of medical jurisprudence, so called, a subject which treats of the legal relations of medicine and of the medical man, is probably better assigned in instruction to the special department which it concerns, — at any rate, so much of it as relates to surgery. The qualities of a good witness, sometimes discussed in lectures upon this subject, are, like those of a poet, rather congenital than to be acquired.

In thus briefly glancing at the education of the practitioner, let us not overlook the wants of another class, who from natural capacity or power of application, or from preliminary opportunities and training, can avail themselves of the advantages of a larger education, — who desire to leave the level plains of practical study, and climb the neighboring and lofty heights of science, upon whose rills those plains have depended for their fertility. In these days, an aspiration toward something more or higher than routine, a desire to transmit to science, even in a humble way, some return for what science has bestowed, is fortunately common. It need not be said that a medical school should, if it can, meet this generous demand for learning with large and ample opportunities. In doing so, however, it should not lose sight of its legitimate purpose, the education of medical practitioners, nor lure the medical student away from essential studies; still less, by too rigid examinations, exact from the future practitioner a disproportionate amount of less applicable knowledge; — and these are propositions upon which I strenuously insist.

Here I may call your attention to the fact that the student of the collateral medical sciences is not always the first in the field of great medical discovery.

It is a generous and pardonable sentiment which would claim for high and abstract science a large share in discoveries of great immediate utility. But medical discovery is not generally made by workers in chemical and physiological fields, but by subsequent and more purely practical observers, who apply to disease the materials and results of such previous work. Abstract science crawls with snail's pace and amœboid reach, letting in here and there a little light, gathering up everything new, true, or probable, whether immediately applicable or for the time useless, so far as any obvious application of it goes, slowly filling storehouses with goods of every kind, from priceless gems to worthless rubbish. The practical man goes there to seek something for his purpose, and takes from the shelves the electric apparatus for his telegraph, lunar caustic for his photograph, ether for anæsthesia, the sugar tests and the food for diabetes. We justly honor the patient and learned worker in the remote and exact sciences, but should not for that reason encourage the medical student to while away his time in the labyrinths of chemistry and physiology, when he ought to be learning the difference between hernia and hydrocele. Let him go to the storehouse and get his clothes, his coals, and his remedies, without being compelled to study tailoring, or geology, or the manufacture of quinine.

If there is a sure advance for succeeding generations in the slow siege approaches of the scientist, a sure progress from pick and shovel, there is also another progress growing out of this, which results from the *coup* of impetuous force, or the strategy of genius. An able writer has said that "the most original and important inventions the world has ever seen were the productions of men who had received little or no previous training in the particular art they have sought to improve." A large part of that successful therapeutics which is the ultimatum of medical science results from such original and not profound experiment. A member of this society a quarter of a century ago, having vainly treated a case of virulent eczema, considered what, as likely to do it least good, had been carefully shunned by previous practitioners, and applied to the excoriated surface an active stimulant, which not only cured it, but has since proved a scientific remedy of modern usage.

We owe the compass, the printing press, the telegraph, vaccination, and anæsthesia — lighthouses and fortresses of human happiness, safety, and knowledge — indirectly to abstract science, and directly to practical working men. Art is the scientific application of the more accurate and positive part of human knowledge. It is this which the student of medical science needs, call it by what name you please. "One of the enormous follies of the enormously foolish education of England," says Sydney Smith in a familiar passage, "is, that all young men, dukes, fox-hunters, and merchants, are educated as if they were to keep a school or serve a curacy." With equal force it may be said that it is not necessary to educate the family practitioners of town or country as if they were to serve in laboratories, and make analyses of biliverdin or uroerythrine.

The great object of modern education is to ascertain what the student wants, and to supply it exactly to his mind in the surest and shortest way. If, therefore, he asks to be taught fishes, do not teach him stones; if he desires a good

English education, do not compel him first to learn Latin and Greek; if he wants to identify fevers and fractures, do not engross his time with cell theories and hydrocarbons.

The medical student does not need to pick herbs from the field, or treat horses and dogs, or consider his parallelogram of forces before pulling in a dislocated shoulder; but he does need to know how to recognize and exactly how to reduce a dislocated shoulder, how to recognize and treat human disease, and what are the medical properties of the drug which the farmer has grown or the merchant imported for the apothecary. He has enough to occupy him profitably and exclusively in his own immediate field of study, without wandering over the whole domain of knowledge, at the mistaken behest of those who have a confused notion of a liberal education and large culture, and whose chief motive for sending the unfortunate student to explore new territory seems to be that they have themselves invested capital there.

If we may fairly assume, on the one hand, that few undergraduates need learn to calculate the curves of a turbine wheel, we may equally affirm that study of the mechanism of the steam-engine, and of a hundred other engines, — as, for example, that magnificent creation of American intellect, the three-ply carpet loom, for years in large and profitable use at Lawrence, and yet so complicated that the Englishman has never been able to introduce and run it, — would afford a profitable field for the exercise of the higher faculties of analysis and combination. Mathematics deals with abstract quantity: our art deals with material. Like chess-playing, the mathematical faculty is not the highest or most profitable quality of inventive mind, in mechanical or other arts, or even in life; yet the conviction of this day and community inclines a little to the view that a medical practitioner who is fitting a presbyopic friend with spectacles, without at the same time explaining to him that $\frac{1}{a} = \frac{1}{p} - \frac{1}{r}$

does not quite rise to the emergency. And this criticism involves neither disrespect of nor ingratitude to any philosopher whose exclusive learning has so prepared the inorganic elements of our science that they can be readily assimilated and digested by the student of our art, and made available, whether for medical practice or medical discovery.

There is a fallacy in the idea of culture. A man accomplished in one direction is not necessarily educated in another. High æsthetic culture did not prevent the distinguished French painter and his friends from superintending the destruction of the Column of the Place Vendôme. The humanizing influences of refined beauty in art neither taught them to restrain their personal and political hate, nor

"With sweet science mollified their stubborn hearts."

Talent and power of application may, indeed, incidentally lead a man to eminence in several directions. But a cultivated, a literary, or even a scientific man, is not necessarily the best physician: the best physicians, indeed, are sometimes possessed of little outside culture. The same is true of other pursuits. The obvious inference is, that the most valuable knowledge is that which is most applicable to the purpose in view.

The great and immediate cause of Prussian success in the late contest with France was proficiency in the science and art of war. That the Prussian government had better material to work with, that the whole body of the people were educated up to a level which enabled them to learn more readily and completely the business of the soldier, and generated, if you please, a stronger sense of military duty, was of course so much the better for them. But this was a question of preliminary and early education. We may rely upon it that, when war came, the highly educated and intelligent

Prussian officers set their soldiers, whoever they were, and whatever they knew, to reviewing, not politics, nor philosophy, nor yet reading and writing, but organization, discipline, and drill. This had been a part of every separate man's education, and this explains their conjoint success.

Even in an atmosphere and country which encourage intellectual growth and expansion, the average condition of society is advanced only so far as each individual advances his province and department of it. Therefore, if he is to learn "a little of everything," let us be sure that he learns "a great deal of something," — of that which is to him most important.

In these days of arms of precision, if we elevate the aim and increase the range, whether in gunnery or education, we are compelled to adjust the sight more accurately to the object. Let us have liberal education in its widest sense, the highest education possible to the whole mind and the whole body of the largest number everywhere; but then let us begin at the beginning, and teach the child, and not at the end; and when the medical student comes to you for three scant years which you cannot extend, and with preliminary acquirements which you cannot then increase, — small capital enough for the study of human disease in all its modern interpretation, — do not send him wool-gathering among the abstract and collateral sciences.

Mathematics, physics, botany, comparative anatomy, physiology, chemistry, as subjects of study, are all secondary to those essential and limited parts of each of these collateral sciences, whether principles or details, which have been actually applied to medical diagnosis and therapeutics, — secondary, in short, to the study of medical science, and especially of medical art.

In giving this utterance to what a friend of mine was once pleased to denounce as scientific blasphemy, and in assigning a limit to the present utility of certain branches of science in medical education, I do not propose a barrier to the progress of human knowledge, but insist that less applicable science should not be confounded with medical art, — what the student may or may not need with what he must have.

Let me advert to a drier, but not less important subject: I mean the machinery of teaching. We shall presently see that the European, especially the German University, administered and directed by the government, has in consequence great advantage in exercising a monopoly of medical teaching, and in thus compelling the student to support and encourage a single and best system. I need not say that such an arrangement is impossible in this country, where State governments grant medical charters without stint to all forms of professed medical faith. However desirable in theory a central guiding power in medical education, in this republican country we neither have nor can we have one.

There exists, no doubt, an eagerness to assume and exercise such power. The American Medical Association, for example, passed, only a year ago, the following vote: —

> "*Resolved*, That the American Medical Association has the power to control the subject of medical education in the United States, and the power to exercise that control in any manner upon which it may be agreed." [1]

I have even heard it alleged, that, if a body sends delegates to the American Medical Association who subscribe to its code of ethics, the delegating body is considered bound by that code. This groundless assumption is the only claim which the American Medical Association, so called, possesses to authority over the medical societies or the medical schools.

[1] Transactions of the American Medical Association, 1870, vol. xxi. p. 35.

The Massachusetts Medical Society is a corporation with no power except that which it derives from its charter, and under this charter it must act as other corporations do, by the votes of its members at legal meetings, and of its officers within the scope of their authority. It cannot delegate to another corporation, or to a voluntary association, the power to make its by-laws, or to prescribe rules for its action. If its members choose to obey the rules of any other association or corporation, it is their individual act, and not the act of the Massachusetts Medical Society; and no such action on their part can bind the Society until it is ratified by the Society itself. The same remarks are especially true of medical schools.

The American Medical Association is a body of medical gentlemen, practically volunteer delegates, having primarily in view the agreeable and commendable object of a journey to break the monotony of medical practice and give them an apology for leaving their homes and their patients at a pleasant season of the year. They assemble to revive old friendships, to form new acquaintance, to make excursions, and to settle down into relations of good fellowship, after a healthy difference of opinion over current medical topics and parliamentary forms. There are among them members who take an active and intelligent interest in the cause of medical science, its progress, and its teaching; but they can exercise little influence except in suggesting what may seem to them desirable.

We must not be startled if so extemporaneous an assemblage, while united in the semblance of parliamentary organization, should pronounce immature opinions, claim for themselves authority, and hastily denounce friends, or even issue bulls of excommunication of as portentous form and as little significance as the tail of a comet, which may indeed overshadow the whole country, but which astronomers assure us may be carried in a man's hat. Nor is it surprising they should virtually say to you, — a State society empowered by your Legislature merely to exact from each member a certain quantity and quality of knowledge, — that, if you do not transcend your legal authority and inquire into whatsoever other knowledge he may possess, and in a way not only unauthorized by the law of the State, but which its lawgivers would forbid, — then they, the Association, will neither let you eat their dinners, join their harbor excursions, nor participate in their discussions, nor will they allow you to use the platform and the name of the Association to ventilate your private or political differences.

This Society, the medical schools, and the medical community can well afford to attach little importance to such of the doings of the American Medical Association as seem skilfully designed, under the specious pretext of setting things right, to set men wrong. A body of so uncertain temper and impulsive action obviously has no authority to express even public medical opinion.

The number of medical schools in this country being practically unlimited, each school is liable to be successfully underbid, whether in fees or educational standard, by its neighbors, so long as the chief object of a large majority of students is the medical degree which confers authority to practise.

Most American medical colleges are virtually close corporations, which, under a board of trustees, in whom the power is legally vested, are really administered by their professors, who receive the students' fees, and upon whose tact and ability the success of the institutions wholly depends.

A University possesses over all its departments a legal jurisdiction; but it may be a question of expediency how far this jurisdiction shall be extended in practice.

The general supervision of a medical college by a University has, indeed, certain advantages. It may insure activity in the teaching, and, if exercised with constant reference to the possibility of thereby inducing change for the better, it may be an antidote to excessive conservatism.

Such wise direction from outside may perhaps to advantage share equally, but no further, the duty of seeking candidates for the offices, and of sifting their qualifications; and while it thus assists such persons to enter the school, may also influence them to leave it, should their teaching prove notoriously inadequate. It may stand between the school and the community, especially the medical community, in satisfying both of the impartial character of appointments, the conscientious labor of incumbents, and their devotion to the best interests of education. It may satisfy the public that the questions of the day, having a direct relation to the best methods of teaching, will receive careful attention, — in short, that the first object of the school is the welfare of the students and the elevation of true medical science, and not the emolument, direct or professional, of the instructors.

But medical teaching should not be too much interfered with, nor its machinery hampered by those who are not familiar with its working.

A large part of medical teaching — perhaps, on the whole, the most important part — is the clinical instruction at hospitals, which it is quite plain can never be in this country, as in Germany, in any way within the jurisdiction of a University. Again, a University, apart from its medical teachers, can know little or nothing of those complicated lines of division between medical subjects, or of their relative importance, upon which depend the establishment of professorships and other offices.

But another consideration lies deeper. In a community where solid scientific eminence and mere notoriety in practice are largely confounded, a University cannot judge accurately of medical men. While in France and Germany, as we shall presently see, the scientific merits of candidates for the higher places are publicly sifted and proclaimed, no such system prevails or can find place here; and while abroad it is well understood that in medicine the most popular teaching may not be the most profitable to the student, in this country professional distinction is often of uncertain character, and you may readily mistake eloquence, or any other attractive quality or accomplishment of the teacher, for science. If you add that in this country medical teaching is generally esteemed, not, as in Germany, as in itself an end, but as a means, — a road to the medical practice which is here the ultimatum of every medical man, — you subject your University authorities to an outside pressure for place and preferment, which they may be equally unqualified to judge of and unable and disinclined to resist.

The policy of enlarging a faculty by an indiscriminate addition of professors may grow out of an erroneous belief that you can teach medical facts from books by acceptable tutors, as you can Greek or physics. The reverse is notoriously true. The teacher of the higher medical branches must filter, digest, and recast book facts, to a degree that implies large actual experience and sound judgment.

For these reasons alone, while formal appointments may be better left to the University, I am satisfied that nominations, as in Germany, should be virtually, at any rate practically, delegated to a faculty of medical men. And the same is true of the establishment of professorships, and of the general organization of the school.

In medical matters, a University should rely largely upon the guidance and wisdom of those to whom it does not scruple to intrust its teaching. It may well hesitate to ignore their advice, and assume more than a general supervision over machinery which has a complicated relation to the medical community, and especially to the rest of medical teaching throughout the country, of which but a small part is connected with Universities, — a machinery which, to insure success, must be largely an anomaly in its relations, its rules, and its offices, when compared with other departments of a University.

If a University desires to secure the services of medical men of competence or eminence, most of whom in this country, unlike teachers of undergraduates, are engaged in active business, it will maturely weigh the question how it may compensate them, — whether by professorial position, which, if you make it common and cheap, ceases to be desirable, — by intrusting them with discretion and authority, which, if you reduce them to the rank and file of tutors, and rule them by a non-medical and comparatively uninstructed interference, they no longer possess, — or by money, which in the higher branches of medical teaching, and in default of other inducements, must be considerable in amount.

German medical science — until fifty years ago infused with German mysticism, and with *a priori* speculation concerning remote affinities — inaugurated about that time a different philosophy, substituting for theory and vain discussion rigorous induction from ascertained facts,—the method, in short, so long before vindicated by Lord Bacon. Soemmerring and Meckel in anatomy, and Burdach and others in physiology, were now laying the foundation of a school of exact observation in medical science. At this same period, also, Laennec was a prominent pioneer of an equally exact school in France, destined to eclipse for a time, by the labors of men with whose names this community is familiar, the slower but solid growth of the German school. But the superiority then and for years afterward so obvious in French medical science, and to whose valuable teaching the German school owes much, has gradually yielded to the rapid strides of more recent German progress. The learned and distinguished Johann Müller, the father of exact physiology, soon followed by Schwann, Henle, Liebig, Rokitanski, Valentin, and Weber, and later by a host of others, of world-wide reputation, inculcated both by teaching and practice the value of accurate experiment, to the exclusion of unproved theory, — a line of study rigorously prosecuted for the last quarter of a century.

The barren fields of speculative hypothesis and arbitrary assertion have thus been fairly replaced by the precise results of induction from observed phenomena; and when we consider the multitude of able minds and the vast labor thus concentrated for years upon the facts of health and disease, we shall be astonished neither at the amount nor at the character of the progress of medical science in Germany during this period, nor at the advantages which the German schools offer at this moment to the medical student.

It may be of interest at this point to refer briefly to the so called materialistic tendencies which are supposed to have grown out of such studies, and which would have less importance were it not for the prominence which the narrower theologians have given to them by active opposition. It could hardly be supposed that the German mind, with its well known tendency to theorize, would rest completely satisfied with the slow deductions authorized by facts. But, curiously enough, the theorizing tendency, which once constructed its hypotheses with little or no foundation, now uses the facts of modern science as a basis for similar hypotheses.

Instead of arguing, for example, upon the relation of life to imaginary conditions of oscillation or tension, it has propounded questions equally impossible of solution based upon the recognized facts of physiology and chemistry. Thus, it being clear that organized bodies have certain properties and modes of action — life, for example — by which they differ from inorganic bodies, we naturally ask whether life is a principle superadded to the material. The philosopher replies: No, it is not necessary that a quality which we find in a body should be added to it, and be distinct from it; for example, the extension and weight of a body are intrinsic to it and inseparable from it; we cannot conceive of such qualities apart from the body itself; and so it is with those elementary qualities of organized bodies whose aggregation constitutes life: in short, life is identified with an organized body, just as are its size and weight. The gist of this argument, that vitality has no existence separate from matter, is, that vitality separated from matter has never been observed by human sense; it is a quality of matter, because we cannot put our finger upon it after it is separated from matter. The advocate of this doctrine leaves no ground for inference, and admits the existence of nothing which has not been observed by his senses. The tendency of this doctrine is obvious. It leads to the conviction that what we cannot observe apart from matter does not exist, — that there is no weight or dimension separate from matter, no vitality apart from organized material, no thought apart from the brain cell.

Such is Materialism, the bugbear of theologians. Moleschott, in 1857, says: "By the very fact of life, plants and animals return to their source. All is resolved into ammonia, carbonic acid, water, and salts. A bottle containing carbonate of ammonia, chloride of potassium, and phosphate of soda, with lime and magnesia, with iron, sulphuric acid, and silex: here is the defunct vital spark of plants and animals." [1]

Such is the position with which Huxley has so stirred the theologians. Because protoplasm, which he assumes to be the lowest form or basis of organized life, is resolvable into ammonia, etc., and because life has never been observed by our senses apart from protoplasm, therefore life is not something added to protoplasm, but merely a quality of it, whose existence ceases with it. We have here only time to answer, that, although we may observe no life without its protoplasm, yet we may kill the protoplasm, and thus separate it from life, while we cannot separate matter from extension or weight.

It will be readily seen that all this leads through a laboratory of chemicals to the old question of religious faith. Without a belief in what cannot be strictly proved, we can have no religion. Religious faith, like all other faith, is a belief, more or less strong, not only in the unproved, but in what may not be susceptible of logical proof. The practical point in this relation, which alone can lead to any useful result, is the question where rigorous proof shall end and religious faith begin; and this question admits of profitable difference of opinion. Beginning with mechanical force, and ascending to muscular agency and to the other signs of physical vitality, to sense, and through the intellectual machinery controlled by the will to the will itself, the individual, the Ego, and so upward to higher Power, it may well be a matter of speculation and difference of opinion at what point of this ascending scale human investigation and discovery will ultimately stop. You can now breed and hybridize both plants and animals. Perhaps some philosopher, with a better understanding of the proximate machin-

[1] The Circulation of Life: Physiological Answers to Liebig's Letters on Chemistry, by Jacob Moleschott, 3d ed., Mayence, 1857, p. 276.

ery of life, may hereafter animate matter. But the vitality of the body is not the whole being. That some of the seemingly inscrutable machinery of what we call life may come within the limit of our comprehension, as the result of future rigorous observation and deduction is not impossible. But it is absurd to suppose that the Ego, the individual, can ever comprehend itself. At some point short of this, investigation must stop; and it is for the philosopher to determine whether he will reject a belief in the existence of everything which lies beyond, or accept something on faith, — which in this case is belief, more or less strong, in a hypothesis of cause working outside the material system, based on and derived from all we have seen, experienced, and inferred of constant and seemingly necessary precedence of force, or whatever one may choose to call it, working within that system. It seems to me better and more consistent logic to accept and to act on this uncertain knowledge than to reject it, especially in view of the fact that most of our unhesitating and daily action is based on equally uncertain knowledge.

Such are the aspects and tendencies of materialism at the present day, about which medical men are popularly supposed to have an opinion. But in the mean time the student of medical science has his hands full of work with pathology and kindred studies, and, as a rule, knows little and thinks less of these speculations.

Let us now briefly review the medical department of the German University, — the undisputed centre of medical teaching at the present day, whether we regard its quality or quantity; — for although much of its system may be impossible to us, there may be also something that will point us in the direction of an improved method of teaching in this country.

The parental care of the German government for institutions of learning is such, that the number of medical schools is limited only by their clinical and anatomical possibilities, being before the present war not far from twenty, while the number of teachers is enormous.

Nominating their own officers, enjoying a certain power of action independent of government, and not unfrequently having no government subsidy, these schools contain three classes of teachers, — the regular or so called *ordinary professors*, who alone are members of the faculty, the *extraordinary professors*, and the *private teachers*, — the last two classes comprising the teachers of specialties.

Any vacancy in the corps of *ordinary professors* is publicly advertised; applications are wholly unrestricted; and from the applicants one, two, or three are selected by the faculty for nomination, — practically an appointment, inasmuch as the first on the list receives the formal appointment then made by the King; an impartial system, which, by insuring the place to the best man, excites an active emulation among the professors of the lesser universities for promotion to the larger and more important centres of instruction. Ability being thus guaranteed, the professor holds his place for life, but may retire on full pay at the end of thirty years of service, — this pay being about a thousand dollars from the government, an amount sometimes increased, during active service, to three or four thousand dollars by students' fees, paid both to professors for private courses and to the faculty. While the professor is thus secure of a minimum, he is at once stimulated to excellence in his own teaching and interested in the success of the whole faculty, considerations neither of which should be lost sight of in the organization of a school.

Of the ordinary professors, the more important, perhaps, are the clinical professors, who range over all medical subjects in two separate and parallel courses of lectures, devoting one to what we call didactic, and the other to clinical teaching, never confounding the two. Chemistry and physics being part of the preliminary course, there are no professors of these branches within the faculty.

The place of the ordinary professor is no sinecure. He sometimes devotes from ten to fifteen hours a week to teaching. Virchow announces about eighteen hours a week with the students, some of which, however, are delegated to an assistant, and the professor of anatomy a still larger number of hours. Moreover, that the student may be sure of a complete course of instruction, the faculty have the right to call on any professor for lectures outside of his immediate branch, it being understood that, the more lectures he gives, the larger will be his receipts; a rule strictly enforced, and the more easily because it is assumed that the two clinical professors alone out of the whole faculty are engaged in the practice of medicine or surgery.

In order to prevent an otherwise necessary increase of the faculty proper, there is an indefinite number of additional and so called *extraordinary professors*, not members of the faculty, but nominated by this body from among the *private teachers*, appointed by the Minister of Instruction, who hold their places for life, and, unless their subject is very unattractive, depend for fees wholly on their classes. These extraordinary professors often give parallel courses upon the same specialty; a competitive method, obviously contributing to good instruction.

In the larger Universities the number of professors constituting the faculty proper, and of the extraordinary professors teaching specialties, is about a dozen each; the former comprehending Professors (in some cases two) of Anatomy, Physiology, Pathology, Morbid Anatomy, Materia Medica, Obstetrics and Diseases of Women, Clinical Surgery, Clinical Medicine, and Medical Jurisprudence; while the extraordinary professors, teachers of permanent specialties, may be designated in general terms as those of Histology, the Skin, the Eye, Dentistry, Syphilis, Diseases of Children, Surgical Apparatus and Bandages, Comparative Anatomy, Special Medicine and Surgery, Mental Diseases, and Veterinary Diseases.

*Private teachers* are appointed by the faculty to give instruction upon any subject within the range of medical science, with the sole restriction that they may not give gratuitous courses upon any subject on which a professor gives lectures not gratuitous; a provision which seems to imply that it is well to nourish professorial teaching with money. They lecture in the halls of the University, their instruction being official, and published as such in the official catalogue. Their number is unlimited, being at Vienna about thirty, at Berlin twenty, and at Breslau a dozen. In these cities the students number respectively about a thousand, four hundred, and one hundred and fifty.

With this machinery the medical faculty receives from the government a guaranteed monopoly of medical teaching, while, on the other hand, the public and the medical student have an equal guaranty of a completeness of instruction practically unlimited in extent, and the excellence of which is insured by the competitive emulation of its teachers.

In glancing at the German student's career we are impressed by the character of the qualifications necessary for admission to medical study, which indeed do not differ materially in degree, though perhaps in kind, from those required for admission to the undergraduate department in our Universities; yet they are higher, I regret to say, than those which a large majority of our medical students could meet. But it is not the preliminary knowledge required by the German University that we miss in this country, so much as the resultant culture and mental training, the capacity for study.

In these we are compelled to acknowledge that the American medical student has large room for improvement.

The year is divided into two terms, together occupying about ten months, and the time devoted to medical study is nowhere less than four years, and in the larger faculties five years, — the result of which, added to extended opportunities for the acquisition of modern medical science under the best instructors, we cannot afford to overlook. It will hardly be credited that there are at Berlin, in each week, three hundred and forty-one hours of medical instruction, and at Vienna three hundred and seventeen, although the student may be required to attend lectures amounting in the average to only twenty or thirty hours a week.

With the single restriction that the studies of clinical medicine and surgery, and of midwifery, cannot be entered upon until the completion of the more elementary branches, the student is left to himself, save for merely general advice from the faculty, to choose among the various opportunities for instruction; and is, as a rule, notwithstanding a common desire to attend the hospitals, required to devote the first half of his four or five years to the elementary and theoretical studies, and certificates of actual attendance upon these branches are rigorously exacted. The teacher is supposed to acquire, to some extent, a personal knowledge of each student; and the student in turn is at liberty to select his teachers in the parallel courses, which, to facilitate his choice, are for the first ten days gratuitous. This liberty of choice is also extended to the different Universities, so that a student may pass from one distinguished professor to another, ultimately complying with the formalities of examination in that University only at which he graduates. But it should be remembered that these examinations are an actual and rigorous test of the student's knowledge.

Medical teaching rests largely on clinical opportunity. The collective hospital at Vienna is immense, and it might be anticipated that a part only of this, and even of hospitals in smaller cities, would be profitably available for medical instruction. The government wisely interferes and provides for this emergency by allowing a clinical professor to select from the whole hospital establishment cases suited to the purposes of instruction, and also to remove from his wards such as are no longer profitable or interesting to the students, who have thus the very great advantage afforded by an unlimited number of selected cases.

All hospital autopsies are made by the professor of pathological anatomy, who selects his cases in the same way as is done in the wards. These autopsies are made independently of the clinical professor who has had charge of the cases; and while the latter, in treating each of them, has been expected to lecture upon it in detail, and to furnish to the students a carefully recorded diagnosis, the pathological professor makes before the class an equally detailed demonstration of the autopsy, also accurately recorded, impartially verifying or disproving the views of the clinical professor. The student further follows the case, if he desires, from the autopsy to the microscope room.

In short, the hospital patient, from first to last, subserves the requirements of the student to an extent impossible in this country.

Physiology, physiological chemistry, and vivisection are taught in appropriate apartments and laboratories.

No one can fail to be struck with the eminently practical character of the medical examinations, and with the fact that they are calculated to determine indisputably the degree of proficiency in the various branches of medical study. The student is tested by the professors, in presence of the patient, in the autopsy room, in the laboratories, in short, in every useful way, by examinations. These examinations take place at irregular periods of the course, and we are not surprised to find that a large number of students are turned back at different stages of their progress. And if the protracted term of study — four or five years, at the least, as already stated — detains the student long under the eye of the professor, and so tends to educate him rather as a follower than an independent leader, it should be remembered that its machinery is arranged to encourage him at every step to try his own powers of flight, and practise him in the exercise of his own judgment.

In other words, a medical school, the appointments to whose faculty are virtually made by medical men, and which is managed by them, — whose teaching is based mainly upon large clinical opportunity and an abundant and accurate demonstration of medical facts, — life and activity grounded upon emulation, — a system guaranteeing to the soundest teacher the widest reputation and the largest classes, with an unrestricted competition, especially in the outset, and holding out as its final prize a permanent tenure of its highest offices with an adequate remuneration, — such are the elements of the great success characteristic of modern German medical education, with its underlying principle of practical instruction in all branches that admit of practical demonstration.

He who comes home fresh from German opportunities, impressed with their obvious advantages, and attempts to incorporate the German into the accepted American system, will find that this luxuriant growth of another hemisphere is not wholly adapted to our soil or to our requirements. He must supplant public opinion by a central government supreme in all matters pertaining to education and hospital administration, replace the American with the German professor, and the American student with the German student.

In Germany, the government enforces a system which distributes a number of salaried places, conferring high distinction, impartially to the best men; and in thus offering large pecuniary prizes to scientific merit, in a country where the mass of the people are poor, makes science itself a field of active emulation which has no ulterior professional aim. This cannot be expected here.

To the foreigner the especial attraction of Vienna, as of Paris formerly, is that the student who desires instruction upon any one of twenty or twice twenty different yet distinctly medical or surgical subjects, of every-day use to the practitioner, can, with half a dozen of his friends, induce an able teacher, for a moderate compensation, and with every facility for clinical or anatomical illustration at command, to exhaust the subject for their particular benefit. The knowledge is exactly what he wants, imparted when he wants it, and by a teacher with whom he is brought into close personal relations. But it is an error to confound the idea of this medical knowledge proper with any vague notion of a higher education and a higher science resulting from extended collateral study. Let us distinctly bear in mind that the American medical student abroad commonly has little to do with either physiology, or even chemistry, unless he pursues it as a special branch of study, and for some purpose other than the practice of medicine.

Paris, once the Mecca of the medical student, has yielded to the predominance of the German, in science as in arms, partly through the original indirect influence of the common school; because, while France means Paris only, Northern Germany, in the words of Colonel Stoffel, is "covered with centres of intellectual activity and production, so that, to enumerate them all, one has to go down to towns of the third and fourth rank," the average intellectual level in which is higher than in France. But I think we must avow that, apart from mere education, there is something in the original character of the German people, a solid and unattractively plain folk, which stamps it as different from the genius of the French or the American people. This special trait has been called the sense of duty; but it seems to me to be rather the instinct of labor without personal ambition. To quote Colonel Stoffel again: "One never ceases to be astonished by it, no matter how much one studies the Prussian people. The most remarkable illustration of this is furnished by the employees of all grades in the different branches of the administration of the monarchy. They are paid with surprising parsimony, they are generally burdened with families, and yet they toil all day long with indefatigable zeal, without complaining, and without appearing to desire an easier position. 'We take good care not to meddle with it,' said M. Bismarck to me one day; 'this laborious and badly paid bureaucracy does the best part of our work, and constitutes one of our principal forces.'" What is this but instinctive labor, the patient routine of the bee, rather than the expanding aspiration generated by the American soil? — and I intend no "spread-eagleism" in this remark.

Until that distant period when the whole face of our country shall be changed, — until this great continent is so crowded with struggling life, and so hopelessly oppressed with the superposed strata of political and conventional form that no individual can upheave the social sediment and lift himself into the active world, but by sheer habit and the force of circumstances shall continue in the last half of his life to investigate the simple cell that occupied his younger years, — there will be few world-distinguished scientists in limited special spheres here, as in Europe. The mass of human knowledge grows, indeed; but many years must elapse before we can expect such growth in this country, — before scientists will look to an American city, as to the Vienna, the Berlin, or even the Paris of medical science. And in the mean time our country needs well qualified medical practitioners.

The considerations which have been offered with regard to the capacity, the wants, and the time of the medical student, and also with regard to the tendencies of modern medical science and instruction, present a wide field for serious reflection. American medical education should guarantee to the student of average preliminary training and acquirement, who has honestly devoted three years to medical study, a knowledge at once adequate to the immediate practice of his profession, and a germ of future growth in the right direction, — knowledge unmistakably medical, practical, comprehensive, and rooted in the soil of modern science.

In this vigorous country, where the pursuits of business exhibit so many striking examples of early capacity, and where the aim of every young man is to find himself in active life, it is plainly difficult to fetter the ambition of the student with a view to insuring greater conventional and average competency. American medical colleges, too, are engaged in active competition to secure the largest classes. If public opinion has prevented the better institutions from reducing their standard of attainment much below a point concerning which there has been a tacit understanding, it is safe to say that no successfnl school has thought proper to risk large existing classes and large receipts in attempting a more thorough education. Steps in this direction have been guided rather by a desire to attract still larger classes, and indeed by a conviction that, while we must accept a certain amount of inferiority, the standard of medical education in this country may be raised, in the future as in the past, gradually and with certainty, by making the best opportunities available to the largest number.

Whatever opinion be entertained of this policy, it will be conceded that it differs from one which absolutely exacts from the medical student more knowledge, and resolutely refuses a degree (too often perhaps regarded as mere authority to open daybook and ledger) until he shall comply with increased requisitions, — requisitions not of a mere formal and technical character, but a guaranty of increased skill in every branch of the medical art.

Such is the object of measures recently inaugurated in the Medical School of Harvard University, upon which the Massachusetts Medical Society now mainly relies for the education of Massachusetts students, — measures adopted by its professors in a spirit of personal sacrifice, with a full sense of the possibilities they may entail of increased labor and diminished pecuniary receipts, and of which I feel it incumbent on me here to say that whatever credit attaches to them is due to my colleagues and to the President of the University.

By the newly adopted plan, the term of study still being three years, no student can receive a degree from this School who has not been connected with it at least one year.[1] A

[1] It may be stated, for the information of those not familiar with medical education in this country that, according to the law, the student, before he can be examined for a degree, must have studied medicine three years, and also have attended two courses of lectures in a medical college authorized by law to confer degrees.

The present usual or winter course of lectures lasts four or five months. Its advantages are that it saves money to the student, — to whom city board during a long consecutive period is often impossible, and who on that account is frequently obliged to content himself with one course of progressive system of study of three years' duration, beginning with the elementary and ending with the higher and more exclusively medical branches, including, as a matter not of form but of reality, all the intermediate subjects of medical study, offers to the student who can devote three years to it what must be considered, in this country at least, a very complete medical education. It involves, as will be seen, the necessity, in part, of three concurrent courses of instruction during each year. The student who joins this School for two years, or even for one year, may, if he pleases, by closer application to study, avail himself of these three courses simultaneously, with the obvious advantage of expanding the former winter course into a year or two years of progressive study during his one or two years in the School.

A part of a year in the Harvard Medical School, or a part of a year in any other school, will count in either case only as time, and not as a "course of lectures," — a measure inuring to the benefit of other colleges, by sending to them any student who desires that two "winter courses" of four months each should entitle him, as now, to examination for a degree in the college at which he takes one of those courses. On the other hand, Harvard College will examine

lectures in a city school, — and that it also economizes the time of the instructor, usually a practising physician, to whom it may be desirable to concentrate his teaching into a part of the year.

The disadvantages of this system relate chiefly to its necessary condensation, which begets a want of completeness in its teaching, — defects, however, which in our own University have been largely compensated by its summer term or school, which has furnished to the student who could afford it a supplementary and comparatively thorough instruction. This school, the first I believe in this country officially identified with a medical college, is also one of the most complete in its organization.

Harvard University has, indeed, long offered to the medical student great advantages; and it was no deficiency in its teaching, compared with that of any other college in this country, that suggested a change in its plan of medical instruction.

any student, who, having complied with all other usual requirements, shall have taken at least one full year's course of study in its own School. In view of two facts, this is a measure which, whatever else may be said of it, insures to the student a higher standard of acquirement than has yet been exacted in this country: first, the progressive teaching attained by abandoning the winter course; secondly, the requirement of competency in all the nine departments of study. This competency, however, is the more easily attainable because it may be practically and finally tested in any one or more branches, at the option of the student, at any one of three annual examinations, failing in which he may try again, when he likes, in those branches alone.

I heartily join with my associates in hoping that these carefully considered measures will accomplish the special purpose for which they have been adopted, which is the raising of the standard of medical education in this country.

I betray no confidence in saying that some of my able colleagues would have been glad to insist upon at least a two years' residence here. My own conviction has been that we are clearly not justified in doing anything seriously to endanger the present large success of the institution we have hitherto administered. In the recent words of one of the great reformers of the day:[1] "If we attempt to go too far ahead of the community, we may be left too far behind. He ventured to think that a system which would gain the attention and respect of the people must be one not too rudely divorced from their old system. He wanted to see the adoption, by the board, of regulations, not in accordance with what he might think right or otherwise, but capable of moving in the direction in which thought was moving," —

[1] From remarks of Professor Huxley on the Bible in London Schools. Boston Daily Advertiser, March 29, 1871.

and, I would also add, in the direction of that enlightened public opinion which in this country is the legitimate directing power in education, and which, as I interpret it, would open to the medical student a more liberal scientific opportunity, while still insisting upon a proficiency strictly medical.

## CODE OF ETHICS OF THE MASSACHUSETTS MEDICAL SOCIETY.[1]

*Object of a Code of Ethics.* — The Massachusetts Medical Society is designed to secure to the public a body of well educated and otherwise trustworthy physicians. Its code of ethics is intended to furnish certain principles and rules of action for their guidance and convenience.

### I.

*The Relation of the Physician to Medical Science.* — A physician should lend his influence to encourage sound medical education, and to uphold in the community correct views of the powers and the limitations of medical science and art.

### II.

*The Relation of the Physician to Medical Business.* — The professional success of a practitioner depends upon qualities connected with his moral character, his scientific attainments, and also his industry and business talent. But the relation of practitioners of medicine to families and households is not like that of tradesmen to their customers. The kind of competition which might be considered honorable in business cannot exist between physicians without diminishing their usefulness and lowering the standard of the medical profession. (See IV. 1; V. 1.)

[1] From By-Laws and Rules and Orders of the Massachusetts Medical Society. Boston, 1887.

## III.

*The Relation of the Physician to his Patients.* — The first duty of the practising physician is to his patient, who has a right to expect that his disease shall be thoroughly investigated and skilfully treated, with charitable consideration for his mental peculiarities or infirmities, and in a relation strictly confidential.

1. The physician should not make unnecessary visits. He should neither permit needless apprehension, nor fail to give seasonable notice of danger.

## IV.

*The Relation of the Physician to other Practitioners and to their Patients.* — In his relations with another medical practitioner and his patients, a physician should be governed by strict rules of honor and courtesy. His conduct should be such as, if universally imitated, would insure the mutual confidence of all medical practitioners.

The foregoing rule should be a sufficient guide of action. Some of the following contingencies will illustrate its application.

1. A physician should take no step with a view directly or indirectly to divert to himself the patient or practice of another physician.

2. If formally requested to assume charge of a patient or family usually attended by another physician, he should consent to do so only after notifying the latter, unless the case be one of pressing necessity.

3. If a physician is called to a patient during the temporary absence or illness of the usual physician, or in case of accident or other emergency, he should direct that the former be sent for as soon as he is able to take charge of the case, and should then relinquish it to him. It is generally agreed that, among several physicians thus called, he who first arrives shall act, unless the family designate another.

4. A communication from the temporary to the usual physician, in the absence of the latter, should be written and sealed, and not simply verbal.

V.

*The Relation of the Physician to Quackery.* — In every community there are minds naturally inclined to quackery, which has flourished in every age. It grows by being noticed, and thrives best under opposition. It is commonly unwise to employ argument against it. But a physician should lend his influence to establish a distinct line between the regular practice of medicine and the practice of quackery, and should avoid any act which might tend to weaken such a distinction either in the professional or in the public mind.

1. Thus, he should not consult with an irregular practitioner; nor countenance the use of secret remedies; nor be interested in medical trade-marked preparations; nor give certificates recommending mineral waters, patents, or medical preparations, or the like; nor give a commission to an apothecary, nor receive one from him; nor advertise himself or his practice in public print; nor publicly advertise advice or medicines to the poor, etc.

VI.

*Consultations.* — Consultation should be encouraged in cases of unusual responsibility or doubt.

A consultation is called for the benefit of the patient, and to give him the advantage of collective skill. Should there be a difference of opinion, discussion should be temperate, and always confidential.

A consulting physician should be careful to say or do nothing to impair the confidence of the patient or his family in the attending physician.

1. See, for guidance of a consultant, IV. 1, 2, 3, 4.
2. At a consultation punctuality is important; and non-arrival within fifteen minutes after the appointed time should be interpreted as non-attendance.
3. For the advantage of the patient, and for economy of time, it is well in a consultation to observe a certain order of business. The following has been found convenient.

The attending physician, having stated in general terms the nature of the case, may then call in turn upon each consultant, if there be more than one, to examine the patient, — the usual order being that of seniority. No consultant should make an examination or inquiry out of turn. On retiring, the attending physician may invite, in the usual order, the opinion of each consultant, who should not be interrupted while giving it; after which he may add his own. In conclusion, a course of action may be agreed on, or the attending physician may be left to act at his own discretion.

## VII.

*Fees.* — A fee table has a local application, and is designed to indicate a fair or average amount due for services. But if the patient fully understands it beforehand, a physician is at liberty to place any value he sees fit upon his services. It is then at the patient's option to decline them or to pay the price. A physician should be considerate of the poor.

1. A patient in moderate circumstances should not be called on to pay a fee unusually large for the service rendered, without a previous explicit understanding. A physician, if able, should offer to pay the medical attendant of himself or his family. Unless by special agreement, a physician attending or acting for another should receive the fees. Among obstetricians a rule obtains that the interval between the birth of the child and of the placenta halves the service and the fee. A fee should be charged for a medical certificate or paper of value to the applicant, — connected, for example, with absence or exemption, life insurance, pension papers, etc., — except the usual certificates of vaccination and death.

## VIII.

*Seniority.* — Seniority applies rather to duration of practice at the place in question, than to age.

# MIND AND MATTER.

## NOTES OF AN INCOMPLETED PAPER.

Whenever certain mental tendencies, or habits, or certain organizations or structures, obviously contribute to a useful end, one which we can understand, such for example as the procurement of food, or the safety of the individual, the orthodox Christian world hastens to recognize in them the display of creative and beneficent design. The coloring and lichenous covering of the nest of the humming-bird, or wood pewee, contribute to, and readily suggest the idea of concealment. The brilliant plumage of certain male birds in spring has been recognized as an essential attraction to the female. A little more remotely, the dangling filament from the jaw of certain fish is said to act as a bait, and lure their prey within reach. But it must be conceded that in such a view we omit the negative facts. The nest of the common robin is a knob of mud in a bare tree, conspicuous to every enemy; a dingy cock-sparrow seems to possess every necessary attraction for its mate; and most fish get a living without displaying a live bait.

From a human standpoint, either great injustice is done to a large part of creation by the omission to furnish it with something which would be an alleged advantage, or there is error in assuming that the lichenous nest of the humming-bird is the result of a beneficence especially directed to the protection of its occupant.

We may go farther, and say, if what is apparently advantageous to the individual, for example the food procuring powers of a tiger, a mosquito, or of many other members of the animal kingdom, is indicative of beneficence to the individual, it is by the same argument indicative of malevolence to the prey which suffers and dies that the consumer may enjoy and live.

Indeed, if we assume beneficence to be a motive in creation, we are equally forced to recognize the evidence of a malevolence of creative motive in the existence of any trait, characteristic, or tendency which, although of benefit to its possessor, is injurious to the comfort, health, or life of the mass; whether it be shown in the case of a man-eating tiger, or a mosquito, or a nettle. We are in the habit, however, of judging of the qualities of created beings from our own standpoint, simply as agreeable or repulsive, as advantageous or obnoxious to man. An argus pheasant, for example, is as conventionally attractive as a monk-fish is hideous. From this point of view these differences appear due to a mere caprice of creative power. If we measure creative wisdom by a human standard of usefulness or beauty in one case, we must do the same in every case, and recognize in the frequent absence of these qualities, and still more in the occasional presence of others humanly speaking both loathsome and noxious, the action neither of beneficence of design nor of malevolence, but of apparent caprice.

But there is another way of looking at this, to which the writer was incidentally led a few months ago while endeavoring to get hold of some flowers of the common prickly pear, from whose spines no precaution seems to avail to protect the hands. These little arrows, barbed and pointed, in their mature state lie loosely in bundles in each sac or quiver, and, if even lightly touched, penetrate and cling with great tenacity to the skin. What is the design of this annoyance to the rest of the world? If for defence, why are not other more attractive or important plants similarly protected against injury?

From this arrangement in the prickly pear it is but a small step forward to the analogous quiver of the Indian, and in the same way a step backward to the attached thorn, whether it be the flexible spine of a moss rose or the modified and formidable spike of the Spanish bayonet.

Such spines in all their varieties must be recognized as weapons. Their attenuated extremities are adapted, if not designed, to penetrate the tissues of impinging bodies. They are plainly productive of injury, and so far as this injury to other organisms repels hurtful aggression, they are significant of defence, and so far as the extent of this defence is unnecessary or superfluous, it becomes offence. In other words, they mean antagonism. But for what useful purpose? And, as has been already asked, why do these especial plants require this especial contrivance for their protection? The question is unanswerable.

But if we recognize in these forms a mere and casual material embodiment of an abstract idea of defence, or, better, of antagonism in its widest sense, of repulsion, — not specially designed for each case, but an embryonic and imperfect manifestation of a principle, often as superfluous to the individual as is a coccyx to a human being, — then we have a solution of the question which can be better understood and one which is capable of large development and application. Recognizing in the thorn, for example, an elementary, embryonic, or atrophied material embodiment of the idea of antagonism, we can easily trace it upward. And this view has the advantage that it is not only a satisfactory solution of the presence of the thorn, but that when connected with the thorn theory, and corroborated by it, it is by far the most satisfactory explanation of certain higher and seemingly capricious antagonisms, as, for example, a quarrelsome temper in a man. We thus readily trace the development of material antagonism from the fixed thorn or spike to the detachable arrow of the cactus and the similarly detachable but poisoned arrow-hair of the nettle, to the nettling organs of certain Medusæ, to the poisoned point of the wasp or the scorpion or the snake, and to the equally fitful and irregular distribution of mental antagonism in the game-cock, the bulldog, the grizzly bear, or the gorilla, with various material manifestations of claws and canine teeth, until we reach its final exhibition in a quarrelsome or pugnacious man. So that when we ask, why is a thorn? we may answer, why are certain men quarrelsome? The series is progressive and connected. The point indeed at which the reader is most likely to halt lies between the unconscious plant and the conscious animal; to the former he may incline to deny the existence of a motive which is obvious in the latter. But modern science admits no interval at this point, except that between conscious and unconscious action.

Phenomena of attraction and repulsion, momentarily modified by varying conditions, are so far common to organized life that no line can be drawn between plant and animal. It is as remarkable that the branches of trees, by an angle of arborization varying in each species, but usually constant to it, should effectually avoid mutual collision, as that free spores, or a flying cloud of insects, or a flock of wild geese should do so.

The tendril of a vine, rapidly revolving in a horizontal circle to find something to cling to, rises towards a perpendicular as it passes the parent stem (which would afford the vine no support) in order to avoid it, and again descends to its horizontal orbit of revolution when it has passed the stem. Here we have direction determined by expediency. Admit these facts, and there is no evading the further admission that a microscopic bit of vegetable protoplasm almost destitute of organization may shoot about in the field of a microscope, in rapid pursuit of whatever locality is attractive to it, and as hastily examining and avoiding whatever seems to it not to be so.

Among such facts there is obviously a true analogy, and if we add to them the curious habits of insectivorous plants, which turn toward suspected food, and either reject it or appropriate and digest it, according as their suspicion of its character has been well or ill founded, we have the motive of the tendril, as before of the spore, determined or modified by an obvious purpose or motive, namely, the pursuit of food, although we do not as yet touch the question of consciousness.

In view of such overlapping facts, it is obvious that the familiar preferences displayed by a stationary plant in pursuit of food and light may all be manifested by a plant which is not stationary; that the same influences which lead the former to reach out for food or light may lead the latter to go in pursuit of them; in short, that the discrimination and election exercised by a stationary plant may be also exercised by a moving one, and as rapidly as it is by so called animals.

The thread of this digression, then, which tends to obliterate the line between plant and animal, and to show how the machinery of feeding is continually developed from the lowest to the highest organisms, corroborates the belief that the machinery of self-defence, a principle which is next most important to plants and animals, may also be traced in a progressive chain. It confirms the deduction that we must recognize in it, not an accident, but an organization for the purpose of antagonism. And if so, we must avow that from a human point of view the machinery of self-defence among organized beings, from the lowest to the highest, is to all appearances distributed arbitrarily and capriciously.

Exaggerated self-defence leads to another equally incomprehensible and superfluous manifestation, which, if not offence, is at least antipathy. Such is that of the dog to the cat, of man to the snake. And so soon as we recognize the truth here implied, namely, that the abstract principle of defence or offence may not only mould material, as in the thorn, or the sting, or the spur, but that it may incite action, we have, as we shall presently see, reached the domain of instinct.

In the mean time we may profitably trace other similar analogies, less convincing perhaps than those already cited, but which, if taken in connection with it, are strongly corroborative of the same conclusion; namely, that material organisms are constructed upon, and their action determined by, not only an obviously systematic and general plan, but also in part by or according to certain detached embryonic ideas which are veritable fragments of mind; and also that these may be distributed singly or sparsely among lower organizations, while in the mental organization of man they are for the first time united, and go far to determine his individual character, as well as his habits of action, according to the proportion in which he is endowed with them. . . .

The main object of our inquiry being the effect upon organized matter of certain detached portions of mind, which, like that of antagonism already considered, are well known as separate motives to action, we are led to less familiar, less widely distributed, and sometimes even rare motives of action. It is impossible not to recognize many such resemblances, although their development may not be traced with the same close connection as in the case of the principle of antagonism.

Allied to the antagonism of offence and of defence is that of mere self-protection, by which the encroachment of the surrounding world is simply and selfishly resisted without injury to it. If a pointed thorn means defence, then the hard exterior of a nut or seed is a natural and avowed protection to its contents, like the dwelling which the mind of the lower animal seeks, and man constructs.

But when a mantis or a moth so resembles the leaves or bark it rests upon that it can hardly be distinguished from them, or the caddis worm surrounds its tube with gravel, or the bird its nest with lichen, or the spider lies in a motionless ball, or the partridge flutters, seemingly hurt, away from its brood, these are positive false appearances to subserve the purpose of self-protection. This is simulation and deception, in an embryonic and isolated condition it is true, but as real as when it animates a conscious being, and becomes the dominant motive of a hypocrite or impostor.

A Venus's fly-trap, which imprisons and slowly digests a fly alive, is in action as distinctly cruel as the spider which does much the same, or as the cat in its protracted torture of a mouse, or the savage Indian in his torture of a man. . . .

Before we further consider the question of the influence of the integral parts of mind upon matter, we may refer to probable instances of such unexplained disparity of endowment as the distribution of muscular strength, the quality of the senses, or varying vitality and longevity. A very striking example of this is manifested in that attribute of organized beings upon which their very existence depends, namely, reproduction.

In order to insure the perpetuation of the species in a large part of creation, the union of two organizations is required; the spermatozoön and the ovum. The attraction which insures the contact of their essential principles is sometimes only the passive allurement of beauty, but it is also sometimes an elaborate demonstration. The efforts of the pigeon tribe and of the English sparrow to attract first the attention and then the regard of the female are almost human. Human love-making is associated with pleasing manners, demonstrations, and even garb. It is not a fanciful but a real analogy that the poet points out between the voluntary demonstrations of the human mind, whether in dress or manner, and the demonstrations or brilliant plumage of certain birds at pairing time. It is hard to doubt that the brilliancy of petal immediately preceding the fructification of certain flowers is allied to this effort to attract, manifested in higher organizations, or to believe that it is an exception to a tendency so widely spread in nature. It is the fragmentary and isolated exhibition of a great and important principle of action in the human mind, — attractive demonstration to promote the perpetuation of the race.

The satisfaction of a peacock who has spread his tail is undoubtedly identical with that of a negro in a suit of many colors. It is gratification in the possession and the display of it. Transferred from trivial and worthless objects to worthy ones the feeling is no longer vanity but human pride, an important, commendable, and useful sentiment, of which the manifestation of the peacock is embryonic and isolated; and we may note incidentally that the strut of a man is often accompanied by a separation of the elbow from the side, through an action of the deltoid muscle, wholly analogous to that of the wing in the strut of the turkey-cock and the drumming of the partridge. . . .

The parasitic tendency is traceable in plants and entozoa, in domestic animals, and in certain men. . . .

A parrot, and still better a myna, talks, not by any peculiarity of larynx, but by peculiarity of brain. A man with a hook would do better than a lamb with a human hand or a Winchester rifle. . . .

A common horsefly is hardly industrious in the ordinary acceptation of the word. It spends much of its time upon the wing in the sunshine, feeding little; nor does it lay up stores. The same is true of the butterfly, although its larva is somewhat exclusively devoted to getting a living. But the ant has always been the emblem of frugal and provident industry. The leading feature of its existence, the necessary result of its mental and physical organization, is labor. Men are similarly different. It is as hard for some men to be idle as it is for others to work. The same is measurably true of nations. The Chinese and Germans are pre-eminently, and by nature, workers; with them a habit of industry is an endowment among other endowments. But with the ant industry is its prominent, and wellnigh its sole endowment, and it is called an instinct.

Gregarious or solitary habits characterize indiscriminately plants and animals. But while in plants and lower animals these tendencies are permanent characteristics of genera and species, in man they are only a peculiarity in the mental machinery of some individual.

Incidentally in this connection it is curious to observe that in certain notably gregarious communities, as of ants or bees, mental peculiarities, and the material organization connected with these, are parcelled out singly to different groups; as if a single human mental peculiarity exaggerated sufficed as a rule to fill the entire capacity of an individual of one of these lower organizations. It is familiar that among white ants the workers are exclusively occupied in building and nursing, while the soldiers, provided with an enormous head and mandibles, rush forth to repel attack or fasten upon whatever is encountered, and represent the antagonism of the community. The industry of the bee, however, does not prevent it from turning soldier on occasion. Indeed, the bee is not only a great worker, and a great fighter, but it possesses a third endowment, it is a skilful builder.

Constructive ability in its highest development is a very complex faculty, and, next to food getting, reproduction, and self-defence, is perhaps more widely spread in nature than any other. It is chiefly manifested in the dwellings for the preservation of offspring and families. But the wonderful contrivance of animals and insects to accomplish this result becomes in man the inventive faculty, and well illustrates the complexity of many other human traits and faculties. To invent a machine, or to devise a method or a plan, requires, first, a precise determination of the ends to be accomplished, which, in an intricate result, affords a field for the best analytic power; secondly, a selection of means, involving judgment; thirdly, a combination of the various fragmentary methods, — a field for the imaginative faculty, involving the perception of harmonious action, coaptation, and concurrence. It is needless to say that each added element requires a reconsideration, and probably a change, of many previous ones. Invention is dynamic chess-playing, and not unlike an inverted game, which, beginning with a single piece, should acquire, by successive combinations, a right to add one piece after another until the whole set should stand in harmonious potency. Herschel affirmed that the inventive faculty involved some of the highest powers of the human mind. And it should be remembered that mechanics are not mathematics. The provinces are both high, but wholly different. The most extraordinary mathematical power may or may not involve other intellectual pre-eminence. One determines how, and the other how much, — two very different considerations. The one says, "Use here a cam or an incline," and the other calculates the curve necessary to the cam or to the turbine.

The constructiveness of the bee is a fragment of such high and complex faculties. He makes his approximate hexagon by a rule of thumb of the most limited application. He knows nothing of mathematics; but as a workman, a builder, a constructor, he is pre-eminent. As we descend to the world of birds, reptiles, insects, mollusks, it would almost seem that the constructive faculty rises in its power. Fragmentary, isolated, incapable of modification, it produces the most wonderful single results, — holes in earth, wood, and stone, — woven cups and covered bottles, — apartments for separate purposes, even for ventilation, — boxes, lids, and hinges, — until the constructive faculty runs wild, and ceases to have a conceivable use. One bird builds a bower, and, having paved it with particolored shells for ornament, runs backward and forward through it; while another turns his back and propels stones, as a hen scratches the ground, until he or she has raised an aimless pyramid twelve feet in height. Naturalists call such exhibitions sexual, and they are certainly no more wonderful than are some human performances under similar soft influences.

Constructiveness is no less wonderful in devising methods of securing prey, whether by a web, or by a sand pit like the ant-lion's. Touch the edge of this pit lightly as an insect might, and the little larva at the apex vigorously snaps sand to overwhelm and drag down its prey. Similarly, a little creature I found on the sea-beach, when placed in a tumbler of damp sand, at once built holes, bringing each load to the surface on his head, and snapping it to a distance to avoid conspicuous accumulation. There is no end among animated beings to such devices in method and material.

But it is impossible to stop here. The plant world has an almost equal fertility of expedient to protect its germinating principle, — whether by filaments to float seeds aloft, wings to scale them to a distance, hooks to attach them, albuminous tentacles to shoot out at the contact of water and hold them, or elastic capsules to project and scatter them. And how can we separate these purely mechanical devices in material and method for perpetuating a race from the similar ones before enumerated? The analogy is obvious. If a thorn means antagonism, these expedients mean, with various motives, constructiveness. . . .

Keeping in mind the fact that these manifestations in the lower world of life are detached fragments of what are known as human faculties and endowments, let us again call attention to the extraordinary apparent irregularity, inequality, and injustice of the distribution of these fragmentary faculties. Any argument showing a beneficent intention implied by their presence applies with equal force to a malevolent design involved in their absence. But there is no need of invoking such argument, because all created life seems to maintain its existence and to perpetuate its species as well without as with these especial contrivances, and the caterpillar and beetle thrive as well as the ant-lion. In order to prove any especial manifestation of beneficence in the gift of such endowments, their possessor should be shown to be better off than his fellows, which he is not. The term *instinct* has been used to designate any exceptional and permanent faculty among the lower orders of created beings. But the instinct which forms the hexagon of wax is the same in principle as that which moulds or paints the shell of the mollusk, or digs in the ground the beetle's hole. It is more striking when more complex, but is still only blind obedience to a detached and fragmentary idea. It is an odd bit of mental mechanism, transmitted like legs and wings, and with the same exactitude, and it guides action, when action occurs, in a certain direction. The instinct of the beaver consists mainly of an impulse to resist the force of running water. This a tame beaver does after a shower in a farmyard. In its wild state it swims back and forth near a dam in search of streams and rills, which it stops. Further than this, it makes branches of trees, and mud which it consolidates with its tail, subservient to this obstruction. Still further, it fells trees by gnawing them on their water side till they fall, and drags them by water, through ditches, to the dam. Whether these long ditches are kept open by the beaver by a separate process or instinct, or are only the result of tree transportation during the several centuries, perhaps, which are required to build a dam sometimes miles in length, seems to be doubtful. The result of the dam is a pond, in relation to the water level of which the floors of dwellings are finally constructed. But it does not appear that these processes are ever materially varied. The outside hexagons of a comb, indeed, lose their shape, and go to join the hive walls ; but instinct, as a rule, bends but little to circumstances, although birds may select, according to opportunity, different materials for nests ; and it is even said that a hen has continued to set for a short time on kittens. Instinct is also more striking when its machinery is something which the human mind does not possess, as for example the mental sense of time which determines migration to a day, or a supposed prescience of the weather ; but this exaggeration of power is no more wonderful than the acuteness of sight in the hawk, or in a bat, which discerns minute insects or obstructions in the dark, or of smell in many wild animals.

In fine, if such endowment is an advantage to certain individuals, it is unequally distributed and places others relatively at a disadvantage. But if, as is more probable, it only modifies the machinery of an existence which is equally assured to all by other expedients, then it must be viewed merely as a peculiarity of mind, not thereby increasing the safety of the individual, but only leading to corresponding peculiarity in action ; in other words, a peculiarity, deviation, or variety in method, without obvious purpose. It is not a special indication of Divine beneficence. . . .

It remains to apply these considerations to the intellect of man. The human intellect is the first instance in the rising scale of development in which the faculties or tendencies of which instincts are the representatives are largely combined, and coexist; although the bee, for example, may both work and fight. Moreover, there is usually a balance or proportion among the various impulses to human action. But if, on the contrary, there is no such balance, and a single faculty largely predominates as a motive in action, one of two things occurs. If it be a useful or advantageous faculty, it may be recognized as a talent, perhaps pre-eminent; but if this faculty and the impulse to its action exist not only in great excess, but are also noxious, or even only useless or purposeless, they are from a human standpoint inexplicable. Such peculiarity is indeed the equivalent of instinct and its material manifestation; it is the equivalent of the thorn, and in this view the thorn is the equivalent of the tail of the beaver; but further, inasmuch as the thorn of a moss rose, for example, is a demonstration to all appearance as unnecessary as the bower of the bower-bird, or the mimic fortress which an insane being formerly built at the point of Blackwell's Island, below the Asylum, it is, like them, not only recognized as the offspring of fragmentary intellect capriciously distributed, but it is a form of true human monomania which is instinct in the lower organism. In the bee we recognize not only a wax accumulating and nesting habit and machinery, but a hexagon "on the brain." To the community the man of one idea is often unobjectionable and great, and, though sometimes an injury, is not infrequently a benefit. But with the monomaniac who may fall beneath the criminal code, the question of this possibility is to be determined by the degree of control his other faculties are capable of exercising over his monomania. . . .

There would be no woven, and probably no pendulous nests, without that mechanism which forcibly opens the beak of the oriole. The beak is thrust through the tissue of the nest, forcibly opened, and a thread is seized on the other side and drawn back. The result is a woven fabric.

I had forty or more Japanese birds like Java sparrows, probably "toy birds" and not a true breed, known as "sociable or crowding sparrows." Having tried in vain to breed them, I at last observed an odd way they had of seizing any bit of string and thrusting it at the top of the cage. Having supplied them with strips of basswood matting and the small empty cages in which German canaries are imported, I soon had a couple of dozen spherical nests with an aperture in one side. The instinct or faculty here was to tread upon a part of the fabric as usual in nest making, but while doing so, to thrust the rest of the material upward with the beak and head in all directions.

These are examples of results from an obvious physical mechanism, and also from a peculiar intellectual tendency. . . .

Arms and legs are mechanical and subordinate to the will, and so is also much of the intellectual machinery. A dog has four legs, and straddles to stand firm. A tree has one, and thickens its roots and buttresses for the same object, and also straddles its roots for strength as well as for food. In both cases this is a manifestation of an intellectual, instinctive, or abstract aim to stand upright; it is a means set in action for that end. Similarly, the tendril and the twist of a vine is an expression of an effort to cling. Some trees are buttressed in an unnecessary and exaggerated way, as is the ceiba, for example. So a thorn is what would be recognized in an animal as the exaggerated expression of an unnecessary effort to antagonize.

Such abstract effort is a fragmentary manifestation of aim, purpose, intention, — in short, of intellect. When the being, whether animal or vegetable, gets higher in the scale, all this may be temporary and occasional, and more or less under the dominion of reflex force, and when higher still, of will.

In vegetable organisms such protective action is conventionally recognized as the work of an all-protecting design of higher mind, which provides for the exigencies of the plant. But there is no evidence that this force set in action by an exigency does not reside in the unconscious plant itself, as truly as reflex action does in a decapitated frog. If we concede that a headless frog scratches his injured side with his leg to lessen pain, or crawls from the palm to the back of a man's turning hand to keep from falling off, we may also concede that an unconscious tree can spread its roots to maintain its upright position, and that it does so without the interposition of any other power than that within it.

But further than this, if we concede that this action has an end or object, the latter has as true a motive as has the frog's scratching; call this action reflex if you please.

Consciousness once eliminated, it is very difficult to draw a line between a mere machine, which, by familiar mechanical expedients, provides for emergencies and acts upon contingency, and a tree, or an unconscious animal, which does the same thing through the vital mechanism. . . .

We are thus led, by a series of successive steps of which it is difficult to deny the logical connection, from the action of mind to that of matter. We have seen that, —

1. The human mind alone unites all known mental faculties.

2. Fragments of the true human mind exist in the lower organizations, either singly or in groups.

3. These are commonly called instincts.

4. They act persistently through generations, with little or no variation.

5. Conversely, an analogously persistent and dominating impulse in man is called a monomania. It is also instinct.

6. If a fragment of mind acts upon matter, it may produce, for example, as a result of the mental fragment of antagonism, either a thorn or a crazy man's mud fort, these being,

in this relation, strict equivalents. All this confirms the theory that mind existed before matter.

7. The alleged comprehension of the motive for which, and the machinery by which, a highest power acts upon mind and matter, has been greatly exaggerated.

8. In the complete existing ignorance of this subject, one plausible explanation of the fragmentary and desultory distribution of mind among the lower organizations lies in a Darwinian view, now and here offered, of the destruction of innumerable individuals who, if still existent, might go to make up a continuous and progressive series of intellectual organizations, from the lowest to the highest. The absence of these destroyed individuals, if proved, would explain the seemingly incongruous prominence of certain existent fragments of mind in other individuals which still remain, as well as of the matter upon which their fragmentary mind has acted.

9. Inasmuch as religion is built upon faith, and begins where sensory demonstration ends, it matters not a particle to the cause of religion where this point is established.

10. Attempted explanations and details of the motives and methods of Divine action are of questionable utility to human progress or human knowledge.

11. The suggestion that we neither do nor can understand the motives of Divine action, is no derogation to a conception of the greatness and beneficence of Divine power. On the contrary, the assumption that we understand its motives is an impertinence. There are reasons of which we know nothing; for example, a sense of the fragrance and beauty in flowers, or the beauty in a distant landscape, produces the highest emotions and fills the eyes with tears, — why, we cannot tell. . . .

# VIVISECTION.[1]

THE worst vivisection is oftener mitigated by anæsthetics than formerly, and anti-vivisectionists deserve the credit of the change. But, on the other hand, there is a great deal more vivisection now, and more work is required to keep it within proper limits.

There can be no question that the discussion of vivisection arouses antagonistic human instincts. It is no common subject which enlists such earnest and opposite opinions. That there is something wrong about it is evident from the way in which the reputation of inflicting its torture is disclaimed. That for some reason it is a fascinating pursuit is equally evident from the bitter contest made for the right to practise it.

Having, in another connection, clearly stated my own views upon this subject, I need not again recite them in detail. There is little in the literature of what is called the horrors of vivisection which is not well grounded on truth. For a description of the pain inflicted I refer to that literature, only reiterating that what it recounts is largely and simply fact, selected it may be, but rarely exaggerated.

Vivisection is not an innocent study. We may usefully popularize chemistry and electricity, their teaching and their experimentation, even if only as one way of cultivating human powers. But not so with painful vivisection. We may not move as freely in this direction, for there are distinct reasons against it. It can be indiscriminately pursued only by torturing animals; and the word *torture* is here

[1] Now first published.

intentionally used to convey the idea of very severe pain, — sometimes the severest conceivable pain, of indefinite duration, often terminating, fortunately for the animal, with its life, but as often only after hours or days of refined infliction, continuously or at intervals. A man about to be burned under a railroad car begs somebody to kill him. The Hindoo suttee has been abolished for its inhumanity, and yet it is a statement to be taken literally, that a brief death by burning would be considered a happy release by a human being undergoing the experience of some of the animals who slowly die in a laboratory. Scientific vivisection has all the engrossing fascination of other physical sciences, but the transcendent torture sometimes inflicted has no parallel in any one of them. As to its extent, we read that in the course of ten years seventeen thousand dogs were dissected alive in one laboratory.

The difficulty is that the community, for want of time or opportunity themselves to investigate the subject, are willing to rely upon the discretion of scientific men. This is an error. In matters of this sort people are reluctant to doubt the infallibility of their doctors. A recent Boston journal says, "The scientists who practise vivisection are neither brutes nor savages, and it is going to be hard work to convince sensible people that they are." The answer to this remark is, that it would have formerly applied with equal force to the upholders of slavery, and yet after some hard work sensible people were convinced, and abolished it.

A recent distinguished writer, a good judge of men, makes the following observation: "Who can say why the votaries of science, though eminently kind in their social relations, are so angular of character? In my analysis of the scientific nature I am constrained to associate with it, as compared with that of men who are more Christians than scientists, a certain hardness, or rather indelicacy of feeling. They strike me as being somewhat unsympathetic, and capable only of cold friendship, coolly indifferent to the warmer human feelings."[1]

It should not for a moment be supposed that cultivation of the intellect leads a man to shrink from inflicting pain. Many educated men are no more humane, are in fact far less so, than many comparatively uneducated people. Having seen something of surgery for half a century, I unhesitatingly give the opinion that unwillingness to inflict physical pain, whether upon man or brute, is largely an implanted instinct, with which human nature is very unequally endowed. Also, that this instinct becomes blunted by habit. The more eminent the vivisectionist, the more indifferent he usually is to inflicting pain; however cultivated his intellect, he is sometimes absolutely indifferent to it.

Let us consider the question of the abstract right to vivisect.

A dog has at least as perfect senses, as acute feeling, and as perfect physical machinery, as a man. He has also a not inconsiderable share of the mind possessed by the human race. The right to vivisect a dog for the benefit of mankind inevitably involves the right, apart from human legislation, to dissect alive a living idiot or the lowest grade of savage.

The argument may be stated thus. Man has no prescriptive right to torture his fellow man for his own benefit, no matter how imperfect or defective his organization may be. On the same ground, he has no prescriptive right to torture an intelligent dog, a horse, or an elephant for profit, unless it can be distinctly shown, from a scientific as well as a theological standpoint, that man is the highest creation possible to the universe, — that he possesses the might that is said to make right. On that questionable ground, for

[1] Henry M. Stanley, In Darkest Africa, vol. ii. p. 161, 1890.

there is no other, man might offer a plausible pretext for subjecting the world beneath him to torture which he can sometimes turn in a comparatively small degree to his own advantage. But is it the case? Man is but a parasite upon a speck of dust whirling in infinite space. Who will deny that in infinite space there are higher beings than man? The possibility is all that is needed for the argument. The vivisector of dogs would undoubtedly object to being himself dissected alive by a superior being for the good of anybody, whether in the pursuit of science, or of a fascinating amusement, or with the hope of making a discovery, or of increasing the reputation of a college, or of gaining a little scientific prominence. In offering this objection to being himself dissected alive for the benefit of somebody else, the vivisector would have the support of the community. Why then has not the dog a right to the active defence of the community?

But, in order to oppose vivisection to best advantage, and especially lest he place himself in a false position, the anti-vivisectionist should bear clearly in mind that what he opposes is painful vivisection only. For there have been wholly painless experiments upon living animals which have led to useful results. Some of the greatest discoveries in medical science were made with no pain whatever; except by a perversion of the term, they involved no vivisection. And yet they have been often and sophistically cited by the vivisector as plausible arguments for inflicting both excessive and useless pain. The fact that a few able men have made discoveries by certain painless experiments upon living animals is used to justify the demonstration of torture to medical students, — to whom it is as profitless as any medical information can be, — and its practice by them. The discovery of anæsthesia has been time and again quoted in favor of vivisection. This is simply preposterous. In making that discovery the experiments from the beginning were painless, and were therefore wholly unobjectionable, as I happen to know, having seen the first of them. The same is true of Jenner's vaccination, which was a wholly painless discovery. Little pain was involved in all that was needed to discover the circulation of the blood, which was inferred from the valvular construction of the veins and then easily substantiated. The sequences of tubercular inoculation are attended by little or no pain of the sort here objected to. They are those of usual medical disease, and cannot be classed with a protracted cutting with knives or burning with hot irons. Seeing a man with hydrophobia, I have doubted whether the mere convulsions of that disease, though fatal, were very painful; and if not, its inoculation is comparatively unobjectionable. As for cerebral surgery, it is a curious subject for investigation, rather than a very profitable or a widely applicable one.

The greatest prizes in the lottery of physiological and pathological discovery have involved little or no pain. But the usual and staple work of a so called Laboratory of Vivisection, Physiology, or Pathology, for the education and practice of medical students in the unrestricted cutting of living animals, and for the indiscriminate and endless repetition of experiments already tried, — where a live dog can be bought and his living nerves dissected, exactly as, in a common dissecting room, you can buy a dead human subject and dissect its nerves, — all this is a very different affair.

A distinguished vivisector once remarked, "To us pain is nothing." When it is remembered that this pain may be, and sometimes intentionally is, of the most excruciating nature possible for human science to invent, and that in a large majority of instances it is to little or no purpose, the remark of this vivisector covers the objectionable ground.

There is no objection to vivisection except the physical pain it inflicts. I believe that in the end it will be advantageous for both the vivisectionist and his opponent to recognize the line which this fact suggests. But it is exceedingly hazardous at the present time to draw this line, or to compromise with and justify even painless experimentation upon living animals, because there can be no question that the practice of vivisection hardens the sensibility of the operator and begets indifference to the infliction of pain, as well as great carelessness in judging of its severity.

Indeed, vivisection will always be the better for vigilant supervision, and for whatever outside pressure can be brought to bear against it. Such pressure will never be too great, nor will it retard progress a hair's breadth in the hands of that very limited class who are likely materially to advance knowledge by its practice. The ground for public supervision is, that vivisection, immeasurably beyond any other pursuit, involves the infliction of torture to little or no purpose. Motive apart, painful vivisection differs from that usual cruelty of which the law takes absolute cognizance, mainly in being practised by an educated class, who, having once become callous to its objectionable features, find its pursuit an interesting occupation under the name of science.

In short, although vivisection, like slavery, may embrace within its practice what is unobjectionable, what is useful, what is humane, and even what is commendable, it may also cover, like slavery, what is nothing less than hideous. I use this word in no sensational sense, and appeal to those who are familiar with some of the work, in laboratories and out of them, to indorse it as appropriate in this connection.

In order that painful vivisection may be as nearly as possible suppressed, not only by public opinion, but by law, it is essential that public opinion should be frequently informed of what it is and may be. Here lies the work of the anti-vivisectionist. Further, every laboratory ought to be open to some supervising legal authority competent to determine that it is conducted from roof to cellar on the humanest principles, in default of which it should be, as slavery has been, uncompromisingly prohibited wherever law can accomplish this result.

The whipping-post, the knout, flogging in the navy, the *auto da fé*, the burning of martyrs and of witches, all have been or are considered to be right and justifiable. When the Church ruled governments, men were burned to death for the glory of God and the advantage of religion. Although religion is better understood, and a correct knowledge of physical facts is the aim of a large part of the learned world, worse horrors still exist, and men learned in a new direction are perpetrating them. A torture of helpless animals — more terrible, by reason of its refinement and the effort to prolong it, than burning at the stake, which is brief — is now being carried on in all civilized nations, not in the name of religion, but of science.

"But burning was useless, while vivisection is profitable." Here we reach the kernel of the argument of the pain-inflicting vivisector. The reply is, that by far the larger part of vivisection is as useless as was an *auto da fé*. It does not lead to discovery. The character of the minds of most of those who usually practise it makes this hardly a possibility. Real discoverers are of a different texture of mind, which you cannot create by schools; nor can you retard their progress by restrictions, put on all you may. But restrictions will and should cut off the horde of dull torturers who follow in the wake of the discoverer, actuated by a dozen different motives, from a desire for research down to the wish to gratify a teacher or to comply with a school requisition.

Every discoverer of a new truth, or inventor of the method which evolves it, makes a dozen, perhaps fifty, useless combinations, experiments, or trials for one successful one. In the realm of electricity or of mechanics there is no objection to this. But when such rejected failures involve a torture of animals, sometimes fearful in its character, there is a distinct objection to it. If a class of young men having no especial aptitude for making discovery — for in this particular the chances are very largely against any of them — are encouraged to practise themselves in its pursuit by exploring living nerves as they would the electric coil, it is time to object further. The law should interfere. There can be no doubt that in this relation there exists a case of cruelty to animals far transcending in its refinement and in its horror anything that has been known in the history of nations.

There will come a time when the world will look back to modern vivisection in the name of science as they now do to burning at the stake in the name of religion.

## VIVISECTION.[1]

In reply to your inquiry I would say that I have no objection to your republishing the paragraphs on Vivisection contained in a former address of mine on Medical Education, if you think they will be of service in restricting it; for there can be no question that vivisection should be properly restricted, and I am satisfied that the attention which has been of late years paid to the subject has been advantageous in this direction. Certain persons being indifferent to the infliction of pain upon animals, somebody should take the part of the latter, as well within the pale of science as outside of it. The not unfrequently atrocious pain of vivisection remains an argument against it, and the onus is upon the vivisector to answer it.

The question of pain leads to a part of the subject generally overlooked, which underlies the whole discussion. Let me briefly emphasize this. The real exception raised does not lie against vivisection, but against painful vivisection. The dissection of an animal in a state of insensibility is no more to be criticised than is the abrupt killing of it, to which no one objects. The confounding of a painful vivisection and an experiment which does not cause pain — either because the animal is under ether, or because the experiment itself is painless, like those pertaining to the action of most drugs, or because it is a trivial one and gives little suffering — has done great damage to the cause of humanity, and has placed the opponent of vivisection at a great dis-

[1] A letter to "Our Dumb Animals." Now first published.

advantage. If all experiments in physiology were as painless as those in chemistry, there would be but one side to this question. A painless experiment upon an animal is unobjectionable.

The extreme vivisector claims the liberty to inflict, at his discretion, protracted and excruciating pain upon any number of dogs, horses, rabbits, guinea-pigs, and other animals. The interest or honest enthusiasm he may happen to feel in some subject of physiology, however unimportant, justifies in his mind the exhibition of this excessive pain to classes, and its repetition by medical students, practically at their option.

This is an abuse. Inasmuch as the reform of any abuse needs remedial measures, such measures have been inaugurated by permanently organized societies, which, even though they may not have been always and wholly wise and temperate in their action, have erred in the right direction. Anti-cruelty societies should be encouraged. The progress of science has suffered little by their existence, and humanity has gained much.

As a rule, the best men or minds are the ones that accomplish true progress in physiology; their work is done unostentatiously, and with the minimum of experimentation. They conceive the most probable and profitable hypotheses, mature them most accurately, and test them with the greatest economy of labor, and, in this case, of animal suffering. Such men are comparatively rare. No laws will hinder them in their work, nor is it desirable that they should. But in their train come a horde of experimenters whose work is characterized more by its quantity than its quality, who, with much talk of science and original investigation, accomplish little of importance, who have become indifferent to the infliction of pain, and who should be repressed. You cannot separate these two classes of investigators, and the only alternative is to supervise them all. Restriction will practically bear where it is needed. It will hold in check the many, and it will not embarrass the few. Except for the science it is assumed to involve, law would prohibit vivisection. As a fact, the supposed science is sometimes little more than a show of it.

The vivisector is looked after if he overdrives his horse on the road, and should be similarly supervised if he inflicts suffering within a laboratory. Merely alleged scientific motives should not protect him. He might try the experiment of driving a horse to death, in order to ascertain the condition of his organs under such circumstances. This would be legitimate, but cruel. The law would supervise a frequent repetition of such a public experiment. Similarly it should supervise private experiments of a like sort, equally made in the name of science.[1]

The removal of a tumor from the brain of an infrequent patient, leaving him a probable invalid for the rest of his life, should he live, which is not likely, is an insufficient apology or reason for the unrestrained dissection of hundreds of living animals. As to "curative operations" on the brain itself, it is safe to say that they will always be rare and hazardous, and curious rather than useful.

The vivisector cites as arguments in favor of an unrestrained right to vivisect, the discoveries of vaccination, of anæsthesia, ovariotomy, antiseptic surgery, the circulation

[1] The name and authority of science should not always go unquestioned. The name of religion has been often made responsible for massacre. Within two years, and to my own knowledge, many birds, especially the common tern, which existed in countless numbers, have been nearly exterminated by a few persons, who have collected tens of thousands of skins, — notably for export, — armed with certificates from Natural History Societies, and who follow the breeding season along the coast. I am assured that the smaller birds have equally suffered, in great measure under the license of science, to supply the demands of prevailing fashion.

of the blood, — in short, every physiological discovery which has been largely applicable and useful. The experiments which led to these discoveries were indeed performed upon living subjects, but were mostly without pain, and were on that ground unobjectionable. No society, however extreme its views or action, can legitimately object to painless experimentation, provided it is really painless. But anæsthesia should be real, and not merely nominal or formal.

Another argument of the vivisectors is: "If war and its nameless horrors, if sport and its cruel battues, were at an end forever, if children no longer suffered from hunger and the diseases arising from neglect, then, with some show of reason, attention might be turned to the physiologist." This argument may be otherwise stated: "A, B, and C, being evils, we need abate neither of them until the other two have been done away with."

The defence of animals must come from those who know something of their capabilities. Most people know little about mind in the lower animals, and care less. There are races of men less intelligent than certain breeds of dogs. Without here discussing the mind of animals, and their inability to transmit their knowledge to man, it may be said that the chief difficulty in teaching the higher animals is not due to their want of mental faculty, but to the difficulty of establishing an understanding with it. It is an arbitrary line which separates the intellect of animals from that of men. There can be little doubt that an intelligent dog has at least the same thoughts, emotions, and suffering under vivisection as a Bushman or a Digger Indian would experience; and if the humanity which would shudder at the vivisection of a being with human speech and human features is callous to the vivisection of an animal without them, the friend of the animal should go to his assistance.

If it is an arbitrary and conventional line which separates the intellect of animals from that of men, it is an equally arbitrary line that places animals in the power of men, or limits the power of one man over another. Such a line needs frequent supervision, and the humane vivisector should concede something of any unrestricted right to which he thinks himself entitled, in order more effectually to restrain the vivisector who believes that nothing is cruel which is done in the name of science, or who has simply become indifferent to the infliction of pain.

## EXECUTION BY HANGING.[1]

In view of the wide-spread doubt whether execution by electricity has advanced the cause of humanity, it is likely that this method will not be widely imitated, at any rate in the present state of science, or in small communities. In the mean while let me offer to those who would do away with some of the objectionable features of execution by hanging certain considerations relating to a modification of it which occurred to me some years ago.

Exactly what does the usual method of hanging accomplish? Whether or not death can be accelerated by a broken neck which produces paralysis, though not necessarily an immediate unconsciousness, or by a supposed shock of blood driven upon the brain, it must be conceded that neither of these effects can be caused with certainty by any adjustment of the noose. What is really relied on to produce death is asphyxia, which is a gradual process. And although asphyxia of itself is painless, needless pain is always inflicted before asphyxia has time to act. The jerk of the rope often produces laceration inside or outside the neck, and has been known even to sever the head.

That neither the drop, nor its equivalent, the weight, insures immediate insensibility, is shown by the fact that the criminal after suspension may put his hands in his pocket, as did Ruloff, or, if the rope should be broken, is still able to walk up the steps to be hanged over again, as has occurred. In fact, however much it be desired to do so,

[1] Now first published.

it is not possible to regulate the injuries resulting from the drop. They are of the uncertain nature of accidents, the needless imperfections of a gross and ancient method, which if it were new would be considered quite as objectionable as "electrocution."

Few persons will maintain that hanging aims deliberately at producing needless suffering before death, even for a short time. And yet that is the working of the present system. The painful drop acts first, while the solace of asphyxia comes slowly and later on, to put an end to sensation, and close the scene. But it would be easy to avoid all suffering. We need only invert the process, and allow asphyxia to supervene before the superfluous injury of the drop is inflicted. This could easily be accomplished by a means so simple that it involves no appreciable departure from the present ceremonial.

Before describing it, let me show that mere asphyxia is painless. A man has more than once been known to commit suicide by bending the knees and gradually leaning with the neck upon a rope until insensible; the moment of danger occurring, according to an authority, when the brain whirls,— the subject then becoming so far unconscious that the constriction of the trachea can complete the full work without his knowledge. To test in another way this sort of insensibility, I once caused two persons to breathe pure atmospheric air from common gas bags. What surprised me was that they voluntarily held the bags to the lips without aid, until one was completely insensible by asphyxia, and the other practically so, the lividity making it desirable in his case to interrupt the experiment. This they would not have done were they suffering pain. Even the common anæsthesia by nitrous oxide, which is sometimes quite agreeable, is largely due to asphyxia. For if to this gas enough oxygen be added effectually to prevent the rigidity and the lividity which accompany asphyxia, together with the nausea and headache which often follow it, complete insensibility is not induced. This experiment I have also formerly tried myself. Asphyxia is evidently painless.

I therefore suggest that the cap now always drawn over the head of the criminal be made of rubber or other impervious material, secured at the neck closely by a string or elastic, and that the objectionable work of the drop be delayed until he has become unconscious by exhausting the oxygen contained in the air within the cap. I doubt whether the criminal would know even of the approach of insensibility. It must occur in a few minutes, however, much as if chloroform were introduced within the cap, and the drop could then be called upon to terminate the execution while the prisoner is unconscious. He would be confined exactly as now, or as in common anæsthesia where resistance is frequent, a medical attendant pronouncing upon the insensibility.

The method suggested practically meets the requirements of those who desire that executions should be more humanely conducted. It will doubtless also commend itself to the instincts of others who may prefer that, in a serious ceremonial, ancient custom should not be departed from.

Whether or not it be desirable to inflict pain in order to prevent crime is a separate question. Be that as it may, the business-like character of the death penalty in any form is not likely to be misunderstood or underrated. However mitigated, it will probably continue to be generally unpopular among criminals, — far more so than life imprisonment with a chance of pardon or escape, which has been proposed as a substitute.