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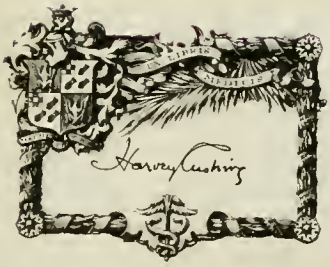

IV. 31.

PHYSIOLOGICAL EFFECTS OF ETHER *Boston*, 1850.

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Note: The text of this pamphlet is based on No. 30 and appears in two forms: one without Appendix (18 pp.) issued in September; the other with the Appendix issued in November. Morton discusses the history of the discovery and mode of action of ether on the nervous system and on the blood-vessels. He disagrees with Flourens that ether affects the cerebrum first, insisting that the cerebellum and medulla oblongata are the earliest affected. He also outlines ten reasons why ether is superior to chloroform.

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PHYSIOLOGICAL EFFECTS OF

SULPHURIC ETHER.

BY W. T. G. MORTON, M.D.

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ON THE

PHYSIOLOGICAL EFFECTS

OF

SULPHURIC ETHER,

AND ITS

SUPERIORITY TO CHLOROFORM.

BY WILLIAM T. G. MORTON, M.D.

BOSTON:
PRINTED BY DAVID CLAPP, 184 WASHINGTON STREET.
Medical and Surgical Journal Office.
1850.

PREFACE.

As I am continually called upon, and addressed by letter, by persons unacquainted with the properties of ether, asking information concerning its safety and adaptation to their individual cases, and also why I will never, under any circumstances, willingly give chloroform; I have thought it best to draw up the following account in answer to such inquiries.

There is no work of small compass and of good authority to which I could refer the majority of popular readers for satisfactory information on these questions; and in order that I might answer once for all such interrogatories, I have reduced my experience of four years practice in etherization to a convenient written form in the present work.

I have compared it with the experience of the most eminent men in America and Europe, whose names will be sufficient guarantee that what is here advanced may be depended on as the present state of knowledge on these interesting subjects.

Though this is intended as a general answer to frequently repeated questions, I do not expect nor intend that it shall be thrust forward as a universal reply; I shall be, as usual, happy to give or to receive any information which may tend to improve or to extend the practice of etherization.

19 *Tremont Row, Boston.*
September, 1850.

SULPHURIC ETHER AND CHLOROFORM.

It is now nearly four years since the first demonstration, by myself, that the inhalation of sulphuric ether possessed the remarkable property of annihilating pain during dental and surgical operations, and that this inhalation was attended with no risk to life. The use of this agent may now be fairly considered as an essential preliminary in all operations, or conditions of the system, in which pain forms an important element. After the first experiment on myself, in the middle of September, 1846, I waited impatiently for some one on whom I could make a more extended trial. Towards evening a man, residing in Boston, whose certificate I have, came in, suffering great pain, and wishing to have a tooth extracted. He was afraid of the operation, and asked if he could be mesmerized. I told him I had something better, and saturating my handkerchief gave it to him to inhale. He became unconscious almost immediately. It was dark, and Dr. Hayden held the lamp, while I extracted a firmly-rooted bicuspid tooth. There was not much alteration in the pulse, and no relaxation of the muscles. He recovered in a minute, and knew nothing of what had been done to him. This was on the 30th of September, 1846. This I consider to be the first demonstration of this new fact in science. As soon as the man whose tooth I had extracted left my office, I consulted Dr. Hayden as to the best mode of bringing out the discovery. We agreed it was best to announce it to the surgeons of the Hospital; but as some time would elapse before an operation, I thought it best to procure some assurance which would induce my patients to take it. I therefore called upon the man who had taken it, and found him perfectly well. *I then called on Dr. Warren, who promised me an early opportunity to try the experiment.*

In the mean time, I made several additional experiments in my office, with various success. From them I select the following, as examples of its varied effects.

I gave it to a lady, but it produced no other effect than drowsiness,

and when breathed through the apparatus it produced suffocation. I was obliged to abandon this mode, and obtaining from Mr. Wightman a conical glass tube, I inserted a saturated sponge in the larger end, and she breathed through that. In this way she seemed to be in an unnatural state, but continued talking, and refused to have the tooth extracted. I made her some trifling offer, to which she assented, and I drew the tooth without any indication of pain on her part, not a muscle moving. Her pulse was at 90, her face much flushed, and after coming to, she remained a long time excessively drowsy. From this experiment, I became satisfied of what is now well proved, that consciousness will sometimes remain, after sensibility to pain is removed.

I afterwards gave it to a Miss L., a lady of about 25. The effect upon her was rather alarming. She sprang up from the chair, leaped into the air, screamed, and was held down with difficulty. When she came to, she was unconscious of what had passed, but was willing to have it administered again, which I did with perfect success, extracting two molar teeth.

Agreeably to his promise, on the 16th of October, Dr. Warren requested my presence at the Hospital to administer the ether to a patient who required an operation on the neck. I applied the apparatus for about three minutes, when the patient sank into a state of insensibility. An incision three inches long was made in the neck, and a difficult dissection among the important vessels and nerves of this region was commenced, without any expression of pain. Soon after, he began to speak incoherently, and appeared to be in an agitated state during the remainder of the operation. On asking him if he had felt any pain, he replied in the negative; adding that he knew the operation was proceeding, and compared the knife to a blunt instrument passed roughly across his neck.

On the next day, October 17th, a tumor was removed from the arm of a female at the Hospital, by Dr. Hayward. In this case I continued the application during the whole of the operation, which lasted seven minutes; there was no sign of pain, though there were occasional groans during the last stage, which she said afterwards arose from a disagreeable dream.

I continued to administer the ether in my office; the following cases which occurred successively there, in about an hour, of which Dr. H. J. Bigelow took the following notes, are good examples of the usual results produced by the inhalation of ether, and of the feelings and expressions of patients under its influence.

"A boy of 16, 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,' he said, 'and had dreamed of Napoleon—had not the slightest consciousness of pain—the time had seemed long:' and he left the chair, feeling no uneasiness of any kind, and evidently in a high state of admiration.

"A girl of 16 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 12, 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 of coming there again, and insisted upon having another tooth extracted upon the spot. * * * * * *

"The next patient was a healthy-looking, middled-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.'"

Early in November, 1846, I applied to Dr. Hayward, for leave to administer it in a case of amputation, which I learned was to take place at the Hospital. The surgeons of this institution, in accordance with the established principles of the profession, which forbids them to use or encourage the use of any preparation of the composition of which they are ignorant, declined its use till informed of its composition. I immediately wrote to Dr. Warren, disclosing the whole matter, and presenting

to the Hospital the fullest right to use my diseovery for the benefit of the institution. Aeeordingly I administered the ether on the 7th of November to a female patient at the Hospital, on whom Dr. Hayward performed the operation of amputation of the thigh; it was entirely sueeessful in preventing pain, the woman asserting that she had been wholly ignorant of the operation. On the same day I administered it in a long and painful operation performed by Dr. Warren, of excision of a portion of the lower jaw, in whieh the patient's sufferings were very much lessened.

On the 12th of November I administered ether to a patient from whom Dr. J. Mason Warren removed a tumor of the arm; the vapor was inhaled for three minutes, when insensibility eame on; the inspiration being continued, the patient was entirely tranquil during the whole operation.

On the 21st of November I again administered it to a patient of Dr. J. Mason Warren, from whom he removed a tumor covering nearly half of the front of the right thigh; the operation was completed in two or three minutes, though there was some struggle during it; after its completion the patient remained quietly on his baek, with his eyes elosed. After he had lain about two minutes, Dr. Warren roused him by the inquiry, "How do you do to-day?" to whieh he replied, "Very well, I thank you." He said he believed he had been dreaming; he dreamed that he was at home, and making some examination into his business. "Do you feel any pain?" "No." "How is that tumor of yours?" The patient raised himself in bed, looked at his thigh for a moment, and said, "It is gone, and I am glad of it." It was then inquired if he had felt any pain during the operation, to which he replied in the negative. He soon recovered his natural state, experienced no inconvenience from the inhalation, was remarkably free from pain, and in three days went home into the eountry.

Having, in a previous publieation,* given a suffieiently detailed account of the proper way to administer sulphuric ether, I shall not enter again into these details, but pass at onee to the consideration of the comparative value of different anæsthetie agents. I need only allude to the comparatively slow progress of this diseovery in America, and the immense mass of testimony from the most eminent men of Europe in favor of its almost universal applieability. To those who would be acquainted with the various attempts instigated by envy, maliee, or interest, to establish priority of diseovery, and deprive me of the honor of originating the idea, and the eonsequent experiments, I may refer to the

* On the proper mode of administering Sulphuric Ether by Inhalation. Boston, 1847.

report of the Mass. General Hospital, re-published with notes by R. H. Dana, Jr., to the Report of the Committee to Congress, and to the award of the Monthyon Prize by the Paris Academy of Sciences.

After the claims of ether had become fairly established, another anæsthetic agent, *chloroform*, was introduced by Prof. Simpson, of Edinburgh, as a means of destroying the pains of parturition. This new agent soon created a strong impression in its favor, and has been by many substituted for ether. Its alleged advantages are its more rapid and intense action, its smaller dose, and its more agreeable taste and smell. Extensive trial, both in this country and in Europe, has, I think, proved its great dangers; several deaths have been caused by it, while there is no well-ascertained fatal result traceable to ether. For this reason, many surgeons, and among others Dr. George Hayward, of this city, have denounced chloroform as dangerous, given up its use, and returned to sulphuric ether with increased confidence.

The question, then, is that of the comparative *safety* of sulphuric ether and chloroform. This question can only be settled by experience, and by comparing their effects on the system; such experience has been accumulated to a great extent, and it is the object of these pages to show that the conclusions drawn from it prove the great superiority of sulphuric ether to other anæsthetic agents. My own experience in the application of the former, which has been considerable, and probably unsurpassed by any in extent and freedom from accidents, will supply abundant materials for its full consideration. For the effects of chloroform, I shall depend on the published accounts of the best authorities.

To make a just comparison, it will be necessary to say a few words on the physiological and pathological effects of ether and chloroform.

Though the general effects of ethereal inhalation are similar in nearly all cases, yet certain idiosyncrasies, or certain conditions of the system, modify the phenomena, as they do of all other medicinal agents. Instead of quiet and sleep, you often see excitement, agitations, or even slight delirium. In some cases small doses will etherize, in others it requires a large dose to produce unconsciousness. Sometimes, while pain is annihilated, the intellect and the senses are unaffected; the circulation, respiration, muscular action, secretions, and consequent phenomena, are variously modified. Besides idiosyncrasy, no doubt many of these anomalous or discordant phenomena are owing to improper quality or quantity of the ether, or some defect in the manner of administration. It is of the first consequence that the ether should be *pure* and highly concentrated. As a general rule, about two ounces (see table on page 13) should be

used to begin with, this being sufficient for full etherization in most cases; and it is better to induce this rapidly by a large dose, than gradually by a succession of small ones. To secure a due proportion of atmospheric air to the lungs, a simple bell-shaped sponge is preferable to complex inhalers. Early experiments were attended with disagreeable results, from the supposition that it was necessary to inhale ethereal vapor alone, instead of atmospheric air charged with this vapor. The effects of ether are usually produced in from three to five minutes. On removing the sponge, and allowing the introduction of pure air, recovery takes place in about the same time. That there is no danger in prolonging the state of etherization for a considerable period, the records of midwifery fully prove. After recovery from this state, the brain and nervous system are rarely inconvenienced by the excitement, if the ether have been pure; even headache is uncommon, and nausea or vomiting, delirium, or convulsions, are quite rare, unless it is inhaled soon after eating.

The symptoms indicate two distinct stages of etherization, or rather the complete and the incomplete. As the latter is all that is required for the dentist's operations, in which no important nerves or vessels are wounded, it is important to be able to recognize it. After the cessation of the slight cough which leads the patient to reject the sponge, the respiration becomes more rapid and audible; the pulse is natural, or slightly accelerated; the pupils are unaffected; the muscular apparatus is somewhat excited, and the movements more or less disordered; the inspirations become deeper, till at last insensibility comes on. In this stage we meet with the most curious affections of the intellectual and sensitive functions, in which sensation is destroyed while the intellect is untouched, the pain perceived but not recollected, or the will active and the power of motion lost. These are now known to be cases of incomplete etherization. The completed stage is characterized by a perfect relaxation of the muscular system; the pulse becomes slow; the pupil often dilated; the respiration often snoring. The sign to suspend the application is the diminished force and frequency of the pulse, and even before this, the muscular relaxation.

Ether undoubtedly acts in the first place as a stimulant, and finally as a narcotic. Magendie and Orfila have offered strong reasons for believing that the anæsthetic state is analogous to intoxication from alcohol. Both produce the same excitement and subsequent insensibility; both act principally on the nervous system through the medium of the circulation; both may be detected in the blood by undoubted tests. It

may, then, be called an intoxication, quickly produced, and as quickly disappearing.

Much has been written by physiologists on the order in which the various parts of the nervous system are affected; and there seems to be some discrepancy of opinion at the present time. M. Flourens (in a memoir before the French Academy in Feb., 1847) maintained that the action of ether on the nervous centres is in the following order: the *cerebral lobes* first are affected—in other words, the seat of the intellect; then the *cerebellum*, when *equilibrium* of motion is lost; then the *spinal marrow*, with loss of sensation and afterwards of motion; finally (if the experiment be carried to this extent), the *medulla oblongata*, cessation of respiration, and death.

My own experience leads me to adopt very nearly the conclusions of Dr. Brown, that the various parts of the nervous system are affected, in cases of complete and normal etherization, in the following order:—The cerebellum first, then the cephalic ganglia, the true spinal marrow, the ganglia of special sense and the cerebro-spinal system, and lastly the cerebrum proper; though it is not probable that the cerebrum is ever fully etherized, from the occurrence of dreams; total insensibility of the cerebrum would be nearly equivalent to death, or complete etherization of the medulla oblongata.

It has been a question whether ether produces its effects through the nervous or vascular systems. The first *(stimulant)* effect of ether is without question due to the conveyance of its action by the par vagum to the medulla oblongata, causing increased respiratory movements and quickened pulse; but, as far as experiments yet prove, the *narcotic* effects of ether are produced through the bloodvessels. This is easily understood when we consider the great extent of the internal pulmonary surface, its vascular net work, and the ease with which air is taken up; once introduced into the pulmonary blood, it would be very soon sent by the heart to the cerebral organs, and produce speedy narcotism. Unlike alcohol, ether taken into the stomach does not produce its specific effects. This has been proved by the experiments of Flourens; and this we should expect from the less extent and absorbing power of the gastric surface. Whether the ingestion of *ether vapor* into the stomach would be equally ineffectual, has not been proved; we know that the injection of the vapor into the *rectum* is speedily followed by insensibility.—*See Comptes Rendus, Avril*, 1847, *p.* 605.

When we consider the immense number of cases in which ether has been administered, and the exceedingly few and trifling accidents consequent

on its use, we may fairly say that its inhalation is unattended with danger. I have administered it in thousands of cases without a single alarming result, to persons of every age, temperament, and condition of bodily health. The experience of Dr. George Hayward, of this city, is to the same effect. He says (Boston Medical and Surgical Journal, April 10, 1850), "I have administered it to persons of all ages, of every variety of constitution, and in almost every state of the system, and I have never known in a single instance a fatal or alarming result. I have given it to infants of seven weeks old, and to individuals of 75 years, with entire success. There is reason to doubt whether death has in a single instance been produced by it, when it has been properly administered."

Its advantages as an anæsthetic agent are its perfect safety, the ease with which it is administered, and the absence of ill consequences. Nausea, vomiting, and irritation of the air-passages, rarely occur unless the ether be impure, or be improperly administered; excessive narcotism may be remedied by cold water externally, and stimulants internally, which will soon excite the respiration to free the lungs from the ethereal vapor. The pungent and disagreeable odor of ether is a trifling objection compared with its advantages over chloroform in point of safety. I may again quote Dr. Hayward in this connection, who says, "I should give it the preference over every other article with which I am acquainted, that is used for the purpose of producing insensibility."

I leave it to surgeons and physicians to speak the praises of ether in the various surgical, medical and obstetrical operations in which it is now universally used, whenever the relief of pain is an object of importance; I shall only allude further to a few results of my own experience in dentistry, which may not be uninteresting to the profession. I will here introduce a table showing these results for a short period of my practice, which will enable me to show the nature of the operations, the quantity of ether required, the time for producing and the duration of unconsciousness, with the general effects on patients of different ages and temperaments. [See next page.]

From these cases, forty-four in number, we see that both sexes are affected in the same manner; that ether may be given at all ages; that for ordinary operations the quantity required varies from one half to two ounces; that insensibility is produced in from one to four minutes; that recovery takes place in less time, proportioned to the severity of the operation; that it is well borne by every variety of temperament; that the

pulse, when affected at all, is generally slightly quickened, rarely slower than natural; and that for the most part those under its influence remain perfectly quiet, and undisturbed by nausea or vomiting.

Sex.	Age.	No. of Teeth extracted.	Quantity of Ether used.	Insensibility produced in	Recovery in	Temperament.	Pulse at commencement and end.	Remarks.
F.	33	16	2 oz.	5 m.	1½m.	Lymphatic.	70–105	Perfectly quiet.
F.	34	21	1½	3	1	Nervous.	77	" "
M.	18	1	1	3	1	Lymphatic.	105	Restless.
M.	40	7	¾	2	2	Very nervous.	100	No resistance.
M.	21	1	1	1	1	Lymphatic.	120	" "
M.	48	1	1¼	1¼	1	Robust.	70	Slight resistance.
M.	23	1	1	1	¾	Delicate.	70–60	Quiet.
F.	. .	2	1¾	3	2	Common health.	65–70	"
F.	23	Nrv. destr.	¾	1½	½	. .	100–130	Considerable agitat.
M.	. .	1	1	½	½	. . . .	. . .	. . . .
M.	24	2	1½	1½	insta'ly	Common health.	Irregular.	. . . .
F.	20	Tooth exc.	1	3	2	. . . .	"	Perfectly quiet.
M.	29	4	½	2	2	Sanguine.	32–110	Quiet.
F.	18	1	1	3	1	. . . .	. . .	Laughter.
M.	10	4	1	2½	1½	Lymphatic.	80–90	Quiet.
M.	25	4	1	3	3	"	. .	"
M.	18	2	1	1¾	1	"	Quickened.	"
F.	21	2	1	1½		Common health.	100–120	Trembling.
F.	33	1	1	1½		"	80	Conscious but insens.
F.	18	1	1	1½	1½	"	130–120	Quiet.
M.	21	3	1½	3	2	"	100	"
F.	25	3	1	3	1	. . . .	80	"
F.	18	2	1	1½	1½	. . . .	100–110	"
M.	21	4 Nvs. desl.	2	3	6	Very nervous.	160–100	"
M.	30	1	1	3	1	Sanguine.	80	"
F.	20	1	1	2¾	1	Weakly.	58–120	Perfectly quiet.
F.	34	1	½	1½	3	Nervous.	130–80	" "
F.	32	6	2	5	5	Lymphatic.	80–90	" "
F.	40	10	1	2	4	Weak & nerv.	70–80	Occasional spasms.
F.	22	16	2	3½	4	Lymphatic.	Quickened.	Quiet.
M.	3	1	1	3	3	Nervous.	130	Resisted.
F.	20	3 roots.	2	5	1½	Lymphatic.	Quickened.	Pleasant dreams.
M.	38	exc.,3 nv. d.	5	6	5	Sanguine.	70–130	Agitation.
F.	43	6 roots.	¾	1½	2	Lymphatic.	. . .	Nausea.
F.	21	Nrv. extr.	2	3	3	Very nervous.	83–120	Dreams.
F.	25	3	3	4	2	" "	Quickened.	Conscious but insens.
F.	18	3	1	3	3	Nervous.	. .	Slight resistance.
M.	19	. .	3	4	2	Very nervous.	. . .	Trembling.
M.	30	1 milk tooth	1	1½	1	Nerv. Sanguine.	Regular.	. . . .
M.	25	8 roots.	3	6½	3	Lymphatic.	Quickened.	Delightful dreams.
F.	20	1	1	3½	3	Nervous.	70–60	Bad taste.
F	16	1	1½	3	1	"	Regular.	Screamed but insens.
F.	25	1 filled.	3	3	10	Lymphatic.	"	Perfectly quiet.
M.	10	5	2	2	1	Sanguine.	Quickened.	Conscious but insen.

Chloroform, or the perchloride of formyle, which was at first extensively employed as a substitute for ether, till numerous fatal accidents led to its more limited use, was first brought into notice as an anæsthetic agent by Dr. Simpson, of Edinburgh, who is entitled to the greatest praise for his scientific endeavors to improve our knowledge of anæsthetic agents. He says it possesses over sulphuric ether the following advantages:—it is more powerful, 120 drops being sufficient to produce insensibi-

lity ; he has seen it produced "by six or seven inspirations of thirty drops of the liquid" ; its action is more rapid and complete, and generally more persistent ; it is more agreeable to the taste and smell. He might have added, if experiments then had allowed, that it is also *very much more dangerous*, and its very danger consists in its so-called advantages. We have reason to believe that the chloroform used by Dr. Simpson is a purer and superior article to that commonly used here ; this may account for the favor with which he views it. To counterbalance its agreeable taste and odor, chloroform is of an acrid caustic nature, and is apt to excoriate the skin. According to Dr. Hayward, its administration is generally followed by headache and vomiting, which continue for hours, with restlessness and want of sleep. Several cases came to his notice where it was taken in small quantity for dental operations, in which the brain and nervous system were affected to an alarming extent. Convulsions have frequently attended its use, as detailed by Dr. J. C. Warren (On Chloroform, Boston, 1848).

The physiological effects of chloroform are of the same nature as those of ether, only greater in degree, more rapidly produced, less to be calculated on, and therefore more dangerous. That the partizans of chloroform were too hasty in maintaining that it always produces a calm sleep, without agitation or excitement (which was one of its alleged advantages), we may quote the distinguished surgeon Roux, who (*Comptes Rendus, Dec.*, 1847) gives details of operations under its influence, performed by himself, in which the involuntary movements (in a state of complete insensibility) were so violent that they were with difficulty managed; in another case the patient's recovery was attended with the same excitement, disordered intelligence and loquacity, which have been set down as peculiar to ethereal inhalation.

Velpeau, though allowing the rapidity and certainty of its action, says that the duration of the insensibility is such as to render it dangerous in unskilful hands. A woman, who had inhaled it for only two minutes, remained for eighteen minutes without giving the least sign of sensibility. Its strength is such that an animal dies under its influence in two minutes, that would require the influence of *ether* for twelve minutes. As a general rule, a *drachm of chloroform* is considered equivalent to an *ounce of ether*. The very fact of its quick and certain action renders it formidable if prolonged carelessly ; it is impossible to know exactly when to stop, and the fatal blow may be given before we are aware of the danger.

M. Dumas, the eminent chemist, considering the extreme power of this

substance (see authority last quoted, p. 891) and its liability to abuse, remarked that chloroform ought to be classed among the *poisons*, whose sale is forbidden *by law* unless on the prescription of a physician; and recommended the police to attend to the subject.

These, and many other authorities which might be quoted, sufficiently attest the great danger of chloroform; and unfortunately there are many cases of *death* which can only be attributed to this powerful agent, though administered with care to healthy persons, in very small quantities, and by cautious practitioners. Even the death of a *single* individual should open the eyes of its advocates to the dangers of its use; but when upwards of *twenty* fatal cases can be clearly traced to the action of chloroform, it seems unjustifiable practice to submit a patient to its dangers, especially when we have in sulphuric ether an agent equally *effectual* and perfectly *safe*.

Malgaigne, in his Report to the French Academy, says that chloroform possesses a poisonous action peculiar to itself, which action, by being too much prolonged, may cause instant death; we can never be certain of being able to control it within the bounds which produce mere *insensibility*, when the passage from this to *death* is so sudden and so near.

Dr. Hayward, alluding to the undoubted fatal cases from the use of chloroform, says, "I know not how a conscientious man, knowing this fact, can willingly take the responsibility and expose his patient to this fearful result."

To show the danger of chloroform, its power, suddenness of action, symptoms and morbid appearances, the table in Dr. Warren's work (above quoted) containing ten fatal cases, may be consulted with advantage. Of these ten cases, three were for operations connected with dentistry, viz., extraction of stumps, toothache, &c.,; two had never used any anæsthetic agent before; while the third had used chloroform frequently without bad effects, yet she died instantly at last while under its influence—showing that previous use with impunity is no security against a final fatal result. The time of inhalation in most of the cases was about *one* minute, from a sponge, handkerchief or apparatus; the quantity varied from twenty drops to half an ounce; death ensued in two cases instantly, in the others in from one to ten minutes—showing the fatal issue cannot depend on the quantity inhaled, nor on the manner or duration of the inhalation, but on an instantaneous poisoning of the nervous centres. The symptoms in most of the cases were paleness of the face, discoloration of the lips, disordered respiration,

extremely feeble pulse, with relaxation of the limbs, preceded in some by rigidity or slight convulsions; in two cases, in which the heart and liver were enlarged, the face is described as of a livid hue. The morbid appearances varied according to the quantity used and the duration of its influence in most of the cases, though in some the poisonous action was so quick that the appearances could not be attributed to the influence on the blood: thus, congestion of the brain, heart and lungs, was found in some who had inhaled but a small quantity for a short period; while in others, under the opposite conditions, these organs were natural. A remarkable fluidity of the blood was a constant phenomenon. It is very evident that the cause of death is not asphyxia, but sudden poisoning of the nervous system, or an instantaneous paralysis of the heart's action.

In the same Journal (for Sept. 30, 1849) may be found an interesting account by M. Robert, of the Hospital Beaujon, Paris, of four cases in which the administration of chloroform was followed by extreme agitation, in two of the cases ending fatally, as he believes, from pulmonary emphysema produced by this excitement.

Chloroform, injected into the arteries, causes in the muscles supplied by such vessels an increased amount of contractility, which may justly be called a partial and uninterrupted *tetanus;* and this it does by a special action on the muscular fibre, and not by any direct action on the blood or on the nerves. Experiments, going to prove this, may be found in the Comptes Rendus, for April, 1849.

As to the relative safety of sulphuric ether and chloroform, we may justly conclude, from the numerous data now existing in the annals of medicine and surgery:—

1. That there is an immense preponderance of testimony in favor of sulphuric ether, both during and after its application.

2. While there is but one case, and that not well ascertained, in which ether has been accused of producing fatal results, there are not less than twenty, and probably many more, in which the fatal result is clearly traceable to chloroform.

3. Chloroform has caused death in the young and the old, the strong and the weak, the healthy and the diseased; and cannot be said to be safe in any condition of the system.

4. Chloroform is much stronger and more prompt in its action than ether, and less volatile; which renders it impossible to calculate its effects, and difficult to avert danger in season to save life. The anæsthetic effects of ether gradually subside when its use is stopped; but the less

volatility of chloroform often causes an aggravation of the symptoms, after the inhalation has ceased.

5. Chloroform may kill directly by its action on the nervous system and the blood, or indirectly by asphyxia.

6. There are certain idiosyncrasies, which cannot be known in advance, in which a very minute quantity of chloroform has produced, and will again produce, death.

7. In females and children, in whom there is generally a greater susceptibility of the nervous system, the action of chloroform is quicker, more complete, and therefore more dangerous.

8. Chloroform has produced instant death from syncope, or cessation of the action of the heart; it is therefore extremely dangerous in cases where the heart's action is enfeebled by lingering disease, by fear, by valvular or aneurismal disease, by old age, by sudden or large losses of blood, or any other cause of weakness.

9. There is no reason for diminution of confidence in the *efficacy* and perfect *safety* of sulphuric ether; while there is an unanswerable reason why chloroform should be abandoned, as its use involves the risk of a *fatal result*, which can neither be foreseen nor prevented, from the immediate suspension of the powers of life during its administration, or consequent changes in the nervous and vascular systems.

10. That while sulphuric ether will produce *safely* all necessary results expected of anæsthetic agents, no one is justified in submitting his patient to the risk of his life by using chloroform, simply because it is more agreeable, more powerful, cheaper, or more portable.

The above conclusions will apply to chloric ether as well as to chloroform, with a due modification for the inferior strength of the former, and for the fact that as yet no fatal effects have followed its use, as far as I know. Many surgeons speak highly of it as an anæsthetic agent, and are satisfied of its safety. But as *chloric ether* is a tincture of *chloroform*, or a mixture in variable proportions of the latter with alcohol, it must obtain its anæsthetic effects from chloroform. Alcohol cannot diminish the danger in idiosyncrasy or in conditions where chloroform has proved fatal. Though its odor is more agreeable, the quantity required to produce insensibility is as great as that of sulphuric ether, and the same time is required in both; it also irritates the skin, is more apt to produce nausea and vomiting, and greater disturbance of the nervous system. Says Dr. Hayward, "I cannot divest myself of the belief that chloric ether is an unsafe anæsthetic agent. * * * I fear that

if it be used with the same freedom that sulphuric ether is, we shall soon have to record some very different results. * * * We cannot be by any means certain that death, when not looked for, may not follow its exhibition."

19 *Tremont Row, Boston,*
Sept. 3, 1850.

APPENDIX.

In addition the authorities quoted, I may here add the following opinions from distinguished surgeons, which have since come to my notice.

Dr. J. C. Warren, of Boston, says, in his recently published address before the American Medical Association (p. 52), "that among the hundreds of thousands of cases in which ether has been employed, marvellous to relate! not an instance of immediate death has yet occurred; I mean, death within two or three minutes of the application."

Speaking of chloroform, he says (p. 56—8), "For some time, no objection occurred to its employment, except an occasional production of heat and soreness in the lungs, and irritation of the face. My colleagues in the hospital also used it; and I suppose we should all have continued to do so up to the present time, had we not been occasionally alarmed by some startling occurrences, and finally by the news of fatal results which reached us from different quarters at about the same period. A sudden death from chloroform occurred in this country in Cincinnati, another in New York. Soon after we heard of two or three in England and Scotland; and subsequently of some others on the continent of Europe. These fatal events awakened the inquiry, whether we had not too hastily abandoned the use of ether. The number of deaths increasing, we had various public and private discussions, which gradually led to the disuse of chloroform, and the employment of the ethers. In many parts of this country, in Great Britain, and on the continent of Europe, a return to ether has taken place, and the number of its friends is increasing. . . . When we come to inquire which is the safest, facts reply that the advantage is entirely on the side of ether; for there is no well-authenticated statement, that we know of, proving unquestionably that ether has ever killed any person downright, that is, caused immediate death. . . . But there is abundant evidence that immediate death has occurred under the use of chloroform in a number of instances.

. . . It must follow, that ether should be judged a more safe narcotic than chloroform; and that it ought to be preferred, unless some decided objection can be opposed to it. The most material objection would be its inadequacy to the production of perfect insensibility. But this is not sustained by facts; for ether is capable of producing a state of perfect insensibility. From this view it appears to us very clearly, that we are not justified in using the more powerful but dangerous article, rather than the less violent but safer; and we should therefore advise the general disuse of chloroform." (p. 59.)

I have received the following letters from distinguished surgeons and physicians, in this and other cities of the Union.

From H. J. Bigelow, M.D., Professor of Surgery in Harvard University, and one of the Surgeons of the Massachusetts General Hospital.

Dr. Morton.

Dear Sir,—I always use ether, and never pure chloroform when I can help it. This is because there are on record a number of authentic cases of *sudden death* from chloroform. I have never had one, nor have I seen one; but I think the evidence upon the subject too strong to admit of a reasonable doubt. The evidence is of this sort:—A healthy person, strong and well, is quietly breathing chloroform as other people do, and every thing seems to be going on as usual, when of a sudden the pulse falters, ceases, and the patient is dead. Now, if this is true, I do not wish to subject myself to a possibility of any occurrence of this sort. If it is not, somebody must disprove the cases, because as they stand they are entitled to credit; while in number they far outweigh any thing that has been alleged against ether. Ether, judged upon this ground alone, merits an unquestionable preference over chloroform, for its safety.

This is my only ground of preference. With some experience, I have no faith in a difference of symptoms produced by these different agents. Chloroform being stronger, is able to act quicker; but as to the inconveniences, anomalous symptoms, &c., of one or the other, they all produce, now and then, convulsions, partial asphyxia, violent resistance and combativeness, cessation of respiration, &c., otherwise alarming, but which in connection with anæsthesia and properly treated, are of no consequence. I see no difference in their usual effects.

A table is a short way of giving other comparative effects.

	Conveniences.	Inconveniences.	Dangers.
Ether.*	.....	Pervading smell.	Little.
Chloric Ether, to be considered as dilute chloroform.	.....	†Blisters skin, unless the face is thoroughly oiled.	do.
Chloroform.	More portable, and less answers the purpose.	do.	It kills people.

* I know no objection to adding a *little* chloroform to common ether, to make it stronger, when the surgeon thinks it desirable to do so.

† "Inhalers" are inconvenient, especially for refractory patients, and for the protracted doses required in surgery.

Lastly, as fact indicates the danger of chloroform, so analogy confirms it. Anæsthesia is drunkenness. The surgeon aims to produce dead drunkenness, by means of the lungs instead of the stomach. Now, alcohol largely taken into the stomach has produced instant death. It is probable that chloroform is strong enough, when pure, to produce the same effect through the lungs; and it is equally probable that ether is not. I have the honor to be, very respectfully,

Your ob't servant,

Henry J. Bigelow.

October 20th, 1850,
5 *Chauncy Pl.*

From John Ware, M.D., Professor of the Theory and Practice of Medicine in Harvard University.

From a letter dated Oct. 18, 1850.

When the purpose is to produce entire insensibility, as for a surgical operation, or in a case of labor, I regard sulphuric ether as very much safer. Indeed, I should employ chloroform for this purpose with some reluctance, and not without satisfying myself, by cautious trials, that the patient has no peculiar liability to be unfavorably affected by it. Where the purpose is to produce the alleviation or removal of some of the symptoms of disease, without producing entire insensibility, I should prefer chloroform. It is for this purpose I have chiefly employed it.

From Z. B. Adams, M.D., of Boston.

In a letter dated Oct. 18th, 1850, after stating that in his own practice he has never seen any thing looking like danger from the use of either chloroform or ether, Dr. Adams observes: "I would, however, say in conclusion, that, since the reports of Drs. Warren and Hayward, I have been a little chary of chloroform."

From R. M. Huston, M.D., Professor of Materia Medica and General Therapeutics in Jefferson Medical College, Philadelphia.

Philadelphia, Oct. 2, 1850.

To W. T. G. Morton, M.D.

Dear Sir,—In answer to your inquiry for my opinion of "the comparative value and safety of sulphuric ether and chloroform," I will state briefly, that I give a decided preference to the former for general anæsthetic purposes. Although less prompt and decided in its effects than chloroform, I regard it as capable of fulfilling all the indications for the employment of such an agent, and without being so liable to cause bad consequences. I have arrived at this conclusion from my observation of the effects of the ether in protracted and painful cases of labor, and of the effects of both, singly and combined, in surgical operations, as well as from a careful examination of the published reports on the subject.

I am, &c., R. M. Huston.

From Thomas D. Mutter, M.D., Professor of Institutes and Practice of Surgery in Jefferson Medical College, Philadelphia.

Philadelphia, Sept. 10, 1850.

Dear Sir,—In reply to the queries contained in your note, I have only to say, that I have for some time abandoned the use of "chloroform" as an anæsthetic agent. In *my* hands, at least, it has been productive of unpleasant consequences. No patient *has died*, it is true, but several have suffered severely. I have used in very many cases, and still continue its administration, the "sulphuric ether," and unhesitatingly give it the preference over any other article I have employed. When carefully administered, I have never known it occasion any serious inconvenience.

Very respectfully yours,

Thos. D. Mutter.

Dr. W. T. G. Morton.

From Alfred C. Post, M.D., of New York City.

New York, September 28, 1850.

Sir,—In answer to your communication of the 23d instant, I beg leave to state, that I regard the use of sulphuric ether, as an anæsthetic agent, as incomparably more safe than that of chloroform. On account of its superior safety, I have, during the past year or two, employed it almost to the exclusion of chloroform. Alfred C. Post.

To W. T. G. Morton, M.D.

From Jno. Watson, M.D., of New York City.

Dear Sir,—In reply to your inquiry respecting the relative value of sulphuric ether and chloroform, I have only to say that my views on this subject are embodied in the First Surgical Report presented to the American Medical Association; and that hitherto I have had no reason to alter the opinion therein expressed. With a comparatively mild, controllable and efficient agent at our service, we are not, I hold, justifiable in resorting to a dangerous one. *Ether can do, and every day is doing, all that can be effected by chloroform, short of the fatal consequences of the latter;* and with respect to these they are more frequent than the profession are officially aware of. I *know* that cases terminating fatally from chloroform have occurred in this city, that have not and probably never will be published; and such I presume is the fact in numerous other places. Very respectfully yours,

New York, Oct. 11, 1850. Jno. Watson.

Extract from a letter from J. Knight, M.D., Professor of Surgery in Yale College.

New Haven, Sept. 15, 1850.

Dear Sir,—In your note of August 30th, you ask my opinion of the comparative value and safety of ether and chloroform, as anæsthetic agents. Their power of producing insensibility to pain is so nearly alike, that I do not know as either is to be preferred on this account. Both are sufficiently efficient. From the statements which have been published of injury resulting from the use of these articles, it would seem that sulphuric ether is more safe than chloroform. Certainly a greater number of injuries and deaths have followed the use of chloroform. How

far this may be accounted for by the fact that chloroform has been more extensively employed, of late years, than ether, I am unable to determine. My opinion is, however, that perfectly pure sulphuric ether, *for general use,* is more safe than chloroform. * * *

Your obedient servant, J. KNIGHT.

Erie, Pa., Nov. 4, 1850.

DEAR SIR,—Your note of 23d September, forwarded from Washington city, has just reached me.

From my own observation and experience, I have had no opportunity of judging the comparative merits of sulphuric ether and chloroform; but from the impression made upon my mind by the reports of others, I give a decided preference to the eth. sulph. for its combination of efficiency with safety. Your obedient servant,

WM. MAXWELL WOOD,
Surg. U. S. N.

W. T. G. Morton, M.D.

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HC
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