ON THE

INHALATION

OF THE

VAPOUR OF ETHER.

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VAPOUR OF ETHER

IN

SURGICAL OPERATIONS:

CONTAINING A

DESCRIPTION OF THE VARIOUS STAGES OF ETHERIZATION,

AND

A STATEMENT OF THE RESULT OF NEARLY EIGHTY OPERATIONS IN WHICH ETHER HAS BEEN EMPLOYED IN ST. GEORGE'S AND UNIVERSITY COLLEGE HOSPITALS.

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PREFACE.

FROM questions addressed to me by medical visitors and students, after the operations in the two hospitals in which I have had the honour of frequently administering the ether, I judged that a fuller account than I had hitherto given of the process might be useful and not unacceptable to many members of the profession, and that there would be some advantage in presenting it in a separate form, although, as a general rule, the medical periodicals and transactions of societies offer the best medium for communications of moderate length like the present.

I have treated as briefly as I could, in the following pages, of the chief application only of the great discovery that will render last winter a memorable epoch in the annals of medical science. I have not even alluded to the use of the vapour of ether in medicine or midwifery, and I have not entered on the relations of etherization to medical science or physiology, although there is here a tempting field for research; for the power we have acquired, through the discovery of our medical brethren in America, of inducing at will and with perfect safety such a state of insensibility as we should previously have thought to be alarming, cannot be without its influence on the progress of our know-

ledge of diseases of which insensibility forms a symptom, and of the functions of the nervous system generally.

The remarks in the text are confined strictly to the practical part of the subject, and a few explanatory notes that seemed to be required are placed in a short appendix.

The inhalation of ether will, no doubt, have superior works to the present dedicated to its elucidation before long, not only from increase of knowledge respecting it, but from improved ways of treating on it, for it is not easy to reduce a new branch of science to suitable language in the first attempts.

54, Frith Street, Soho Square,
September, 1847.

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ON THE

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SURGICAL OPERATIONS.

THE point requiring most skill and care in the administration of the vapour of ether is, undoubtedly, to determine when it has been carried far enough. In order to communicate, with some degree of clearness, what I have been able to observe by close attention to the subject, I shall divide the effects of ether into five stages or degrees; premising, however, that the division is, in some measure, arbitrary,—that these different degrees run gradually into each other, and are not always clearly to be distinguished,—and that the language I have used has been chosen with the sole object that my meaning might not be mistaken.

In the first degree of etherization I shall include the various changes of feeling that a person may experience, whilst he still retains a correct consciousness of where he is, and what is occurring around him, and a capacity to direct his voluntary movements. In what I call the second degree, mental functions may be exercised, and voluntary actions performed, but in a disordered manner. In the third degree, there is no evi-

dence of any mental function being exercised, and consequently no voluntary motions occur; but muscular contractions, in addition to those concerned in respiration, may sometimes take place as the effect of the ether, or of external impressions. In the fourth degree, no movements are seen except those of respiration, and they are incapable of being influenced by external impressions. In the fifth degree, (not witnessed in the human being), the respiratory movements are more or less paralysed, and become difficult, feeble, or irregular.

If a middle-aged man, of about the average size, is supplied with air mixed with vapour of ether, in the proportion of 45 per cent. vapour to 55 per cent. air, and breathes it easily and without obstruction, he usually consumes about two drachms of ether per minute. It is not all absorbed, for a part is expired after passing no farther than the trachea. At the end of the first minute he is usually in the first degree of etherization; of the second minute, in the second degree; of the third minute, in the third degree; and at the end of four minutes, having inhaled an ounce of ether, in the fourth degree. If the inhalation is now discontinued, he commonly remains in this degree of etherization for one or two minutes, passes gradually back into the third degree, which lasts for three or four minutes, at the end of which time he is in the second degree, which lasts about five minutes, to give place to a feeling of intoxication and exhilaration, which lasts for ten or fifteen minutes or longer before it entirely subsides.

Having thus sketched an outline of the process of etherization, we may now proceed to examine the different states of it a little more closely.

Generally, all that the patient remembers of the effects of ether occurs whilst he is under its influence in the first degree only, and his feelings are usually agreeable—often highly so. I consider that it is not practicable to perform operations, in the absence of pain, without carrying the effects of ether further than this degree. Whilst the effect of the ether is going off, however,—after persons have been completely insensible,—they are not unfrequently free from the pain of an operation, which is still going on, at a time when the mental faculties have returned, together with the special senses of sight and hearing, and when they are consequently in what I have denominated the first degree. Of this degree, as it follows the others, we shall have to speak again. If etherization is not carried further than this degree it quickly subsides, without leaving any appreciable effects; but if the inhalation is continued, the second degree succeeds to this.

When the ether is administered in the method that I recommend, the patient usually passes quietly and quickly through the second degree of etherization without its being manifested in any way. As he is not questioned, the state of his mental faculties does not appear, and he passes rapidly into the next degree. Sometimes, however, when from the tendency of the vapour to produce coughing it is given in a more diluted form than usual, and occasionally, also, from peculiarity of constitution, this degree of the effect of ether is made

apparent by gesticulation, words, or attempts to move; and in hysterical females, sometimes by sobbing, laughing, or screaming. The patient often tries, by lifting up his hands or moving his head, to remove the inhaler from his face whilst in this stage. He feels something there interfering with his ordinary respiration, and the purpose and nature of it have passed from his mind; his endeavours are voluntary, but guided by instinct rather than reason. He can often be quieted by language addressed to him, and will do as he is bid, although unconscious of where he is,—as his answers, if he makes any, shew. At other times he is obstinate, or regardless of what is said. I believe that all the dreams which patients have when taking ether, occur only whilst they are under its influence in this degree. If the ether is discontinued at this stage of the inhalation, the patient goes back into the first degree, either immediately or in the course of a few minutes, according to the extent he has advanced, or the time he has been kept in this degree. According to what I have seen, a surgical operation would cause pain, if etherization were not carried farther than this degree, although, if the pain should not arouse the patient and bring him back to the first degree, he would probably not remember it. But it would be more difficult for the surgeon to operate with this amount of etherization than without ether.* It appears that surgical opera-

* From accounts that I have heard of two or three cases, it seems probable that if the patient were kept for some time in this stage of etherization, by breathing very diluted vapour, an immunity from pain might in some cases result; and this is corrobo-

tions have often been performed in this stage, and several eminent surgeons were at one time opposed to the use of ether, on account of the struggling which they supposed to be inseparable in most cases from operations performed under its effects.

When the patient has been more deeply etherized, he is often totally insensible to a surgical operation, as the effect of the ether is going off, whilst he is under its influence only to the second degree. Of this we shall speak below.

To proceed to the third degree. It is stated above that if the patient moves or struggles, when under the influence of ether in the second degree, his movements are guided by volition, though not by knowledge or reason; but if he struggles in the third degree of etherization his movements are not voluntary, any more than the struggling in hysteria or epilepsy. Usually, however, there is no struggling. The patient may have moved his eyes about in the second degree, and even directed them to objects, but in this degree they are stationary, or if they do move, their motions have nothing of a voluntary character. They are sometimes turned upwards as in sleep, but I think not so frequently as in the next degree. The eyelids may be either open, or partly or tightly closed, but in either case, if lifted or moved by the finger, the orbicularis palpebrarum contracts. The breathing is usually regular and somewhat

rated by an observation I made on a bird, which had been for ten minutes in an atmosphere containing ten per cent. of vapour of ether; but it is not likely that such a plan of administering ether would generally succeed, or be so good as that usually adopted.

deep; the patient lying still, or, if sitting, having a tendency to slide out of the chair; but occasionally the limbs are rigidly contracted, and when this is the case the patient sometimes holds his breath for several seconds at a time. He may moan in this degree of etherization, but never gives utterance to articulate sounds, which are always an indication that he has not advanced farther than the second degree, or has returned to it. Therefore the performance of a surgical operation in this stage would not cause a person to cry out in articulate sounds, unless it roused him, and caused him to return to the second degree; it might, however, cause him to groan and flinch. If this degree is well established, and if the patient has been detained in it, at the same point, by inhaling at intervals, or by inhaling dilute vapour, an operation may usually be performed without producing any other effect than a distortion of the features expressive of pain, and, perhaps, a slight moaning, and an increased frequency of respiration, and, in some instances, a general rigidity of the muscular system. If this degree of etherization is not well established when the opération begins, the first cut may cause a sudden contraction of the whole muscular system. Persons in a full state of health, and more particularly those in a state of plethora, are much more liable to struggling and rigidity in this degree, than those whose strength is reduced by illness; and if from any cause the supply of atmospheric air is limited, and something of asphyxia is combined with the etherization, I believe that the struggling is more liable to occur, and is more severe.

There is never any recollection of operations in this degree, even when symptoms of pain have been exhibited, and there is scarcely ever, I believe, any sign of pain in this degree, when it succeeds to the fourth, as the influence of the ether is subsiding. If the exhibition of ether is discontinued in the third degree, the patient goes back into the second degree immediately, or in the course of two or three minutes.

In the fourth degree all the muscles are relaxed, and the limbs hang down, or rest in any position in which they are supported. The eyelids fall down over the eyes, or remain as they are placed by the finger. The eyes are either turned up or remain central. The breathing is deep, regular, and automatic, and there is often snoring. The muscles of the face partaking in the general relaxation, the countenance is devoid of expression, having a placid appearance as in a sound sleep. Sometimes the lower jaw has a tendency to droop; the mouth is partly open, and the features are so relaxed, that the countenance is altered, and has the vacant appearance seen in paralysis, idiocy, or a helpless state of drunkenness; and if there is at the same time snoring and blowing of the lips in respiration, as now and then happens, an appearance is met with that would be truly alarming, if we did not know that it was only due to an agent which is flying away every moment in the breath, to leave the patient, in a few minutes, without any permanent trace of its having been there. In this degree of etherization the patient always remains perfectly passive under every kind of operation; and as the muscles are completely relaxed,

this is the proper stage for the reduction of dislocations. The patient never begins to snore until he has reached the fourth degree, or is passing into it from the third, and from all that I have hitherto observed, I believe that when he snores from the effects of ether, he is always totally insensible to every thing which is done to him. This degree of etherization seldom continues more than two or three minutes after the process of inhalation is left off, and I have never kept the patient in this stage more than five or ten minutes; but in operations of long duration have allowed the effects of the vapour to diminish somewhat from time to time. The integrity of the functions of respiration and of circulation is not impaired in this degree. The breathing is generally deeper than usual, and although it has been somewhat stertorous in two or three instances, yet it continued with great regularity, and the stertor subsided in a minute or two. The pulse is distinct and of good volume, even in patients affected with hectic, in whom, just before the inhalation, it was small and hard. It is usually accelerated, as in all the other stages of etherization. The sensibility of the glottis and pharynx continues in this degree, for the blood which flows backwards in operations on the nose and mouth is all swallowed, none of it getting into the trachea.

In the fifth degree, as met with in animals inferior to man, they remain motionless and flaccid as in the fourth degree, and respiration begins to be irregular, feeble, or laborious. The muscles of respiration begin to suffer the loss of power which already involved the

merely voluntary muscles. The sensibility on which respiration depends, and which has outlasted the special senses and common sensibility, now begins to be abolished under the effects of an increased quantity of ether. This is the stage immediately preceding death when animals are killed by ether, and there can be no doubt that it would be met with in the human being, if the vapour were exhibited so as to increase its effects to a dangerous degree beyond what is ever required. (1)* However nearly dead animals may be from ether, if the breathing has not actually ceased when the vapour is discontinued, they always recover, as was stated by the author, at the College of Physicians, when he had the honour of performing some experiments at the conclusion of Dr. Wilson's Lumleian Lectures, on the subject of Pain, in March last. This circumstance illustrates forcibly the great safety of the inhalation of ether, and how much it differs in this respect from asphyxia, and the exhibition of narcotics by the stomach.

The fifth degree of etherization has only been mentioned as a state to be avoided, and we proceed now to the degree which follows the fourth, when the patient is no longer kept in it; and this is the third degree, as it appears a second time. It is usually less marked now than when it preceded the fourth degree, and struggles and rigidity are less frequent,—seldom, if ever, taking place except they have previously occurred in the same degree, and not by any means constantly, when such has been the case. If struggles do occur,

* The numbers refer to the Appendix.

and especially if they are accompanied by moaning, as sometimes happens, and if a surgical operation is going on, it may appear to an inattentive observer that the patient is feeling pain, when such is not the case; for a closer attention will shew that the supposed signs of pain are not increased when cuts are made, or ligatures tied on the arteries; and if the ether is not re-administered, and the patient is allowed to recover still further during the operation, it will probably happen that in the second degree he will either lie perfectly calm, or talk in his dreams about subjects totally unconnected with pain, or the operation which is still going on. And it is not to be supposed that he is becoming less sensible as the effects of the narcotic are subsiding. I believe that pain is seldom felt in the stage of which we are treating—the third degree succeeding the fourth—and of course never remembered afterwards, as there is no knowledge or mental perception of it. This stage of etherization seldom lasts longer than from two to four minutes before it gives place to the second degree, if the inhalation is not resumed.

The second degree is usually much better marked as the patient is recovering from the ether, than when he is getting under its influence; it also lasts much longer at this time, the reason of which is obvious; for when he is inhaling the vapour he is quickly removed from this into the third degree, but when the inhalation is discontinued the vapour is got rid of, in a ratio varying directly with the quantity in the blood, which is a constantly decreasing ratio. The blood, in passing through the

capillaries of the lungs, shares its ether with the air taken into the air cells, and, consequently, the process of de-etherization becomes slower as it goes on (2). For this reason, also, this degree continues longer than the third, often lasting five minutes, and occasionally more than twice that period. The dreams which patients so often say that they have had during the operations, take place, I believe, only in the second degree of etherization; and generally in the recurrence of this degree, as the effects of the ether are subsiding, and more commonly after than during the operation. If the patient talks, it often happens that what he says is in accordance with what he afterwards remembers of his dreams, which often refer to early periods of his life; and a great number of patients dream that they are travelling. The impression of the length of the dreams can of course be no argument as to how long the person was dreaming, and that impression is often of a longer time than the whole period of insensibility; and I think that there is every reason to presume, that there can be no dreams or ideas of any kind in the third and fourth degrees of etherization, and that for a short time there is not only, as in a sound sleep, the absence of mental functions, but also the impossibility of their performance. Indeed, from a comparison of what patients sometimes express by words or gestures under the influence of ether, with what they say of their dreams, it would appear that the dreams which are remembered occur only when the patients are fast emerging from the second degree into a state of complete consciousness. Some of the mental states met with in this degree are highly interesting in

a psychological view, but the description of them does not form a necessary part of this small treatise. The laughing and crying, which are now and then met with in this degree, are not always the result of joy or sorrow, or even connected with any state of mind corresponding to the expressions, but resemble the laughing and crying of hysteria. The patient is often incapable of pain in the stage which we are considering, but not always so; very commonly he is so in a part of this stage, but if the operation continues he begins to shew signs of feeling it, and the inhalation has to be resumed before he passes into the first degree.

After the patient has recovered his consciousness of surrounding circumstances, there is usually a degree of exhilaration, or some other altered state of the feelings for a little time,—accompanied, sometimes, with a little confusion of the mind, and inability to walk steadily. This, which I have called the first degree of etherization, subsides more slowly than the other degrees, remaining, in some instances, half an hour in a marked degree, and to a slight extent for two or three hours. The patient often expresses his gratitude to his surgeon in more ardent and glowing terms than he otherwise would do if the remaining effect of the ether were not counteracting his usual reserve. Let us hope that *in æthere veritas* is as applicable as the old reading, and that, in these instances, we only witness the usual feeling of the public towards the medical profession. Commonly, the patient would feel pain if any part of an operation were performed in this stage, but not always; for, in some instances, the special senses of

sight and hearing, and complete consciousness and volition, return before common sensibility, and the operation may be going on, for a short time, without his feeling it, and perhaps, whilst he, thinking that it is concluded, is remarking that he did not feel it. But even in these exceptional cases the patient soon begins to complain, if the operation continues. Sensation usually, however, remains blunted for some time, and there is generally no smarting in the wound for a little time (often half an hour) after consciousness has completely returned.

The effects of ether were divided into three stages by Dr. Plomley, of Maidstone,* early in the year. The first degree in the above division would include his first two stages, and the next three degrees would be comprised in his third stage. M. Longet † divides etherization into that of the cerebral lobes, and that of the annular protuberance; and M. Flourens makes three degrees as follows:—

"Under the action of ether, the nervous centres lose their powers in regular succession; first, the cerebral lobes lose theirs, viz. the intellect; next, the cerebellum loses its, viz. the power of regulating locomotion; thirdly, the spinal marrow loses the principle of sensitiveness and of motion; the medulla oblongata still retains its functions, and the animal continues to live: with loss of power in the medulla oblongata, life is lost." (Gazette des Hôpitaux, 20 Mars, 1847: quoted in Brit. and For. Med. Rev.)

* Lancet, Jan. 30.

† Archives de Méd., Mars 1847.

My second degree corresponds to the etherization of the cerebral lobes of M. Flourens. There are, to be sure, occasionally, dreams and indications of disordered intellect, but these could not be recognized in animals, the subjects of his experiments. His next stage corresponds to my third degree; and his last, or the etherization of the spinal marrow, to my fourth degree. The division I have made from observations on patients, will, I think, be found to be better for practical purposes than this, which it very much resembles, of M. Flourens, the result of experiments on dogs; and it involves no theory about the functions of the nervous centres, which is perhaps an advantage, as those, particularly of the cerebellum, are probably not definitively known.

It will be observed, that the non-liability to pain does not correspond uniformly with the state of the patient in other respects when under the effects of ether, and that I have made the division into degrees, according to the other and obvious symptoms, and not according to that which could only be determined by the knife.

The question may be asked, whether the medical man can always determine in what degree of etherization the patient is, and by that means estimate correctly whether or not he is liable to pain. I am not sure that he always can, by the mere observation of the patient. I have never been deceived as to the degree of etherization, but then I always know the strength of the vapour which the patient is breathing, and by observing the length of time that he has been inhaling, and the depth of his inspirations, I know in what stage

he ought to be, and am in this way guided in the cases in which well-marked symptoms are absent. In many cases, the moment when an operation may, with propriety, be commenced, is indicated by unmistakeable signs; but, in other instances, it must be acknowledged that the point has to be determined by the consideration and balancing of several particulars. This, however, ought to be no obstacle; for it is only in this way that the medical man is guided in his usual avocations. His diagnoses and prognoses are generally arrived at by a mental operation of this kind, and not by the observation of some certain sign.

I have spoken of a knowledge of the strength of the vapour as being essential to a correct determination of the state of the patient at all times: and this brings us to the apparatus for the administration of the vapour, as, without a suitable one, the proportions of air and of vapour cannot be determined.

I had the honour of shewing that these proportions could be easily and precisely controlled by means of the temperature,* and of introducing an inhaler, by which the quantity of vapour in the air the patient breathes can be accurately regulated. It is made of metal, the best conductor of caloric, and placed in contact with water, the best and most convenient regulator of temperature; and, consequently, we are enabled to avail ourselves of the law which determines the quantity of vapour of ether that air will take up, and hold in sus-

* Med. Gaz., Jan. 22; and Lancet, Jan. 23.

pension at various temperatures, in order to regulate the strength of the vaporized air as we wish.

The opportunity was afforded me of using the apparatus soon after it was made, very frequently, in St. George's Hospital, and I believe that this was the first institution in which the vapour of ether was constantly applied with uniform and complete success in surgical operations. Several alterations in the details of the instrument were made, after it was delineated in the medical journals in the early part of the year, but the following drawings shew the form in which I have used it for the last three months.—(See engraving next page, of which the following is the description.)

A. Box of japanned tin or plated copper, of the size and form of a thick octavo volume, serving as a water-bath when the apparatus is in use, and at other times containing the elastic tube and face-pieces. Attached to this by clasps, and moveable at pleasure, is

B. The spiral ether chamber, of thin tinned brass, or copper plated with silver.

C. Opening in ditto for putting in and pouring out ether, and for screwing on,

D. Brass tube, by which the air enters which the patient inhales.

E. Another opening in ether chamber for screwing on

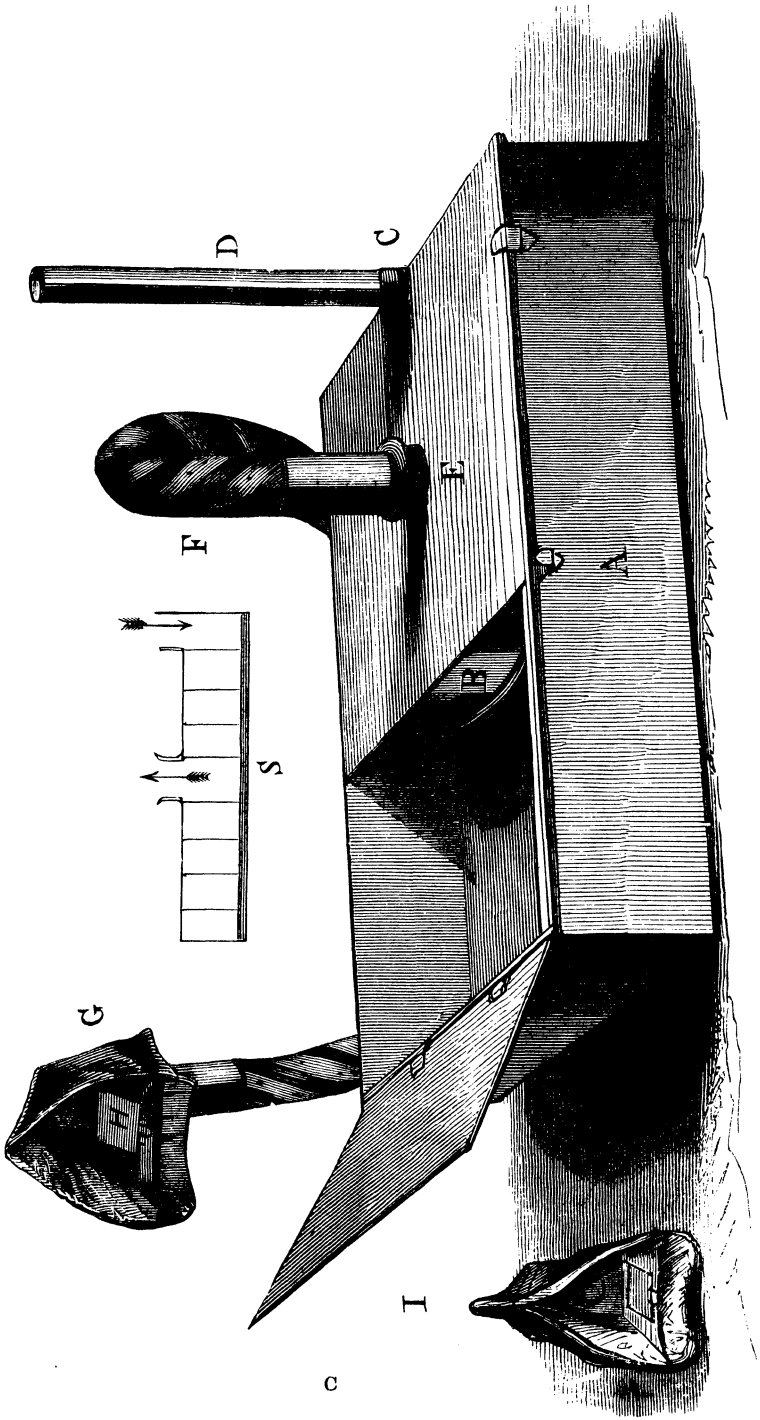
F. Elastic tube about three feet in length.

G. Face-piece.

H. Inspiratory valve of ditto.

I. The same face-piece compressed, to fit it to a smaller face.

S. Section of spiral ether chamber, B.



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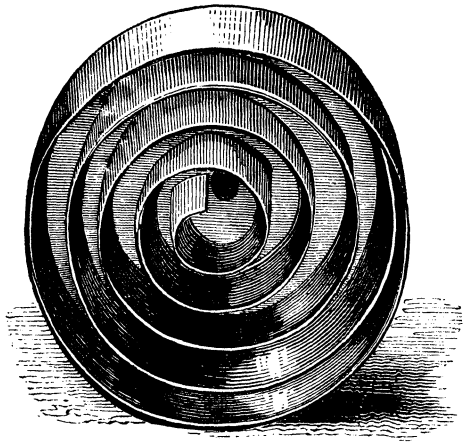

Drawing of ether chamber, with the bottom removed to shew the interior. The volute, of the same metal as the chamber, is soldered to the top, and reaches to one-sixteenth of an inch from the bottom.

The dotted lines indicate the position of the expiratory valve when turned aside for the admission of unvaporized air.

The tube screwed into the opening at which the air enters is merely for preventing a trifling loss of ether which would arise from evaporation of it into the apartment during the process; and it effects this object in a more simple manner than a valve would, and offers less resistance to the ingress of air than the most delicately-balanced valve. The vapour of ether, being heavier than air, will not diffuse itself, in opposition to gravity, through the air in the tube, in the short space of time between the inspirations of the patient.

When an inspiration is taken, the air, having entered by this tube, which is five-eighths of an inch in internal diameter, passes round four times on the surface of the ether, and becomes saturated with its vapour, and expanded by it, in the same way that air gets saturated and expanded with the vapour of water in passing over the surface of the sea. This spiral arrangement is adopted from the inhaler of Mr. Julius Jeffreys for aqueous vapour. The dimensions of the ether chamber are not a matter of indifference. It is nearly six inches in diameter, and an inch and a quarter in depth. The depth of the first I used was two inches; afterwards it was one inch, and finally the present depth was determined on. It is desirable to have the chamber as shallow as practicable, in order that all the air passing through it may be brought successively in contact with the surface of the ether; and, on the other hand, it is necessary to leave a considerable space above the ether for the air; otherwise, when a patient draws vigorous and deep inspirations, as sometimes happens when he

is partly under the influence of ether, the ether will be agitated into waves, and splashed into the elastic tube. The space between the coils of the volute is five-eighths of an inch, and it is of importance to be careful that it is uniformly turned, and presents no inequalities, or the same result—the splashing of the ether—may take place. When made with regularity, these proportions of the inhaler leave ample room for the passage of air, as the ether covers the bottom to but a very small depth, even if three or four ounces are put in. This part of the apparatus was at first made of tinned iron, but it was found occasionally to become rusty by use.

The receptacle for water holds above 100 cubic inches. A small quantity of water would be cooled by the conversion of ether into vapour during the process of inhalation, and the intention of accurately regulating the proportion of vapour to the air would not be efficiently fulfilled: 100 cubic inches of water will, however, supply the caloric necessary to the conversion of one or two ounces of ether into vapour, without being much reduced in temperature; and, as the heat of the water employed differs but little from that of the air of the patient's room, it is not much altered during an operation, by radiation or other causes.

In order to leave as much room as possible for the operator and his assistants, it is requisite to have an elastic tube of about three feet in length. It ought to be so capacious as to offer no impediment to the most rapid inspiration; and to meet this requirement it must

be wider than the trachea, to compensate for the resistance arising from friction of the air against the interior of the tube. It is, therefore, three-quarters of an inch in internal diameter. The pipe for the admission of air to the ether is but five-eighths of an inch in diameter, as stated above; but that is amply sufficient, since it has to give passage to a much smaller volume of fluid than the elastic tube; for the air expands to nearly twice its bulk, in passing over the ether, by the vapour it takes up.

The method of obliging a person to get all the air he breathes through tubes and valves, which is essential to success in the inhalation of ether, is perfectly new, and, in such a process, greater facilities for respiration are required than would generally have been supposed. On this account, many of the apparatuses at first invented did not allow of easy respiration, but offered obstructions to it,—by sponges, by the ether itself, by valves of insufficient size, but more particularly by tubes of too narrow calibre; and there is reason to believe that, in many instances, this was the cause of failure, and that in others the insensibility, when produced, was partly due to asphyxia — a circumstance especially to be avoided: for, as I stated at the Westminster Medical Society on Feb. 13,* I found that when an animal was gradually asphyxiated by mixing carbonic gas with the air, or, what amounts to nearly the same thing, by compelling it to breathe in a limited quantity of air,

* Med. Gaz. Feb. 26, p. 383. M. Flourens, also, Gaz. des Hôpitaux, 20 Mars, remarks on the similarity of the phenomena of asphyxia induced in this way, to those of etherization.

insensibility to injuries was induced; but, that it was a painful process to induce insensibility in this way, and also dangerous to the life of the animal—the insensibility so induced being of short duration before it ended either in death, or recovery to a state of sensibility; circumstances which practically cause it to differ widely from the state of etherization.

For the first three months I used a mouth-piece which did not include the nostrils; consequently they had to be closed, and the patient was obliged to breathe entirely by the mouth. This plan always succeeded (except, perhaps, in one instance), and generally very well, but sometimes not without difficulty; for some of the adult patients, after they lost their consciousness, made such strong instinctive efforts to breathe by the nostrils, that the air was forced through the lachrymal ducts, and occasionally they held the breath altogether for a short time, and were getting purple in the face, when the nostrils had to be liberated, for a short time, to allow respiration of the external air, and thus a delay was occasioned. I was therefore ready to adopt a face-piece invented by Mr. Sibson, of the General Hospital, Nottingham, which permitted inhalation by the nostrils as well as by the mouth. This face-piece I used for some time, and it was the foundation of that I now use, which has been altered, however, considerably from it in form, to allow of the introduction of valves into it, and a greater adaptation to faces of different dimensions.

In the face-piece depicted at p. 18, the central part, containing the valves, is made of metal—brass, tinned iron,

or plated copper; all the rest of thin sheet-lead, the pliability of which admits of its being easily adapted to the peculiar form of the features. The lead is covered with silk or glove-leather externally, and is lined with oil-silk where it comes in contact with the face. The valves are made of vulcanised India rubber; they are light, are attached so as to rise with the least appreciable force, and they close again, of themselves, in any posture in which the patient can be required to be placed. I have contrived the expiratory valve to turn on a pivot, so as to allow of the admission of external air, and to supersede the use of a ferrule or two-way tap, at the same time that it is performing the office of a valve. It is advisable, however, to make use of every contrivance of this kind for the admission of additional air to that which has passed over the ether as little as possible, and to regulate the strength of the vapour by the temperature alone; for we can only form a rough estimate of how much air is thus admitted. When a stop-cock with graduated openings is used, it at first sight appears different; but the air passes through the external opening in preference to the more circuitous route over the ether; and when the respiration is gentle, the whole of the air the patient breathes may enter by an outward opening that would only admit a third part of what he inspires when the respiration is forcible.*

* Mr. Ferguson, 21, Giltspur Street, City, made the apparatus in the first instance; and Mr. Matthews, Portugal Street, Lincoln's Inn, Messrs. Philp and Whicker, and Mr. Coxeter, have since made it, and there is no restriction respecting the making of it.

It is generally known that the ordinary rectified sulphuric ether is unsuited for inhalation, on account of its containing a considerable quantity of alcohol, the vapour of which is irritating to the air-passages. The alcohol also alters the boiling point of the ether, and the elastic force of its vapour at all temperatures; consequently, without having the ether free from it, we should be unable to regulate, by means of the temperature, the proportion of vapour in the air that the patient breathes. The alcohol can be separated by means of water, and what is called washed ether is now supplied, for inhaling, by the principal druggists and surgical instrument makers. Common sulphuric ether can be prepared, for inhalation, by shaking it well up with twice its bulk of water, in a bottle, allowing it to stand for two or three minutes, and then decanting off for use the ether which floats on the top, whilst the alcohol is left mixed with the water. The water takes up a considerable portion of ether, as well as the alcohol, in this operation, which is, consequently, attended with loss when the washings cannot be re-distilled, and turned to account. It is therefore better for the surgeon to procure ether ready prepared.

Ether combines with about one-tenth of its volume of water in being washed: this can be separated by potash or chloride of calcium, and most completely by distilling from quicklime: but I think it preferable, as I stated in a lecture at the United Service Institution,* to allow this small quantity of water to remain in the

* See Lancet, May 29.

ether, in order that the air which is inhaled with the vapour of ether may be always saturated also with vapour of water, when it will be more bland, and less irritating, than if it contained but little moisture, as is always the condition of air in frosty weather, and often under other circumstances. Some attempts have been made, by means of complicated and expensive apparatus, to add the vapour of water to that of ether, but I believe without succeeding in that indication, unless at the sacrifice of more important ones, whilst this object can be fulfilled by the simple and economical expedient of not separating the water from the washed ether. (3)

The specific gravity of ether of this kind, *i. e.* free from alcohol, but containing water, is ·735 at a temperature of 60° Fahrenheit, and it boils at about 98°.

The following table is the result of a fresh set of experiments, made on the above kind of ether, in the way described in my paper in the Medical Gazette of March 19, and differs a little from the table then published:—

TABLE *of the Quantity of Vapour of Ether that* 100 *Cubic Inches of Air will take up at different Temperatures.*

Temp. Fah.	Cubic inches of vapour.	Minims of ether.
50°	52	64
51°	54	66
52°	56	69
53°	59	72
54°	62	76
55°	65	80
56°	68	84
57°	72	88
58°	76	93
59°	80	98
60°	84	102
61°	88	107
62°	92	112
63°	97	117
64°	102	122
65°	107	128
66°	112	134
67°	117	140
68°	123	147
69°	130	156
70°	138	165

Having considered the state of etherization, and the apparatus and kind of ether to be used, we may now proceed to the mode of conducting the process of inhaling, and the points to be attended to in order to insure its constant success.

I am not aware that any state of the patient with respect to age, constitution, or disease, positively contra-indicates the use of ether during a surgical

operation. The patients to whom I have given it have been of all ages, from early childhood to nearly eighty years—six of them being upwards of seventy. They have been in the most different states of general health; two or three had symptoms of tubercles in the lungs; one, of whom I shall speak afterwards, had extensive disease of the heart; two or three had been subject to attacks of congestion of the head, and yet there have been no ill consequences from the ether in any case, and not even any unpleasant effects to counterbalance its advantages, except sickness and vomiting in a few instances. There are, however, certain states of the body in which ether sometimes acts less pleasantly and favourably than in others; but it fortunately happens that these are the states in which we seldom find patients who require surgical operations. Persons in robust health are sometimes less promptly and easily made insensible than others, and are more liable to excitement in the second degree of etherization, and to struggling in the third degree, and also to have a headache after the ether. Such persons, however, do not often require even a trifling operation, and if they do so, a little abstinence and purgation will place them in favourable circumstances for ether, if they wish to have it. And, if a person in robust health should require an operation on account of an accident, the temporary depression consequent on the injury, and, usually also, loss of blood, would serve as a preparation. On the other hand, insensibility is induced with great ease in persons debilitated by long illness, and in children under all cir-

cumstances. Children are, indeed, amongst the most favourable subjects for ether, recovering from its effects as promptly as they are brought under its influence, and it possesses more than the usual advantages in their cases, as, without it, their struggles would often interfere with the performance of the operation.

A full meal causes a temporary plethora, and it has seemed in several instances to render the operation of t e ether less easy. It is attended, also, with the further unpleasantness, that vomiting often takes place when inhalation follows it. The best preparation for the ether is, probably, a sparing breakfast, or luncheon from two to four hours previously, and a person should never begin to inhale with his circulation quickened by exercise or any kind of exertion.

The water-bath of the apparatus should be three-fourths filled with water, or, at all events, sufficient should be put in to come fairly in contact with the ether chamber, which may as well be fixed in its position in the bath before the ether is put in. The temperature which seems most suitable is about 60°. I do not think it ever necessary to raise it above 65°. In winter a little hot water requires to be added, to elevate the cold water of the patient's room to the required point, but, in hot weather, the water is often 70° or upwards, and its temperature requires to be lowered, which may be done by mixing spring water with it. Or, to save time and trouble, the operator may be provided with some sal-ammoniac and nitrate of potash, powdered, and mixed together in equal parts; three or four ounces of which mixture being

dissolved in the water in the apparatus, will depress its temperature about ten degrees. At the heat I have mentioned, the air will exceed in quantity the vapour, in the mixture the patient breathes; and although it is desirable to induce insensibility as rapidly as possible, this is better than giving the vapour stronger, for a greater quantity will generally be inhaled in a given time than if it were more concentrated, since, when it is too strong, it either excites coughing, or causes the patient to hold his breath. The indication is to give as much vapour in the air as the patient can be got freely to breathe; and 90 parts of vapour to 100 of air—nearly 47 per cent.—is usually about this limit. It must not be supposed, in any case, that because the air of the apartment is of a suitable temperature, the use of the water-bath may be dispensed with; for the vaporization of the ether in the inhaler would cool the apparatus and the air passing through it: less and less ether would be taken up, and at the time when the full strength of the vapour is most required, the patient would probably be breathing air of a freezing temperature, with very little vapour in it.

The tube and face-piece can be screwed on in readiness, and just before the inhalation the ether may be put in. Two ounces, or two ounces and a half, is the quantity I generally introduce, and I always measure it, and again measure what is left at the end of the operation. The quantity of ether required to produce complete insensibility, is, usually, from six drachms to one ounce in the adult, and, in children, in

the same proportion, according to their size; and the quantity required to keep up insensibility during the operation is seldom greater than that which induced the state of etherization. (4)

The position of the patient during inhalation is a matter worthy of consideration. In nearly all capital operations, the position which the surgeon would select, independently of the ether—viz. on the back, with the head supported on a pillow—is a very favourable position for inhalation. For operations on the anus, the patient has to lie on the side, with the knees drawn up, as it would be impossible for him to stand, or even to kneel, and lean over a chair or table, when insensible; and the recumbent posture, I believe, is as convenient for the surgeon, and would be at least equally so for the patient, even if he had to suffer the pain. Sitting upright in a common chair is not a good position for inhalation, and should, therefore, if possible, be avoided. It has answered very well in a number of cases, but on two or three occasions caused some difficulty; either from the patient, when insensible, having a tendency to slide off the chair, or from his stretching his limbs out, in the second or third degree of etherization, when it became impossible to keep him seated. If the patient is obliged to be seated, a chair with a high back, to rest the head against, is the best seat. The dentist's chair answers very well for his operations, as the patient is partly reclining, and has the head supported.

It is generally the best plan to place the patient, before inhaling, in just the position that will be suitable

for the operation, that there may be no delay when insensibility is induced. Sometimes, however, the patient may be first rendered insensible, and then moved, especially when moving causes great pain, as in some cases of diseased knee. The tourniquet, or the bandages for lithotomy, can be applied whilst the inhalation is going on, but the surgeon should have all his instruments in readiness before the inhalation.

The apparatus being prepared, should be placed on a small table, or a chair, or on a corner of the operating table, near the patient's head, and the assistant, who administers the ether, should stand on the opposite side of the patient to that which the operator will occupy. The face-piece should be moulded to the features, with the expiratory valve turned to one side, so that the patient may breathe scarcely anything but air at first; and then the valve should be turned a little at each inspiration, gradually to cover the opening, and by this means to cause the etherized air from the apparatus to be admitted by degrees, to the exclusion of the external air; in order to prevent the irritation to the air-passages which would generally arise from the sudden access of air strongly charged with vapour of ether. As the vapour is less irritating to the mouth than the nostrils, it is advisable to request the patient to breathe by his mouth at first. With the face-piece here recommended the patient has no difficulty in learning how to inhale; he merely has to breathe as if it were not on his face, and it offers no obstacle to his doing so. The pungency of the vapour is often complained of at first, even when it is admitted in this

gradual way, but the larynx soon comes to tolerate it, and the external aperture can generally be quite closed by the valve, in from a quarter to half a minute. If the patient holds his breath, or coughs, it is sometimes necessary to delay closing the opening for the admission of external air, a little longer, or to open it again for a moment after it is closed; but it is to be recollected, that as the ether produces its effects on the nervous system, it allays the irritability which at first obstructs the respiration of it, and in the meantime the patient must be encouraged to persevere. He soon loses his consciousness of what is going on around, and enters into the second degree of etherization—often by the time that the etherized air can be admitted of its full strength, and generally within a minute or two afterwards, and he usually becomes quite passive if he has not been so previously. It now and then happens, however, that the patient becomes somewhat excited at this stage of the proceedings, and talks, or sings, or laughs, or cries, and wants to move. In such a case he must be kept quiet, and the face-piece must be kept applied, even although he tries to get rid of it; for it would be wrong any longer to pay attention to his apparent desires, when he is not in a conscious and rational state. I have not met with any instance in which the patient could not be kept inhaling, with the assistance of somebody to hold his hands, and perhaps to assist in steadying his head; and as I do not think that it would ever be proper to make a patient insensible with ether without the presence of a third person, there can never be any difficulty in this stage.

I understand that the ether has often been left off, and given up as a failure, on account of the excitement produced by it, under an impression that it was producing an opposite effect to its usual one, and acting as a stimulant instead of a sedative. Guided by a few experiments on small animals, made in January, I acted on the principle that there is no person who cannot be rendered insensible by ether, and looked on the excitement as the occasional result of the cerebral functions being disturbed by a quantity of ether insufficient to suspend them altogether. If the patient goes on breathing the ether, we may rest assured that he will soon become quiet; especially, if he begins to breathe deeper, as often happens during the state of excitement, when a few inspirations make him quite passive. It can scarcely be required to interrupt the process unless the patient should hold his breath, but if he do, the face-piece should be removed, or the valve opened for a moment, and the process then resumed again. It is consolatory, however, to know that if one is obliged to desist, insensibility will often be induced, on the process being resumed, without any excitement or struggling. It is advisable to begin again as soon as the patient is calm, and, if possible, before he has relapsed into the first degree, or he will perhaps want to make a long speech. I prefer always to go on without stopping, and let the ether subdue the excitement it has produced. I have always succeeded in making the patient quite insensible, except on one occasion, and then the ether was given up, not from any doubt of its producing its usual effects, for it had

made the same patient insensible a day or two before; but, from a fear on the part of Mr. Cæsar Hawkins, who was about to operate, that the struggling might recur during the intended operation—one of unusual difficulty and danger—the removal of a large ovarian tumour. The ether caused a kind of hysterical paroxysm in this woman; she was more violent than any, except one, other patient that I have seen, and the difficulty was increased by the circumstance of the ether being exhibited by a tube in the mouth, whilst, after losing her consciousness, she made efforts to breathe by the nostrils. As she was unwilling to undergo the operation without ether, it was not performed.

Struggling or resistance of any kind, in the second degree, is an exception; the patient generally, as I have stated, remains quite passive after losing his consciousness, and a person inexperienced in the effects of ether may suppose that he is fit to be operated on; more especially if, as often happens, the limbs are quite relaxed. I have often heard a medical man say, on lifting a patient's arm and seeing it drop down again, "the muscles are quite relaxed, he is under the influence of the ether now,"—at a time when the state of the muscles merely depended on volition not being exerted on them, and when a cut would, undoubtedly, have roused a vigorous resistance.

In the earlier cases I used to raise the eyelid to look at the pupil. I was not able to learn much from it, as generally it is not much altered from its natural state, and remains more or less sensible to light in all stages

of etherization; but I soon found that the eyelids furnished very good information with regard to the state of the patient. In the second degree of etherization the eyelids have lost none of their sensibility; on touching them, indeed, the eyes are often moved in an evidently voluntary manner, and any kind of voluntary motion shews that the effects of ether have not extended beyond this degree. (5) The breathing in this stage has not altogether lost its voluntary character, and it is often like the breathing in sleep.

The moment when the patient passes from the second degree to the third, is not always clearly distinguishable, but that is of no great consequence, as it is only mistaking between the second and fourth degrees that would be of importance. Generally, however, the transition can be distinguished. If there has been any kind of voluntary act—as raising the hands, or repeating a word, or making a singing or humming sound—it is discontinued; or, if the eyes have been moved about, or the eyelids lifted spontaneously, these actions cease. If the patient has been perfectly passive in the second degree, a state of slight rigidity of the limbs often marks his passage into the third. The eyelids retain their sensibility, and are closed again on being lifted with the finger, but no voluntary motion is occasioned in them or the eyes, and there is not a resistance offered to their being opened, as there often is in the second degree. If the patient has been breathing steadily for three minutes with the valve closed, or for two minutes if a child, an operation not requiring a nice dissection may generally be commenced in half

a minute after etherization has reached this degree, without waiting for any other signs than those mentioned; but he should be held steadily, as possibly he might otherwise flinch a little at the first incision. If there is any doubt about the patient's condition, it is preferable to wait a little longer till the excito-motory action of the eyelids diminishes, or till the breathing is decidedly automatic, or accompanied with a tendency to snoring, or till the countenance is somewhat altered, which is sometimes the case before the eyelids are quite passive. The face-piece affords a facility for seeing the features which the mouth-tube and cushion did not possess, as it can be removed and re-applied in a moment, and without the process of inhalation being interrupted, if it is done during an expiration. If the countenance is altered,—as, if it were paralysed more or less,—the operation may always be begun; although it is by no means necessary to wait in every case for this symptom. The practice, I believe, is occasionally resorted to, of pricking the patient to ascertain whether he is insensible: there is no harm in it, but I consider that it would be inconclusive where it furnished only a negative result; and I never adopt it, as I constantly observe that there may be insensibility to a slight lesion—as a suture in the skin, for instance—at a time when a greater wound would cause signs of pain.

If, instead of a quiet passive state, there is struggling, or great rigidity of the limbs in the third degree, it is necessary to wait for the next degree—that of complete relaxation—before the operation is begun. The involuntary struggling is now and then considerable

in the third degree,—in one case, to be subsequently mentioned, resembling an epileptic paroxysm, the patient, however, being subject to epilepsy. There is occasionally also a rigid state of the whole body, which, in one instance, took the form of opisthotonos, but the patient, a boy, was heated and out of breath, when he began to inhale, by exerting himself for some time previously, in opposition to the traction by pullies which was used in attempting to reduce a dislocation of the hip. If the patient goes on breathing steadily, however, he very quickly becomes passive, and lies still. The only circumstance which can cause any difficulty is his holding his breath, which he sometimes does, not from the pungency of the vapour, as in the earlier stages, but, apparently, from spasmodic contraction of the muscles of respiration. In two or three cases the breathing was interrupted till the face became quite purple, but the patients soon went into the fourth degree, on its commencing again with deep and quick inspirations. If the skin becomes inclining to purple, the face-piece may be removed for half a minute, if it is thought proper, for the patient to breathe unetherized air until the skin resumes its usual colour; but there need be no alarm, as the breathing always becomes extremely regular when the next degree is attained, and the inhalation need never be given up at this stage, as there can be no danger from ether when the limbs are rigid; and it is better not to begin the operation till the respiration become equable and regular, but to wait for the fourth degree in all cases in which the third is at all unfavourable.

There are never any strong demonstrations of pain in the third degree, and a number of surgical operations may be performed without carrying the etherization further,—generally, without any symptoms of pain,—but, in some cases, with the result of a little flinching or moaning, and perhaps a contraction of the features. These very slight tokens of obscure sensation, of which the patient knows nothing, and which do not at all interfere with the operation, may, however, be disregarded when they do occur.

If the inhalation has been continued, and the operation deferred on account of movements or rigidity, the latter may be commenced as soon as the patient becomes still, and his muscles relaxed. If there is the least approach to snoring, whether there is complete relaxation of the muscles or not, the operation may always be commenced, and judging by what I have seen, will never elicit any signs of sensation.

If the operation does not involve the mouth or nose, I am in the habit of continuing the inhalation until after it is commenced; and, if there are any obscure signs of pain, for a little time longer, until they subside. But if the operation has no effect on the patient, I either remove the face-piece, or open the expiratory valve a little way to dilute the vapour. If there is the least snoring I always leave off the vapour entirely, even without waiting for the commencement of the operation when I have requested that it may be begun. The snoring now and then increases for a quarter or half a minute after the inhalation is left off, the breathing becoming deep, accompanied with heaving of the

chest, and sometimes also blowing of the lips; but this stertorous breathing always subsides again in a minute or two, and need therefore excite no alarm; it should, however, always be looked on as an indication for discontinuing the ether for a time. It is not possible always to avoid having the breathing somewhat stertorous; for in some patients, no sooner does this kind of breathing subside, than symptoms of pain from the operation begin to appear; and no sooner are these symptoms removed again by the ether than the stertorous breathing re-appears. I have, however, never known it to leave any cerebral symptoms afterwards.

The inhalation having been discontinued during an operation, the time of resuming it must depend on circumstances. If any important steps of the operation are going on, it is advisable to anticipate the return of sensibility to pain, and to resume the inhalation so soon as returning sensibility of the eyelids, or any voluntary motion in them, shews that the patient is returning to the second degree. If only some secondary part of an operation—as the tying of arteries—is going on, we may wait till there is some sign of the operation being felt before resuming the inhalation, and it will remove any such sign in a very short time; it being seldom necessary to continue the inhalation more than half a minute, or a minute at the furthest, if the valve is closed, and the vapour of full strength, when it is resumed during an operation, after insensibility has been previously induced. There is very seldom any struggling in the third degree as it succeeds to the fourth; but if there is, it may then be

necessary to give more ether to keep the patient in the fourth degree for some time; not because he would feel pain with a less degree of etherization, but because he would not be sufficiently still. Some patients begin to show signs of feeling the operation before there are any other tokens of sensibility, or of ideas, or any voluntary movements; but very often the patient may be allowed to return to the second degree, and to remain some time in it during the operation without shewing signs of pain. Most usually the only sign that he is in this degree is voluntary motion in the eyes or mouth; but, occasionally, the patient talks during the latter part of the operation in a way that shews he is dreaming. If he does not offer to move at the same time, that is not a reason for giving more ether; but if his conversation shows that his dreams are of an uneasy nature, and if he moves about, the inhalation should be resumed if the operation is not completed. Indeed, uneasy dreams—as of quarrelling or misfortunes—during an operation, may proceed from the operation itself, and words of anger or distress may follow each cut; but when the patient is talking about pleasant or indifferent subjects, it is very evident that he is not in pain.

Insensibility to pain may be kept up for a long time without risk, by allowing partial recovery from the effects of the ether occasionally. I lately kept an elderly gentleman quite oblivious for two hours and a half after Mr. Liston had applied a thick paste of chloride of zinc to a large ulcerating tumour on his face. Each time that he began to feel the smarting the ether was

resumed, — at first, after intervals of ten minutes; then, of a quarter of an hour; and finally, of twenty minutes; the recoveries becoming each time more complete before the pain recurred. But the patient had no recollection of them, for each time that he recovered his consciousness, he asked if Mr. Liston had gone without applying the caustic. At the end of two hours and a half, having been allowed to recover more completely than before, he considered that the pain was not more than he could bear, and the inhalation was not resumed. Five fluid ounces of ether were used, and no effects of any kind followed it, unless that the pain, for some hours, was not so great as it probably would have been.

The ether often occasions an increased flow of saliva after it has been continued for a few minutes; it is therefore well to be provided with a towel to wipe the patient's mouth, and the valves of the face-piece, if they get wet, as they would otherwise act not quite so easily. In the third and fourth degrees the saliva would merely flow from the patient's mouth, but in the second degree he is capable of spitting it out.

In operations on the mouth and nose, the inhalation of course has to be discontinued before they are commenced; but the operator should begin the moment the face-piece is removed, in order to take advantage of the full effects of the ether. In operations attended with no great loss of blood, as the removal of polypi from the nose, and the extraction of teeth, the inhalation can be resumed at any moment, if the sensibility returns before they are completed; but operations attended with

the division of blood-vessels cannot be interrupted; and therefore it becomes desirable to induce a state of insensibility that will last to the end of the operation. If etherization is carried to the fourth degree, complete insensibility usually continues for three minutes after the inhalation is discontinued—sometimes, indeed, for a longer period; but its continuance may generally be depended on for three minutes. This period will allow of the performance of the operation for hare-lip, and some others; and a state of unconsciousness usually lasts above five minutes longer, a period during which any pain there might be would not be remembered afterwards. In the third degree, the muscles which close the jaws are often contracted, but in the fourth degree the mouth falls open; but I do not consider it necessary, on that account, to carry etherization as far as the fourth degree for the extraction of a tooth; for an assistant can easily open the mouth by taking hold of the chin, and recovery is more speedy when the effects of ether are not carried beyond the third degree. When the dentist wants the mouth cleared of blood, he should use a small sponge, as the patient cannot wash out his mouth when insensible.

In all the cases I have witnessed, the patients have recovered their mental faculties very promptly and completely after the conclusion of the operation,—generally within a few minutes,—and in two or three cases only has the period of recovery been delayed for half an hour. I do not think that any thing is ever required to promote the return to sensibility. When the

patient is sufficiently etherized to feel nothing of a surgical operation, he is far beyond the reach of stimulation by ammonia, cold affusion, or any thing else; and when he is so far recovered that these things would make an impression, there is not long to wait for his complete recovery. Elderly people are slower in recovering than young ones; as their respiration is less active, and the ether takes a longer time to evaporate in the breath. For the same reason, if sickness has been caused by the ether, the patient is longer in recovering, as it depresses the respiratory movements.

Although many patients recover their consciousness at once, as out of a natural sleep, yet there is often a short period during which the mind wanders as it is reviving from its temporary suspension; and during this time it is advisable not to talk to the patient, or ask him any questions, but let him remain silent, if, as is generally the case, he will. If, however, he talks in an excited way, a word or two may be addressed to him to calm him; and this condition lasts but a very few minutes.

I may remark here, that, except an oath once or twice, from patients who were probably in the habit of giving utterance to them, I have never heard anything said, under the effects of ether, which could not with propriety be repeated.

Except a headache, on one or two occasions, the only unpleasant effect that I have ever seen from the inhalation of ether has been sickness and vomiting, which are only occasional results, and seldom occur except when a meal has been taken just before the

ether,—a measure which I prevent when I have the opportunity. It is when, after a meal, the etherization is deep—for instance, in the fourth degree—and continued for some time, that vomiting is most liable to occur. It may take place either during the insensibility or not till after it. The contents of the stomach are in some cases rejected merely by the action of the stomach and œsophagus, without any accompanying straining, or even the assistance of the respiratory muscles, and without apparent sickness. At other times, both during insensibility and afterwards, the vomiting is accompanied by an expression of sickness in the features, diminished temperature of the surface, with or without sweating, and diminished strength and frequency of the pulse. When sickness occurs it greatly prolongs and increases the insensibility to what the surgeon is doing; even if the consciousness has returned, pain is seldom felt during the sickness. The nausea and vomiting generally subside immediately; but, in two or three instances, have continued till the following day.

The blood that flows in operations under the influence of ether is not much altered in colour. The blood which spirts from a divided artery is sometimes of its usual vermilion tint, at the very time when the inhalation is going on; frequently, under these circumstances, however, the arterial blood is rather less bright than usual, but the venous blood being at the same time less dark than common, the flow of mixed blood is of the ordinary colour of such blood; and the

patient's lips remain unchanged in hue. It has been only when the patient has been holding his breath, or coughing, that I have observed the arterial blood to be of a dark colour; and I consider that those writers who have described it as being, usually or always, of a venous appearance, must have used inhalers that did not allow of a proper supply of air. The blood always coagulates on the floor of the operating theatre, and the black blood which flows during an amputation, when the tourniquet is applied, constantly becomes afterwards red on the surface from exposure to the air. (6)

There has not been any considerable secondary hæmorrhage, except in one case, after an amputation; and, therefore, I cannot look upon ether as causing any increased liability to it: nor, indeed, is there anything to prevent every vessel, large enough to require a ligature, being tied at the time of the operation; for there is a good pulse,—a better pulse, indeed, generally than there would be if the operation were performed without the ether.

The following account of the exhibition of the ether, in a few cases, from notes taken just afterwards, is introduced to illustrate the usual effects of it.

Case A.

A gentleman, aged 49, whose health was much impaired by long illness and residence in the East Indies, had suffered for several years from stricture of the urethra, with fistulous openings in it. No catheter could be introduced, and none of his

urine passed the natural way. On April 24, Mr. Liston performed an operation for his relief, part of which consisted in cutting into the urethra in the perinæum. Mr. Thomas Morton, Mr. Emanuel Baker, the usual medical attendant of the patient, and Mr. Cadge, were present. The patient having been bandaged as for lithotomy, began to inhale. He breathed steadily and pretty deeply, and became insensible without any excitement or struggling. In four minutes the eyes were turned rather upwards, and there was slight snoring. The operation was now commenced, and it caused no sign of pain. It was concluded in seven minutes, during which he inhaled, at intervals, vapour more diluted than at first. Two or three minutes after the conclusion of the operation, he said a few words incoherently like a drunken man, but was not spoken to, and became silent again. Five minutes after the conclusion of the operation he spoke rationally, saying that he did not begin to feel any stupifying effect from the ether yet. The pulse was but little influenced throughout.

After having been put into bed it was found that there was hæmorrhage, and it became necessary to take up a small artery. He could not be got to lie still enough for it to be seized, so the ether was given again, twenty minutes after he had recovered his consciousness, and thirty-six minutes after the commencement of the first inhalation. In two minutes he was quite insensible, the eyes being turned up, and the respiration rather snoring: he was lifted up, and some cushions placed under him, and he inhaled a little more vapour, and then the artery was secured as he lay quite motionless, and he recovered his consciousness a minute or two afterwards.

℥xiv. of ether were consumed on the first occasion, and ℥vi. on the second. The temperature of the water-bath was 67°; somewhat higher than I now employ.

Being situated at the patient's head, I did not see the operation, and consequently could take no notes of it. It was successful in establishing the natural channel for the urine, and the fistulous openings gradually closed up. The patient had spectral illusions occasionally for a week or two after the operation, but was not

alarmed by them, and did not mistake them for realities. He fancied they were caused by the ether; but they most likely depended on his weakly condition, for a time increased by the loss of blood during the operation. I have not heard of anything of the kind after ether in any other case.

Case B.

On June 19, a lady below the middle age, a patient of Dr. Locock's, who was present, inhaled the ether for an operation, which Mr. Liston performed. Her malady was, in the first instance, a simple serous cyst, at the inner part of the left eyebrow, over the frontal sinus. The walls of the cyst were bony, except at the most prominent point, and here there was only membrane. The cyst was punctured, and the opening kept patulous by caustic potash. Suppuration followed, and for a time the walls collapsed and the swelling diminished; but afterwards the opening in the bone contracted so much as to prevent the free exit of the pus.

The water-bath being prepared at 64°, the inhalation was commenced, and went on easily and steadily, and insensibility was induced without any struggling. Four minutes after the process was fully commenced, the eyes were turned upwards and towards the right, the pupils being rather contracted, and at this time the operation was begun, without causing a flinch or cry. Mr. Liston made a crucial incision, reflected the flaps, and cleared the bone for the application of the trephine. The inhalation had been left off just after the operation began, and by this time there were evidences of returning sensibility—motion of the eyelids and a little groaning—so the ether was resumed, and Mr. Liston waited half a minute before applying the trephine; at this time the patient was rather rigid from a general contraction of the muscular system, which became relaxed just afterwards, during the concluding part of the operation. A circular piece of bone was removed with a moderate-sized trephine, and a great quantity of pus escaped. The cavity was found to lead to the bottom of the frontal sinus, and some lint was lightly pushed into it. The

second inhalation (with the vapour more diluted than in the first, by means of the two-way tap I then used) was continued during the trephining, for I did not know that the operation would be concluded so soon, and was left off just as the operation was concluded. At this time the breathing was inclined to be stertorous, and accompanied by gentle blowing with the lips; but it returned to the natural state in about two minutes. A minute or two afterwards the patient vomited, and she began to recover her consciousness two or three minutes later—about six minutes after the ether had been left off. She spoke in rather an excited way at first, about the operation she had undergone without feeling it, and forgot this conversation; for some minutes afterwards she inquired if the operation was going to begin. When I left, half an hour after the operation, the patient had recovered from the effects of the ether, all but a feeling of sickness, which soon afterwards subsided.

In a short time she was able to wear a plug of India rubber, which kept the soft parts from closing, and the discharge has been since gradually diminishing.

Case C.

St. George's Hospital, July 22.—Mr. Cæsar Hawkins operated on James Fry, æt. 30, for necrosis of the tibia. The patient inhaled without any impediment, except from a little coughing. In between three and four minutes he appeared to be established in the third degree. The vapour was now somewhat reduced in strength, and in a minute longer the eyelids were nearly passive; there was an approach to snoring, and the countenance was devoid of expression. The operation was now commenced without the least sign of pain. He had a little dilute vapour occasionally during the operation. The bone was trephined in two places, and the operation completed in five minutes, by the removal of a considerable sequestrum, and he shewed no sign of pain during the performance of it. It was observed, that the pupils of the eyes were sensible to light during the complete state of general insensibility, whilst the lower jaw was hanging down.

The pulse was good throughout, but somewhat accelerated. He recovered his faculties soon after he was removed to bed. He had no sequelæ of any kind from the ether, and said that he had the best sleep during the operation that he had had for a long time. ʒij. of ether were used. He recovered favourably.

Case D.

Directly after the above operation, Mr. Tatum performed lithotomy on Henry Hemson, æt. 10 years, in good general health. In between two and three minutes after he began to inhale, he was perfectly insensible, the eyelids drooping, and the eyes being rather turned up. The staff was introduced without sign of pain, and he was moved to the bottom of the bed; the ether, in the meantime, having been left off. He inhaled again for about half a minute before the operation began; for he had begun to show signs of sensibility by opening his eyes. The operation was performed without the least sign of pain. I could not see the steps of it, but it was concluded in about two minutes by the extraction of a mulberry calculus, about the size of a kidney bean. He seemed in the third degree during the operation, and not quite so deeply etherized as on the introduction of the staff. He looked about him directly the operation was concluded, and began to sing a school lesson. His face was florid all the time of the inhalation. Mr. Tatum informed me, that the bladder had a tendency to contract, and empty itself by the side of the staff, at the beginning of the operation: this would probably have been prevented by his being etherized a degree further, viz. to the fourth. The little boy quickly recovered.

The following case shews the smallest amount of etherization with which an operation can be satisfactorily performed, as it seemed only just carried to the third degree.

Case E.

Mr. Keate, assisted by Mr. H. C. Johnson, operated on Sir ——, for two sinuses by the side of the rectum. The patient was rather nervous about the ether, but when he had commenced inhaled very well. In two minutes the eyes were turned quite up, the lids however being kept closed, and they were briskly closed again directly they were lifted up. The face-piece being removed for a moment, the features were observed to be unaltered in expression. At this moment, the expiratory valve was opened a little, to dilute the vapour further; the water in the bath being 64°, and consequently, the patient having been breathing equal parts of air and vapour. At the end of another minute—the third from the commencement of the inhalation—there was no further alteration in the patient, except, perhaps, that the eyelids did not close again so briskly on being lifted by the finger; but I observed that Mr. Keate had got a probe introduced into one of the sinuses unknown to me, and with this proof of the patient's insensibilty, I requested that the operation might be performed, although otherwise I should have thought the patient scarcely ready for it. During the division of the first sinus the patient held his breath, and moved one hand a little, and stretched out his fingers; and during the division of the second sinus he also moved one foot a little, but not so as to interfere in any way with the operation; and he did not move his body or utter the least sound. The inhalation was discontinued just as the operation was concluded; and half a minute afterwards, as Mr. Keate was thrusting a pledget of lint into the wound, the patient flinched and uttered an angry expression; and directly afterwards he tried to raise himself up from the sofa, but was easily prevented. In less than a minute, he said that he had been in Lancashire disputing with some people; and on Mr. Keate informing him that the operation was concluded, he expressed his surprise and satisfaction, and seemed to have recovered his faculties completely, having been unconscious only three or four minutes altogether. The pulse was counted between the operation and the introduction of the lint, and it was at the rate of 88 in the minute. ʒvijss. of ether were expended.

The attitude and respiration of this patient, and the slight movement of his limbs during the operation, were precisely the same as those of a person suppressing the usual indications of pain, and I have noticed the same thing in some other cases. The dream about the conversation probably occurred at the moment when he first spoke.

In the following case the difficulties in the way of etherization were greater than in any other instance I have seen, but would have been much lessened, and the patient could have been kept steadier during the operation, if I had had at that time the experience and precaution to recommend a semi-recumbent posture on a table or couch, instead of that of sitting in a common chair.

Case F.

Miss R. had a tumor of the lower jaw, which commenced fourteen or fifteen years ago, at the symphysis, and extended laterally till it reached nearly the size of the fist, producing great deformity. On May 28, Mr. Liston removed the tumor; Mr. Morton, Mr. Cadge, and some other surgeons, being present and assisting. The patient, who appeared to be between twenty and thirty years of age, was in good general health, but had suffered occasionally from epilepsy. The inhaler was prepared with the water-bath at 65°—the temperature of the water in the room. She was with difficulty got to inhale, even whilst she preserved her consciousness, and in the course of a minute or two, when she passed into the second degree, and had lost the knowledge of where she was, and what was being done, the difficulty was still greater; she sobbed and screamed very much, and stamped with the feet, and pushed the face-piece off with her hands. She was, however, held by those present; and when the face-piece was pushed away it was put on again directly, and in two or three minutes the screaming and all the efforts of a volun-

tary character ceased, and she passed into the third degree, but became, at the same time, extended in a state of great rigidity, so that she could not be kept seated, and appeared to be in epileptic convulsions with frothing at the mouth. The exhibition of the ether was persevered in, and the patient became suddenly quiet, going into the fourth degree of etherization about five minutes after the inhalation was commenced. She was placed again in the chair; the breathing became slow, deep, and regular, and the eyelids were observed to have lost their sensibility. The inhalation having been continued a little longer, was left off about six minutes after it was begun, and the operation was immediately commenced. An incision was made along the inferior edge of the jaw, and a second crossing it over the chin, from below the middle of the free border of the lip; the flaps were dissected off, and the bone exposed: during this part of the operation the patient sat breathing quietly, and not moving or uttering a sound. Mr. Liston then extracted two or three molar teeth with the forceps, and at this time the patient uttered a sound expressive of pain, and struggled. The struggling and demonstrations of pain continued as the bone was being cut through far back on each side. At this time I dipped a small sponge in ether, and held it to the patient's nostrils, standing behind her (7). Although her mouth was, of course, widely open, she was breathing in some measure by the nostrils, and in a little time became quiet, being apparently perfectly insensible. The bone having been divided, the tumor was depressed, and removed by dividing the mucous membrane and hyoid muscles, the tongue being held forward by a strong ligature drawn through it. The sponge was wetted occasionally, and kept applied to the nostrils, but without the effect of keeping up complete insensibility; for, apparently, the breathing was sometimes performed entirely by the mouth, where, of course, the sponge could not be placed, and the patient struggled again now and then during the tying of the arteries. The pulse was very good, though frequent, at the end of the operation, notwithstanding the loss of blood necessarily attendant on it. She was put into bed ten or twelve minutes after the operation began, and some small arterial branches were secured afterwards. At

this time she seemed to have recovered her consciousness (the nature of the operation, however, preventing her from speaking for some time). The wound healed by the first intention, and the patient was able to walk out within a fortnight. She said that she felt nothing of the removal of the tumor, and she was much satisfied with the ether; but for which, indeed, she could not have been prevailed on to submit to the operation. Her appearance was much improved, the deformity caused by the want of the jaw being much less than that which the tumor produced.

Ether contributes other benefits besides preventing the pain. It keeps patients still, who otherwise would not be. I gave it lately, for this object alone, to a child on whom Mr. George Pollock operated for cataract by drilling. The child was perfectly quiet, and the eye and eyelids were quite passive. It had been operated on before, and without the ether would have made all the resistance in its power. In the case related at page 45, Mr. Liston considers that he should have been unable to secure the bleeding vessel without the second application of the ether.

The relaxing effects of ether are much greater than those of the warm-bath and emetics. In the case, No. 40 of the list subsequently to be given, Mr. Tatum reduced a dislocation of the shoulder of ten weeks' duration, in a muscular man, under the influence of ether, when it was observed, before the traction was exerted, that the muscles were completely relaxed, and the arm much more moveable than before the inhalation. Other cases of reduction of old dislocations, under the effects of ether, have been related in the medical journals, and also cases in which the surgeon was enabled, by means of it, to reduce strangulated herniæ with the taxis, where,

otherwise, an operation would have been required. In Case 7 of the second list, farther on, the ether superseded one of the most difficult operations in surgery, and enabled Mr. Liston to get a catheter into the bladder without using the knife.

The real value of the inhalation of ether in surgical operations must be mainly determined by the ultimate success of the cases in which it is practised. A surgical operation is a necessary evil, submitted to for the advantage of a greater good which is expected to result from it; and if the ether added at all to the danger of the operation, or diminished in any way the full advantages to be derived from the operation, it would be the surgeon's duty to recommend his patient to submit to the pain, excruciating as it often would be to him, and distressing to those who have to witness it. It is very evident, *a priori*, that an agent which so alters the circumstances of the patient, cannot be without its effects on the ultimate results of capital operations; and since severe pain generally exerts a deleterious influence on the economy, and the use of ether in thousands of trivial operations has shewn it, when properly managed, to be attended, either with no danger, or the least conceivable amount of it, it seems to follow that etherization must lessen the danger of serious operations, unless we think (with one or two renowned doubters, who seem to look upon a surgical operation as a natural process, in which the pain plays some essential part), that the sufferings of the patient in some way aid his recovery, instead of being deleterious to

him. However, the proper and philosophical course to pursue, as soon as we have the opportunity, and one generally followed in medical science in similar instances, is impartially to examine the results, disregarding what we might beforehand expect.

In order to contribute what I can towards such an examination of the influence of ether over the results of surgical practice, I subjoin a list of all the operations in which I have administered the ether in St. George's and University College Hospitals. In the very few cases which ended unfavourably, and in some of the others, I have added notes, which I have copied from the Hospital case-books. The operations down to about Midsummer were briefly but correctly reported as far as related to the ether, in the Lancet, from time to time. In no case in which I have given the ether did the patient know anything of the operation, except, two or three times, some trivial part of it, such as tying an additional small artery after the inhalation had been discontinued. And it may be remarked, that the constant success with which ether is capable of being employed, is one of its greatest advantages; and, that the patient may have the full benefit of this discovery, he should not only be spared the pain, but also the anticipation of it, often so depressing to his powers, and should feel confident, from the time the operation is proposed, that he will suffer no pain, and be exposed to no danger. In most of the following cases the patients have looked forward to the operation merely as the time when they would get rid of a painful joint, or some other troublesome

disease; and this has been generally the case also in private practice.

LIST OF OPERATIONS WITH ETHER AT ST. GEORGE'S HOSPITAL.

1. January 28, Mr. Cæsar Hawkins removed dead bone from the interior of the tibia of William Daphne, aged 6 years.—Recovered. Left the hospital March 10.

2. On the same day Mr. Cutler performed amputation of the thigh on the patient whose case is subjoined:—

"William Cowen, aged 23, a stout healthy-looking groom, was admitted into the Oxford Ward, Dec. 1, 1846, having a short time previously been thrown with great violence by a horse. On the interior and anterior surface of the right thigh, about its middle, a wound in two lines, meeting at a right angle, and three inches long each way, penetrated the muscles in its whole extent, and exposed the bone. The vessels were almost laid bare, but the hæmorrhage was slight. The right leg was fractured at its lower third, with much comminution. Four days after admission, inflammation of an erysipelatous character appeared round the wound, and crept up the limb during the following eight days. Considerable irritative fever and depression gradually supervened, and increased as the discharge became more profuse and ill-conditioned. 29th. A very large quantity of foul pus was let out by an incision on the external surface of the thigh, and on the 27th of January, 1847, the knee-joint presented every appearance of being distended with pus. The patient was in such a state of extreme depression, as to render any motion, or attempt at examination, productive of most alarming symptoms; and a phthisical cough troubled him. Such was the state of the case, when, at a consultation of the surgeons, it was determined to give him the chance of an operation under the influence of ether. On Jan. 28, therefore, the vapour was administered by Dr. Snow. In less than three minutes perfect insensibility was produced,

and it was continued whilst the patient (who was in too weakly a state to bear removal to the operating table) was drawn to the foot of the bed, and amputation of the thigh performed, consciousness only returning during the washing of the stump, which was productive of pain. He said that he felt nothing of the operation: no sickness or headache followed. He passed an excellent night, free from the usual startings of the stump; was in good spirits next day, and smiled when addressed. On the twelfth day he was up. From this time his health slowly and gradually improved: the cough, at all events, did not increase. The stump granulated, without an unfavourable symptom, till the beginning of April, when some inflammation about it, and slight fever, ended in the formation of an abscess. He was discharged May 12, to go into the country, the stump being nearly healed, and small sores only remaining of the ulcers.

"He was re-admitted to the hospital this autumn, almost destitute, much emaciated, and suffering with cough and hæmoptysis. He has derived considerable benefit from the treatment, and will shortly be discharged."—ADOLPHUS J. GEE.

3. On the same day, also, Mr. Tatum removed a large fatty tumor from the shoulder of Francis Lewis, aged 42; a man of colour.—Recovered. Left the hospital May 26.

4. Feb. 4, Mr. Cæsar Hawkins operated for necrosis of the tibia, on a young woman—(I neglected to take down the name and age in this and one or two other cases).—Recovered, and left the hospital.

5. On the same day, Mr. Cutler performed the operation for fistula in ano, in a middle-aged man.—Cured.

6. On the same day, also, Mr. Tatum amputated the breast of Caroline H——, aged 32 (married), for scirrhus.—Recovered. Left the hospital March 3.

7. Feb. 11, Mr. Cutler performed lithotomy on Wm. Doran, aged 4 years.—Recovered without an unfavourable symptom, and left the hospital March 3.

8. The same day, Mr. Henry Charles Johnson amputated the breast of Ellen A——, aged 40 (widow), for scirrhus. This patient was suffering from bronchitis at the time of the operation, and the ether caused a good deal of coughing, and was left off somewhat prematurely on this account, and the operation performed. There was some struggling, but the patient talked during the operation about matters quite unconnected with it, and said afterwards that she felt no pain. Her cough was relieved for the first two or three days after the operation.—She recovered favourably, and left March 10.

9. Feb. 25, Mr. Cutler removed the right mamma of Mary F——, a cook, aged 54, affected with scirrhous tumor.—Recovered. Left on March 31.

10. The same day, Mr. Cutler amputated the thigh of Thomas Hood, aged 13 years, for long-standing scrofulous disease of the knee-joint, by which he was much debilitated.—Recovered. Left April 7.

11. On Feb. 25, also, Mr. Henry James Johnson amputated the thigh of Anne Atkinson, æt. 11:—

"This little girl was admitted August 19, 1846, under the care of Mr. Keate, in a weakly, emaciated condition, with necrosis and caries of the left leg, reported of a month's standing, and to have commenced suddenly, with pain and fever. The entire middle third of the tibia appeared to be diseased, and several sinuous openings existed in this situation, leading to necrosed and carious bone. The tenderness was excessive.

"Dec. 24, 1846, the health having improved somewhat under treatment, numerous small pieces of dead bone were removed by operation; no immediate ill effects followed, and the wound continued in a tolerably healthy condition till about the second week in January, 1847, when it was attacked by erysipelas, which in the course of a week extended up the thigh, and then faded rapidly, leaving the patient much reduced, and the knee-joint, and the thigh immediately above it, red, tumid, and painful. Thus the case continued, the patient getting weaker, and the

abscesses increasing up the thigh. As the great tenderness of the parts, and the state of the patient, precluded every attempt to examine the state of the limb in the usual manner, the ether vapour was administered by Dr. Snow's apparatus, with perfect success, and, while the patient continued in a state of unconsciousness, the condition of the parts was ascertained sufficiently for the surgeons in consultation to determine on amputation.

"Feb. 25. The thigh was removed at its middle third by the flap operation, the ether vapour being again inhaled with the same success as before. On examining the limb it was found that the abscess was situated in the ham, and amongst the muscles of the thigh, having a very slight connection with the joint, which was, for the most part, healthy. No sickness or headache followed. The patient had a sound night's rest, undisturbed by starting of the stump, and the following day said she was much easier than she had been for a long time, and did not know till 9 this morning that the limb had been removed. She never gained strength, however: there was scarcely an attempt at healing, and the bone was exposed. She sank gradually, and died March 5."—ADOLPHUS J. GEE.

Examination, eleven hours after death.

"*General Appearances.*—The body was a good deal emaciated. There were superficial sloughs on the sacrum, trochanters, and crests of the ileum. The left leg had been amputated above the knee: the extremity of the bone was exposed, and the stump in an unhealthy condition. The right foot was œdematous.

"*Thorax.*—There were some recent adhesions of the pleura on the left side, chiefly at the outer and back part of the chest. Some shreds of lymph were adhering to the surface of the lungs, but there was no fluid in the cavity of the pleura. The anterior portions of the left lung were healthy and crepitant, but the posterior and lower portions were much congested, consolidated, and contained numerous secondary abscesses, in various states of suppuration and of various sizes; the seat of the abscesses being chiefly near the surface of the lung. The right lung was in a

similar condition to the left, containing various abscesses at its posterior part.

"The heart was healthy, but flaccid; the blood particularly fluid. There were some loose fibrinous coagula in the cavities.

"*Abdomen.*—The viscera were all healthy.

"*Left lower extremity.*—The extremity of the bone was denuded of periosteum to about the extent of half an inch, and the bone itself of a dark colour. The wound was foul at the posterior part, but in front had apparently been commencing to heal. Ligatures were found attached to the femoral vein and artery, the wound around being both foul and unhealthy. The periosteum was easily pulled off the bone for some distance above the sawn extremity. On opening the femoral vein it was found to be filled with thin darkish-coloured pus as high as the bifurcation of the abdominal cava; but the lining membrane gave no indication of inflammation of the coats of the vein."—GEO. POLLOCK.

12. March 4, Mr. Tatum amputated the leg of a man, much reduced by disease of the ankle-joint.—Recovered.

13. The same day, Mr. Tatum also amputated the leg of James Thomas, aged 17, for strumous disease of the foot.—Recovered. Left May 12.

14. March 11, Mr. Cutler removed the great toe of Henry Bunn, aged 14, together with its metatarsal bone, for strumous disease of the bones.—Recovered, and left the hospital.

15. The same day, Mr. Tatum amputated the thigh of James Stanmore, aged 15.

"He was admitted Feb. 24. Inflammation of the leg began twenty-three weeks before his admission, and matter was let out from the knee about three months before his admission. When admitted he was much emaciated, and very pale. Pulse very quick, weak, and sharp. Tongue clean and moist. The natural shape of the extremity was lost, and it was at least double its natural size. Several incisions in various parts of the leg, and two or three fistulous openings on the knee, were discharging tolerably healthy pus, and the skin round the incisions was thickened and

tuberculated. The thigh and left nates were highly œdematous, and there was a large excavated bed-sore over the sacrum. Shortly after admission an attack of shivering was followed by increased swelling, and a blush of erysipelas from the hip to the knee. His appetite became worse, and his debility increased. March 8, these symptoms subsided, and on the 11th amputation was performed. As the patient could not be moved, owing to the excessive tenderness of the part, and his weakly condition, he was brought into the theatre on the bed. After inhaling the vapour of ether for two or three minutes by Dr. Snow's apparatus, he fell into a state of perfect insensibility, was drawn to the edge of the bed, and the operation performed, without his evincing any sign of consciousness. The parts cut through were highly œdematous, and the muscles pale and flabby. Some sickness occurred on his return to the ward, but he slept well, with very little starting; he suffered, however, more from that cause on the following day, but was quite easy on the 13th, on which day the stump was dressed for the first time. No union had taken place—suppuration had commenced. The case progressed favourably till the 19th (the eighth day after the operation), when, after suffering much pain during the night in the stump—relieved in the morning by dressing—the patient was seized, about 1 P.M., with a severe rigor, followed by a slight hot stage. Pulse frequent, and very weak; tongue clean and pale. From this time he sank rapidly, several rigors occurring daily. There were bilious vomiting and stools. Latterly he was free from all local pain. The discharge from the wound was profuse and fœtid, and the bone protruded slightly, but the stump in other respects looked well. There was slight wandering delirium the last two days only. He died on the 27th."—ADOLPHUS J. GEE.

Examination, fifty-seven hours after death.

"*General appearances.*—The body was much emaciated. The pelvis was a good deal distorted, from lying in bed. The left leg had been amputated recently above the knee, and the wound was still open. There was a considerable bed-sore on the sacrum.

"*Thorax.*—There were some old pleuritic adhesions on the left side of the chest. There was considerable inflammation and softening of the lower and back part of the left lung, with several secondary abscesses. There were old adhesions of the pleura on the right side, and several secondary abscesses in the back part of the lower lobe of the right lung. The heart was healthy, and contained some loose fibrinous coagula.

"*Abdomen.*—There were some adhesions of the peritoneum at the upper surface of the liver. The viscera were generally healthy. There was a small quantity of pus in front of the left hip-joint, apparently in the substance of one of the inguinal glands. The glands in the groin were generally enlarged, and of a black colour. The cellular sheath of the femoral vessels was much condensed, and very much firmer than usual. The femoral vein was blocked up with pus and purulent coagula, and the interior of the vessel was of a black colour. This inflamed condition extended from the end of the stump to the interior of the pelvis. The end of the bone was protruding from the stump, and quite exposed. There was a large quantity of matter burrowing up, in the back part of the stump, in the substance of the muscles. New bone had been recently thrown out on the lower part of the surface of the bone. The head of the femur was dislocated on the dorsum of the ileum, and perfect, though recent, anchylosis had taken place between the two bones. The acetabulum was filled with recent darkish-coloured lymph, and almost all traces of cartilage had disappeared. The bones forming the joint, &c., were softened, and readily cut with the knife."—GEO. POLLOCK.

16. March 18, Mr. Keate amputated the leg of Samuel Richards, aged 9, a boy of colour, for disease of the ankle-joint.—Recovered.

17. The same day, Mr. Cæsar Hawkins amputated the forearm of Henry Knight, aged 45, for disease of the wrist-joint.—Recovered.

18. The same day, also, Mr. Henry Charles Johnson amputated

the breast of Mary A——, aged 48, married, for scirrhus.—Recovered. Left the hospital April 14.

19. April 1, Mr. Cæsar Hawkins removed a fatty tumor from the shoulder of Mary Brindle, aged 48, a cook.—Recovered. Left April 21.

20. The same day, Mr. Cutler amputated the leg of George Stamper, aged 23, who was admitted March 25, with disease of the ankle-joint of five years' standing. There is a scar on the left side of the sternum, from which a piece of dead bone separated five years ago. He has had a cough during the last winter, and Mr. Gee's notes contain the following:—"Dr. Fuller examined his chest, and found that there was some condensation at the upper part of the right lung." On examining the limb after the amputation, the ankle-joint was found to be destroyed; about half an inch of the inferior articulating extremity of the tibia being perfectly necrosed and loose, the articulating surface of the astragalus deprived of its cartilage, and nearly all the bones of the foot softened. His cough was relieved the first two days after the operation, and still more so as his health improved. The stump healed by granulation, and he left on May 5.

21. April 8, Mr. Cæsar Hawkins amputated the thigh of Thomas Witcher, aged 18, for disease of the knee-joint.—Recovered. Left on May 19.

22. The same day, Mr. Cæsar Hawkins also amputated the fore-arm of George Richardson, aged 48, for severe disease of the wrist-joint. This patient was in a very bad state of health, and suspected to have disease of the lungs.—Recovered. Left May 19.

23. The same day, Mr. H. C. Johnson operated for hare-lip on a little girl apparently about twelve years old—an out-patient. Cured.

24. April 15, Mr. Cæsar Hawkins operated on Mary Andrews, aged 57, by needles and ligatures, for a vascular tumor of the lip. Cured. Left May 15.

25. Same day, Mr. Cæsar Hawkins operated for necrosis of the metatarsus, on Caroline Collins, aged 7.—Recovered.

26. April 29, Mr. Cutler amputated the thigh of Ann Coston, a servant, aged 19. This patient had been subject to inflammation of the knee-joint from her childhood, and from Midsummer to Christmas last year she was in the hospital with symptoms of ulceration of the cartilages, but went out much relieved. She was re-admitted on March 17. The pain had recurred about a month after leaving the hospital, and had been getting worse ever since. The pain and tenderness still increasing, and being accompanied with starting of the limb again, and her general health being good, amputation was performed by a circular incision. The cartilages were found to be extensively destroyed. Two hours after the operation she was comfortable—the pulse quiet and regular, the stump oozing freely. An hour later, there was sudden hæmorrhage from the wound in a jet. The stump was opened, and was found full of coagula, which Mr. Cutler removed, and secured two vessels. There was not much blood lost, and there was no return of the hæmorrhage. She suffered from starting in the stump and pain in the abdomen, the first two days. These symptoms subsided; but on May the 3d she became worse, and was attacked with sloughing phagedena of the stump.* On the 5th the ulceration ceased, after having exposed the shaft of the bone, and by the 16th she was much improved, having a good appetite, and the stump granulating. She went on improving till the 26th, being then upon crutches; but the following day she was again attacked with sloughing phagedena, with much pain and fever, and a brown tongue. On the 30th the ulceration ceased, but in

* The wounds resulting from the operations had healed well—in a great measure by the first intention—till about this period, when sloughing phagedena being prevalent in the hospital (and apparently in the neighbourhood, for some patients came in with it) it attacked some of them. It did not, however, commence first amongst the subjects of operation. See a clinical lecture on this subject, by Mr. Hawkins, in the Medical Gazette.

a day or two began to extend again. On the 4th of June, however, the complaint seemed to be finally arrested, and from this time she steadily improved, and an excellent stump was formed by granulation, and contraction of the skin over it. She was discharged convalescent on August 11.

27. The same day, Mr. Tatum amputated the thigh of Maria Lindley, aged 15, for disease of the knee-joint. She went on favourably, and on the 26th of May was so far recovered as to leave the hospital with the stump nearly healed, but she returned again in a few days with sloughing phagedæna. The flaps sloughed off, leaving the bone bare, and she was extremely ill for some time, but recovered, and left the hospital with a good stump.

28. May 6. Mr. Keate amputated the thigh of George Missen, a labourer, aged 26, for extensive and long-standing disease of the knee-joint. June 12, discharged convalescent—going into the country.

29. May 13. Mr. Cæsar Hawkins performed an operation for necrosis of the humerus, on George Uren, aged 16. The operation necessarily lasted a long time, but the boy was perfectly insensible throughout its duration. The wound healed extremely well. In a week the patient was going about the ward, and was soon quite well.

30. May 20. Mr. Keate operated on Sarah Perrott, aged 21, for necrosis of the tibia. Recovered.

31. Same day, Mr. Cæsar Hawkins removed an epulis from the mouth of George Patient, aged 34. Recovered. Left June 2.

32. Same day, also, Mr. Tatum amputated the leg of William Walsh, aged 22, much emaciated and very feeble, for scrofulous disease of the ankle. Recovered. Left the hospital July 7.

33. May 27. Mr. Cutler operated on Alfred Frith, aged 18, for necrosis of the tibia. Was soon well.

34. June 3. Mr. Tatum amputated the thigh of Ellen Benson, aged 14, for disease of the knee-joint of long duration: the cartilages were destroyed. On the 8th, she was going on favourably, but soon after this was attacked with sloughing phagedæna. The end of the bone had to be sawn off, and she remained for a long time in a very precarious state, with hectic and diarrhœa. After a time, however, her health improved somewhat, and she left the hospital on Aug. 4, to go into the country. On Sept. 14th, the nurse had heard from her friends that she was still improving.

35. June 10. Mr. Cæsar Hawkins removed a malignant tumor of the testis from Thomas Wild, aged 46. "This man was admitted May 5, with enlargement of the left testis, which commenced five months previously. It was about the size of an ostrich's egg, irregularly pyriform, dense, and hard, with some fluid in the tunica vaginalis above it. There was no pain, but some tenderness. The scrotal veins were not enlarged; the cord was apparently healthy. The epididymis and testis were not distinguishable. In the left breast, also, there was a tumor about the size of a small chesnut, not very hard, having an irregular corded surface, very moveable, unattached to the skin or nipple, and neither tender nor painful. The patient was thin, and had an unhealthy aspect. The appetite was bad, and pulse weak. His health improved considerably, and the tenderness diminished soon after admission.—10th. About an ounce of yellow albuminous fluid was let out of the tunica vaginalis by a grooved needle, and a course of mercury and sarsaparilla was commenced, but discontinued on the 30th, as the testicle increased in size under it.—June 10th. Castration was performed: the patient being placed under the influence of ether was perfectly insensible to the operation. The tumor removed was about five inches long, and two and a half in diameter. A section through it presented a purplish hue; it was composed of a soft pulpy substance, and much dark red fluid could be squeezed out of it. The centre was somewhat harder, yellowish, and intersected by white bands. No trace of the healthy structure of the testis could be discovered. The tunica vaginalis at the upper part contained about an

ounce of yellow fluid, and had the disease projecting into it. No headache or any other symptom followed the etherization, and for the six succeeding days the case progressed well.—15th. Some slight pain under the right scapula was complained of, but on the 17th, after having the previous evening suffered from slight chilliness, he was seized with some pain, unattended by tenderness, in the right ilium and lumbar regions, and frequent bilious vomiting and diarrhœa. The countenance was yellow, haggard, and anxious. Pulse accelerated, and tongue rather dry.—18th. All these symptoms continued, and there was tenderness on the right side of the abdomen, and no water having been passed for twelve hours, about half a pint loaded with lithates was drawn off.—19th. There were some swelling and tympanitis at the upper part of the abdomen, with very little pain. At 9 P.M. he died. For the last twenty-four hours the sickness was almost incessant; a black grumous matter being vomited."—ADOLPHUS J. GEE.

Examination, sixteen hours and a half after death.

"*General Appearances.*—The body was well formed, but emaciated. There was a hard swelling, about the size of a small egg, felt in the left breast, which, on being cut into, proved to be simple enlargement of the gland.

"*Thorax.*—In the cavity of the left pleura there was some thin bloody serum. The left lung was slightly congested, and filled with frothy serum. On the anterior surface of the middle lobe there was an encephaloid deposit of about the size of a nutmeg. There were two similar deposits in the middle lobe of the right lung. The heart was quite healthy.

"*Abdomen.*—There was a considerable quantity of pus in the peritoneal cavity. The intestines were glued together by bands of lymph. The vessels of the intestines were injected. There were several small deposits of a malignant nature on the lower part of the ileum. There was a large encephaloid tumor, of about the size of an orange, lying in the third and fourth lumbar vertebræ. The vessels were quite free, and lying behind it. All

the viscera were healthy."—Entered by Mr. Mackin, house-surgeon. GEO. POLLOCK.

36. The same day, Mr. Cutler amputated the middle finger of John Felton, aged 63, a countryman.—Cured. Left the hospital July 6.

37. June 17, Mr. Cæsar Hawkins amputated the thumb of Joseph Croker, aged 20, on account of scrofulous disease of the bones.—Recovered.

38. June 24, Mr. Cutler amputated the leg of John Gale, aged 19, for disease of the ankle-joint of six months' standing, having first lanced an abscess in it whilst he was insensible, and ascertained with the probe that the joint was extensively diseased.—Recovered. Left the hospital July 28.

39. The same day, Mr. Tatum operated on James Walters, aged 14, for necrosis of the tibia.—Recovered.

40. The same day, Mr. Tatum also reduced a dislocation of the shoulder, with the pullies, of ten weeks' standing, in Richard Rowlings, aged 31.—Recovered the proper use of the joint.

41. July 1, Mr. Cutler amputated the thigh of Mary Lessiter, aged 26, for extensive and long-standing disease of the knee, by which she was reduced to a very feeble state.—Improved from the time of the operation, and left the hospital August 24, in good health.

42. The same day, Mr. Cutler also amputated the leg of Henry Stanton, aged 44:—

"This patient, a stout hale man of temperate habits, was admitted June 9, with an irregularly-shaped, dark, and very painful ulcer over the tibia, about the middle of the left leg; the limb below it was indurated and swelled, and the ankle-joint was fixed. The ulcer was of thirty years' standing, and proceeded from a severe lacerated wound, caused by the shaft of a gig, exposing the bone, which frequently exfoliated. The ulcer remaining had

been productive of much suffering, and continued about the size of the palm of the hand, till a short time before admission, when it rapidly increased a third. The ulceration having ceased under the treatment, on the 1st of July amputation was performed, by the earnest desire of the patient. The operation was a long one, owing to the difficulty experienced in securing some of the vessels. The patient having inhaled ether, was insensible to the early part of it, but recovered consciousness during the application of the ligatures, the inhalation being discontinued, [under an impression that the operation was on the point of being concluded]. On examination, the tibia, immediately under the ulcer, was found to be thickened, carious superficially, its compact tissue very hard, and the cancelli softened. Considerable pain in the loins, to which it appeared he was subject, supervened shortly after the operation, and was the cause of a restless night. The following morning it still continued, and the urine was alkaline, but clear. The tongue was moist; pulse weak and regular. A draught of opium and ether relieved the pain, but at 9 A.M. of the 3d, a rigor, followed by heat and sweating, occurred, and a fatal train of symptoms rapidly appeared.—5th. The stump looked somewhat sloughy.—6th. The whole surface of it was affected with phagedæna. The urine was again acid, pulse 120, very weak, tongue clean and rather dry, and he sweated freely. About 2 P.M. on the 7th, he was seized with a second rigor, from which he did not recover: the lips continued pale, skin cool, and pulse imperceptible, and he died 6½ P.M."—ADOLPHUS J. GEE.

Examination, twenty hours after death.

"*General Appearances.*—The body was rather fat, and its surface exsanguine. The left leg had been amputated below the knee-joint. The stump was sloughy on its surface, with no evidence of granulation; above the wound the leg was rather œdematous.

"*Thorax.*—The lungs were crepitant and healthy throughout. The cavity of the pericardium contained a very small quantity of blood-stained serum. The heart was rather large and flabby, and

the structure soft, and lacerable without difficulty: there was much fat on its surface. The left ventricle was somewhat dilated, the walls not hypertrophied, but much fat mixed up with the muscular structure. The aortic valves were much thickened, and two of them so much affected and contracted, that they together were about the size of a healthy one; almost cartilaginous in structure, but free from atheroma. The right ventricle was considerably dilated, and its walls were extremely thin, in some places having very little muscular structure between the external and internal membranes, and the muscular structure throughout having a considerable proportion of fat mixed with it: the inner surface generally was blood-stained. The cavities contained some fibrinous and some black coagula.

"*Abdomen.*—The viscera were healthy.

"There was no inflammation of the femoral or iliac veins."—GEO. POLLOCK.

43. July 8, Mr. Henry Charles Johnson removed three encysted tumors from the scalp of a middle-aged woman (an out-patient). —Recovered.

44. July 22, Mr. Cæsar Hawkins operated on James Fry, aged 30, for necrosis of the tibia.—Recovered. (This case and the next are described at pp. 48 and 49).

45. The same day, Mr. Tatum performed lithotomy on Henry Hemson, aged 10 years. — Recovered without an untoward symptom.

46. August 5, Mr. Cæsar Hawkins removed four loose cartilages (one of them ossified, and as big as a seed of nux vomica) from the knee-joint of Francis Clayton, aged 27, a countryman, who had been troubled with the largest one eleven years. The operation was performed by getting the foreign bodies into a suitable position under the skin, and cutting directly upon them, and pressing them out.—Recovered. Left the hospital Sept. 1.

47. August 12, Mr. H. Charles Johnson operated for the

removal of an old and unsightly cicatrix from the lower lip of Christopher Woodward, aged 25.—Recovered.

48. August 19, Mr. Tatum performed an operation on Betsy Power, aged 17, for necrosis of the tibia.—Sept. 16. In good health, and wound fast filling up by granulations.

49. August 26, Mr. Cutler removed a scirrhous tumor situated in the cellular tissue, just above the right mammary gland, of Diana Jones, spinster, aged 49.—Recovered, and left the hospital Sept. 15.

50. Sept. 2, Mr. Henry James Johnson removed a scirrhous tumor of the mamma of Martha F——, aged 36. — Sept. 16. Going on well, filling up by granulation; a good deal of skin was affected, and had to be removed.

51. The same day, Mr. Henry Charles Johnson removed a scirrhous tumor from the breast of Sarah H ——, aged 45.—Sept. 16. Healing favourably.

52. The same day, Mr. H. C. Johnson also opened a deep-seated abscess of the mamma of Elizabeth R——, aged 40. She was placed on the operating table, and had the ether, as it was surmised that a larger operation might be found necessary.—Sept. 16. Nearly well.

In addition to the above operations, Mr. T. B. Bumpsted, house-surgeon at the hospital, has administered the ether in four cases of emergency, with the same kind of apparatus. One was a case of compound comminuted fracture of the thigh, occurring to John Lidgate, aged 26, on the 27th of July, in which Mr. H. Charles Johnson amputated high up, just below the trochanters. Another operation was an amputation of the arm, performed also by Mr. H. C. Johnson, on account of the brachial artery being opened by ulceration a few days subsequent to an accident to the elbow. The two remaining operations were for strangulated femoral hernia in women.—All the four patients recovered.

The following are the operations in which I have administered ether in University College Hospital:—

1. May 3, Mr. Liston performed lithotomy on Joseph Rice, aged 28, who had come from Australia to have the operation done. A ligature had to be applied to an artery in the anterior part of the wound—apparently an irregularly distributed branch of the pudic: the calculus was a globular mulberry one. The patient went on well. After the 26th, no more urine passed by the wound.—Discharged, cured, June 6.

2. The same day, Mr. Liston also removed a large encysted tumor, in a sloughing state, from the scalp of a woman, aged 72. —Recovered.

3. June 4, Mr. Liston performed excision of the elbow-joint of John Harris, aged 37, on account of extensive disease of the joint and surrounding parts, following an accident. The soft parts having been dissected off, the whole of the articulating part of the condyles of the humerus, the head of the radius, and the ulna (as low down as the coronoid process), were removed. Went on favourably.—Discharged, cured, July 27. Uses the hand, and has considerable power of flexion and extension.

4. June 5, Mr. Quain amputated the thigh of Charles P——, aged 12, for disease of the knee-joint of some years' standing. Antero-posterior flaps were made: pus flowed at the first incision, showing that the abscess extended up the thigh. The circular incisions were made so as to exclude the abscess.—Recovered favourably. Discharged, cured, in August.

5. June 7, Mr. Liston performed lithotomy on John Atkin, aged 70, in whom the presence of stone had been diagnosed eight years previously. A few hours after the operation there was some hæmorrhage from the bladder through the elastic tube, the urine passing by the side of the tube; but it ceased of itself. He suffered from pain and feverishness for a few days, but afterwards went on favourably, and left well on August 17.

6. The same day, Mr. Liston amputated the index finger of

Mary Mills, aged 25, at the metacarpo-phalangeal articulation, for spina ventosa of the proximal phalanx.—Discharged, cured, June 20.

7. June 18. Mr. Liston introduced a catheter for John Willis, aged 42, who had stricture of the urethra, caused by an injury twelve years ago. He passed his urine in a very small stream for the last three years, and latterly only by drops, and no catheter could be introduced. Mr. Liston intended to divide the stricture by cutting in the middle line of the perinæum, but when the patient was got fully under the influence of the ether in the fourth degree, a No. 1 catheter was introduced right into the bladder through the stricture, and the intended operation was not required. The catheter was tied, to retain it in the bladder. On the 23d it was removed, and No. 2 passed, and then No. 3, which was allowed to remain two hours: he could now pass his urine in a moderately-sized stream. He went on well till July 22, when he had an attack of suppression of urine. He recovered from this, and went out cured on the 27th of July, being able to pass his urine in a good stream.

8. June 26. Mr. Quain amputated the index finger of Joseph Phillips, aged 70, at its metacarpo-phalangeal articulation, for necrosis of the bones of the phalanges.—Became out-patient July 12: was cured.

9. The same day, Mr. Quain also amputated the leg of Robert Gray, aged 54, below the calf, for disease of the tarsus, caused by an injury two years and a half before. "There was considerable difficulty in securing the peroneal artery, which was retracted beneath the fibula. He was insensible during the operation, but owing to the length of time occupied in securing the arteries, the effect of the ether had almost passed off." The stump healed very well, but a few days after the operation, diarrhœa, to which he had been subject for two years, set in, and could not be permanently checked, and he died August 14. After death the mucous surface of the large intestine was found to be abraded at intervals in its whole length. It was of a dark slate colour in the greater

part, and where the slate colour was wanting, the vessels were injected. The gut was also much thickened. The small intestines were healthy, and the other viscera nearly natural.

10. July 2. Mr. Liston amputated the thigh of Belinda Norris, aged 15, for disease of the knee-joint of four years' duration. She was in a state of great debility, but her health improved from the day of the operation, and she was discharged, cured, in August.

11. The same day, Mr. Liston performed an operation on Emily Cannon, aged 5½ years, for scrofulous disease of the metatarsal bone of the great toe, removing it at the metatarso-tarsal joint.—Progressed favourably, and was made an out-patient in August.

12. The same day Mr. Liston reduced a recent dislocation backwards of the elbow, in a boy (an out-patient).—Cured.

13. July 9. (In a private ward of the hospital), Mr. Liston operated for prolapsus ani on A. H., a woman aged 27, removing some hæmorrhoids and folds of relaxed mucous membrane. —Cured.

14. The same day, Mr. Liston extracted a polypus from the nose of a young female.—Cured.

15. The same day, (in the operating theatre), Mr. Liston removed a diseased testicle from Joseph B., aged 47.—Discharged cured, August 14.

16. The same day, Mr. Liston performed lithotomy on Charles Butler, aged 10½ years, removing a mulberry calculus about the size of a bean. The child got rapidly well.

17. The same day, Mr. Liston amputated the ring finger of Sarah Powell, aged 14, at its metacarpo-phalangeal articulation, for disease of its first phalanx. Made out-patient, July 13.

18. July 23. Mr. Liston amputated the arm of George Aliston, aged 26. The arm had been affected with scrofulous disease for twenty years. It commenced in the elbow-joint, and extended to the fore-arm, hand, and fingers. The limb was much swollen,

and had several ulcers and fistulous openings in it. It was amputated by antero-posterior flaps, rather above the middle of the humerus. The patient, who was in a state of great debility from the disease, went on favourably till the 27th, when erysipelas attacked the stump. On the 28th, erysipelas attacked the face also; it subsided in a day or two, but the debility continued, with low muttering delirium, and he died August 1st.

Autopsy, twenty-six hours after death.

Body much emaciated. Old adhesions of the right pleuræ. Puckering of the apices of both lungs, and a cavity the size of a pea in the apex of the right one. Heart and other viscera healthy. Stump sloughy; flaps partly adherent, but loose from the bone, which was denuded of periosteum.

19. July 31. Mr. Quain amputated the thigh of James Godden, aged 27, for disease of the knee-joint of twenty years' standing. He was extremely ill and feeble at the time of the operation, but recovered favourably, and was discharged cured, Sept. 16.

20. Aug. 3. Mr. Quain removed a tumor from the front of the tibia of Sarah Howell, aged 19. Made out-patient, Sept. 8.

21. Aug. 11. Mr. Morton operated for stone in the bladder, on Mary Ann M—, aged 35.

"This patient was admitted 17th July, 1847; married six years, and of good constitution. Soon after a natural labour, two years and a half ago, she began to experience pain and heat during micturition. As the symptoms increased she was sounded in the country, but no stone was detected. About a year ago, she miscarried in the fifth month of pregnancy. About this time she was again examined twice, but no stone was discovered, and the disease was regarded and treated as one affecting the coats of the bladder. About this time, also, the urine began to deposit much mucous and phosphatic sediment. It was also alkaline, and contained some albumen and pus-globules. Mr. Morton examined her, and at once found a large rough stone. Aug. 11. She was

placed under the influence of ether by Dr. Snow, a Weiss's three-branched dilator introduced into the urethra, and that canal dilated to its full extent. The cervix vesica was then notched, in the direction of the rami of the pubes, to a limited extent, and the forefinger introduced into the bladder, and the parts still further dilated. The forceps were then introduced, and a large rough stone extracted, the patient having been perfectly insensible throughout the operation. By Mr. Liston's advice a tube was introduced into the bladder, and allowed to remain for twenty-four hours. The stone weighed iv. drs. xii. grs. Its long diameter was an inch and three quarters, its short diameter an inch and a quarter; the long circumference four inches, and the short one two inches and seven-eighths. Aug. 19. Hitherto she has had no incontinence of urine, and is quite well. Sept. 1. She left the hospital in good health, but she is not able to retain her urine so long as formerly, though this varies, as on some days she can do so for five hours at a time, whilst at other times she passes it every quarter of an hour."

22. Aug. 30. Mr. Liston dissected out a large tumor from the side of the face and neck of Thomas H—, aged 66. It dipped behind the angle of the jaw, and had been operated on before. The wound healed chiefly by the first intention.

23. Sept. 8. Mr. Liston performed lithotomy on Benjamin Bonsey, aged 76. The stone was about two inches in its long diameter. Sept. 16. Going on well to this time.

It is very evident, that in none of the six cases that ended fatally, out of the foregoing two lists, can the event have been caused, or in any degree promoted, by the inhalation of ether, since there are very sufficient and well-recognised causes to account for the result.

The case of Stanton, No. 42 in the first list, is particularly illustrative of the great safety of ether

under proper management, in cases which might be presumed te be the most unfavourable for its use. The disease of the heart in this man was very great, and etherization was carried to its full extent, and complete insensibility kept up for a quarter of an hour, yet not the least ill effect resulted from it; he completely recovered from the influence of the ether before he was removed from the operating table. The patient—a bad subject for the operation, undertaken at his particular request—was attacked with phagedenic ulceration, and died in one of the cold fits of the fever attending it; the strength of the heart being apparently insufficient to establish re-action.

The following Tables shew the result of the larger operations. One case of lithotomy is not included; as, although the patient is going on favourably, time enough has not yet transpired for the result to be declared.

1.—St. George's Hospital.

Operations.		No. of Cases.	Recoveries.	Deaths.
Amputations.	Thigh	11	9	2
	Leg	7	6	1
	Arm	1	1	0
	Fore-arm ..	2	2	0
	Total ...	21	18	3
Lithotomy.		2	2	0

2.—University College Hospital.

Operations.		No. of Cases.	Recoveries.	Deaths.
Amputations.	Thigh	3	3	0
	Leg	1	0	1
	Arm	1	0	1
	Total ...	5	3	2
Lithotomy .		3	3	0

3.—Both Hospitals combined.

Operations.		No. of Cases.	Recoveries.	Deaths.
Amputations.	Thigh	14	12	2
	Leg	8	6	2
	Arm	2	1	1
	Fore-arm ..	2	2	0
	Total ...	26	21	5
Lithotomy .		5	5	0

The first Table includes the two amputations in which Mr. Bumpsted administered the ether, and it comprises, I believe, all the amputations at St. George's Hospital since January 28, except one—an amputation of the leg after an injury, which was performed without ether, and I think in the night-time—(the patient

recovered). The deaths after all the twenty-six amputations, as shown in the third Table, are five, which is a little below 20 per cent. This is lower than the average mortality after the removal of diseased limbs; Dr. Lawrie's return of the Glasgow Infirmary, for instance, giving 24 per cent. (The mortality after amputations on account of injuries was 54 per cent. in his return.) The five cases of lithotomy all ended in recovery. There were six operations on the female breast at St. George's Hospital, in which the whole gland was removed, and the patients all recovered from the operation. Finally, after the fifty-six operations in this hospital, there were but four deaths; and after twenty-two operations in University College Hospital, but two deaths. Although this number of operations is not large enough to determine a question of this kind, yet it must be admitted that the results are so far very satisfactory, and tend to confirm the expectation which we might reasonably entertain beforehand, respecting the influence of ether over the patients' recovery.

APPENDIX.

The Notes refer to the Numbers in parentheses in the Text.

NOTE (1), p. 9.

THE circulation of the blood continues for a little time in animals after the respiration has been arrested by the influence of ether, and it ceases, apparently, from want of the respiration, and not from the direct effects of the ether. This I observed early in the year, but it was first made known by the Parisian physiologists. The reason of this, I believe, is not that ether is incapable of paralyzing the heart and blood-vessels, but that it sooner affects the medulla oblongata, and the nerves connected with it, than the ganglionic nervous system. Indeed, I have ascertained that such is the case, from observations I have made on frogs. If placed in air containing but 20 or 30 per cent. of vapour of ether, they very quickly become affected, probably from the rapid absorption of the vapour by the skin: in a minute or two the respiration ceases, and they have every appearance of being dead, except that the heart can be seen pulsating on the under side of the chest. If they are now withdrawn, the circulation continues, the ether gradually evaporates by the

skin, and respiration recommences, in a period varying from 5 to 15 minutes, according to the length of the previous exposure to the vapour: whilst, on the other hand, if they are allowed to remain in the air containing vapour, more ether continues to be absorbed, and in about five minues the heart ceases to beat perceptibly, although its pulsations would continue for hours without the respiration, even in a frog immersed in water that has been deprived of its air by boiling. Some slight vermicular contractions of the heart, that would be visible on dissection, continue for a little time, and if the frogs are withdrawn from the vapour during this interval, and kept moist, they may yet recover, although they sometimes show no signs of life for an hour and a half.

Although etherization and asphyxia resemble each other in some respects, yet the rapidity with which frogs are affected with ether, whilst they are so very slowly asphyxiated by privation of air, proves that they differ widely, and shows clearly enough that the effects of the vapour of ether are not due to its excluding part of the oxygen of the air by the space it occupies, as might at first, perhaps, be supposed. That such is not the way in which ether acts I ascertained in a more direct way in the beginning of the year, by supplying artificially the oxygen so displaced, when I found that the peculiar effects of ether were produced in animals just as readily as before. If hydrogen, nitrogen, or any neutral gas which does not support life, were mixed with the air, in even half the quantity that vapour of ether is commonly mixed with it, the oxygen of the air,

over-diluted, would fail to be imbibed into the blood in exchange for carbonic acid, and the patient would suffer asphyxia, the blood being arrested in its passage through the pulmonary capillaries. The oxygen is often reduced by the vapour of ether to 10 or 11 per cent. of what the patient breathes, whilst if it were reduced but to 16 per cent. by a gas which is not absorbed, no increased efforts of respiration would prevent asphyxia from quickly supervening.* That nothing of the kind takes place during the inhalation of ether depends on the circumstance that the vapour is absorbed as fast as it reaches the air-cells of the lungs, leaving the oxygen in its usual proportion per cent.; and to get enough of it the patient usually enlarges his respiratory movements instinctively, as he would do if situated on a high mountain, where the air is much rarefied.

Note (2), p. 11.

When air is admitted to a liquid containing ether, the liquid parts with some of its ether to the air; whilst, if air containing ether is admitted to a liquid containing none, it parts with some of its ether to the liquid; and in either case a balance is established. The interposition of a thin animal membrane between the liquid and air, like that between the blood and the air

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* See a paper "On the Pathological Effects of Atmospheres vitiated by Carbonic Acid Gas, and by a Diminution of the due Proportion of Oxygen."—*Edin. Med. Surg. Journ.*, Jan. 1846.

in the lungs, does not interrupt this interchange. The quantity of ether that a limited portion of air will withdraw in the form of vapour, from a liquid containing it, is determined by the temperature and the quantity in the liquid: for instance, if the liquid is saturated with ether, the air will become saturated also, for that particular temperature; if the liquid is half saturated, the air can only withdraw as much as will half saturate it; and so on, in a direct ratio, as I have ascertained by experiments. It is not improbable that some of the ether inhaled is decomposed in the body; but this does not alter the question of de-etherization in this manner, for assuredly by far the greater portion of the ether escapes by the breath unaltered.

Ether exists in the blood during etherization as a liquid, not as vapour. Although the temperature of the blood is a little higher than the boiling point of ether, yet it is capable of absorbing the vapour readily, and holding it in solution. 100 parts of water at 60° will hold in solution about 10 parts of ether, or rather more than 23 times their own volume of the vapour: at 100°—the temperature of the blood—water will absorb and hold in solution about half the above quantity, and it is capable of absorbing the vapour of ether, and holding it dissolved at all temperatures up to 212°, its own boiling point, but in a constantly diminishing quantity. Blood, on account of its density, absorbs less ether than water at corresponding temperatures; but it is capable of absorbing more than it has ever the opportunity of doing in the process of etherization.

NOTE (3), p. 25.

The quantity of water contained in washed ether is more than sufficient to saturate the driest air at any temperature at which it can be breathed; and that it does rise in vapour along with the ether, may be experimentally ascertained, by attaching two tubes containing chloride of calcium to an inhaler, or a Wolf's bottle, in which there is some ether, washed and not deprived of the water, and then passing air over the whole; when it will be found that the air, after parting with all its moisture to the chloride of calcium in the first tube, takes up water again along with the ether, and gives it up to the chloride in the second tube, in quantity increasing with the temperature.

NOTE (4), p. 30.

The size of the patient is the only circumstance which I have observed constantly to influence the quantity of ether required to produce insensibility, when the inhalation goes on steadily; if the inhalation is interrupted, however, more ether is used, as the process has to commence, in some measure, afresh. The man who was the subject of excision of the elbow-joint by Mr. Liston, in University College Hospital, might seem an exception to this. The ether was finished soon after the operation began, although ʒij. had been put into the inhaler; I found afterwards, however, that it had not been all inhaled, but that a great part of it (owing to an irregularity in the volute of the inhaler I was using, by which the passage for air was much con-

tracted at one place), had been splashed into the elastic tube, whilst the patient was breathing deeply and forcibly. Females generally consume less ether than males, but then they are usually of less stature and weight. Hard drinkers do *not* appear to require more ether than others, and are not more difficult to render insensible. The time occupied in producing complete insensibility varies with the activity and depth of the respiration; but it seldom exceeds two to three minutes in a child, or four to six minutes in an adult, when the inhalation is not interrupted; unless the vapour gets diluted to a greater extent, by the valve being kept open, or the face-piece not fitting, or by some other means.

Note (5), p. 35.

There is no difficulty in distinguishing voluntary motion from excito-motory movements, or the rhythmic automatic ones, in a patient who is unconscious of what is occurring around. Voluntary motion is recognized as such at once, even in an animalcule under the microscope, but much more readily in one's own species. Both sensation and voluntary motion may exist in the second degree of etherization without consciousness, as in natural sleep, when a person feels the heat or the cold, and pushes off the coverlet, or folds it closer round him, according to circumstances, without waking; consequently, the assertion of the patient that he has had no pain is not to be considered a proof that there has been none, in cases where there have been unequivocal demonstrations of it. On the

other hand, every little struggle or moan must not be considered a proof of pain, since it may be independent of the operation, or merely excito-motory, or the result of very obscure sensation. And when cries expressive of pain do occur, they must not be taken as a measure of the pain, for when the patient is unconscious he is not using the slightest self-control. There is no room for an opinion that the patients generally have pain, and are unconscious or oblivious of it; for when the ether is well administered, there is generally no expression of any kind by the features or voice, and a number of patients recover their mental faculties and special senses, whilst the sensibility is still so far blunted that the minor parts of an operation cause no pain.

NOTE (6), p. 45.

Dr. Pring, of Weston-super-Mare, found (as he stated in the Lancet, May 1st), that ether will render arterial blood dark-coloured, and impair its coagulation out of the body; but a much larger quantity of ether was no doubt introduced than enters the blood during inhalation.

NOTE (7), p. 52.

The method of giving ether with no other appliance than a sponge placed over the mouth and nostrils, which was introduced by Dr. Smith, of Cheltenham, is one that will succeed in causing insensibility; and this is a happy circumstance that will extend the use of ether to many cases of emergency, in which otherwise the patients might be deprived of its benefits. In the

cases of infants it is perhaps the best way of exhibiting ether, but for children of two years of age and upwards I have a small face-piece, and prefer to use the inhaler. The simple sponge is preferable, for all cases, to many of the apparatuses which were in use, and Dr. Morton, of Boston, U. S. (as appears by a communication he sent to the Lancet), uses it in preference to the inhaler he at first employed ; but I cannot admit that it is equal to a good apparatus. It is an expensive means, as not one-half of the ether which is dissipated enters either the mouth or nostrils of the patient; and it is a means which does not admit of any kind of regulation as regards the strength of the vapour.

In large operations on the face, like that described at page 52, the administration of the vapour of ether per rectum—the method of Prof. Pirogoff, of St. Petersburgh—would certainly be better than inhalation, if it is equally safe and manageable. The Professor, (I think I have read so), has removed the superior maxillary bone, under the influence of ether exhibited in this way. He recommends this plan, indeed, in all cases, as preferable to inhalation, on account of certain disadvantages and discomforts which he considers attend the latter; but, in all probability, he has not seen inhalation practised with a good apparatus, and I have not had sufficient experience of his method to be able to speak of its merits.

THE END.

WILSON AND OGILVY, PRINTERS, 57, SKINNER STREET, SNOWHILL.

EUROPE GOES TO SLEEP

News of Bigelow's report reached England, and on December 19, 1846, the first ether anesthetic was administered. The effect was figuratively explosive. This is what had been sought for centuries. While America was arguing over the "real" discoverer, much progress was made in Europe. Representative of this are the contributions of Sir James Young Simpson and the alpha of physician anesthetists, John Snow.

27.

Snow, John (1813-1858)

On the Inhalation of the Vapour of Ether in Surgical Operations.

London, John Churchill, September, 1847.

(The copy shown was Snow's personal copy, and is one of only six original copies extant.)

This practical treatise deals with degrees of etherization and equipment. Many questions are raised, which will be the subject of his later extensive investigations.

man did the work. This was no exception; Dr. Cupples surveyed the surgical practice of 138 surgeons in Texas, and compiled information on 4,293 operations. There were 3,547 anesthetics listed with only one death. Some of our modern hospitals would be hard-pressed to show better statistics. This is a remarkably well done survey, and some of its motivation may have come from the following paragraph contained therein.

> "If the whole truth must be told, the writer of this Report remembers to have read in the London Lancet some years ago — "What good (professionally, that is) can come out of Texas?" and he has it very much at heart to answer the sneer of the great London journal by proving, from a survey of their work, that the surgeons of Texas, country doctors though they be, though no long string of academic honors illustrate their names, are second to those of no country in the variety, the boldness and the success of their operations, in practical skill, in fertility of resources, and in that self-reliance founded on knowledge, without which no man can be a successful surgeon."

36.

Possibly not medical, but certainly "anesthesiological," the following supposedly true story is told by Colonel May, a member of the Cavalry, stationed at Ft. Mason, on the Llano River in 1850.

> "Soon after the peculiar properties of choloroform became known, a quantity of it came into the possession of Colonel May, commanding Fort Mason. One day he assured his redskin visitors that he could kill a man and restore him to life at pleasure, and proposed to experiment on one of their number. To this they grunted serious objections, but consented to let him try his skill on a small dog that accompanied them. Taking it into an adjoining tent, he soon returned with it apparently dead; and to convince them that

PEMBROKE COLLEGE,
OXFORD.

10th November, 1939.

My dear Paul,

Just a short note to acquaint you of my safe arrival in this country where I find things are very unchanged. I want to thank you for the courtesy you extended to me in inviting me to be present at the Examination of the American Board. Would you, too, convey my greetings to Harriet and tell her how sorry I was to have missed her during my fleeting visit.

I am getting John Snow's genealogical tree written out and will enclose it in a letter to you shortly so that you can stick it in his book on ether.

Later. John Snow's books & diplomas were in the possession of his sisters Hannah & Mary. When they died these were left to their great nephew John Snow who handed them on to us.

Love to you both!

John Snow

R.R.Macgregor

Dr. Paul M. Wood,
131, Riverside Drive,
New York City,
U.S.A.

27 April 1951.
The book opposite, an ether, was John Snow's personal copy, passed on to me by his great nephew, John Snow, Solicitor, in Oxford. RRM