

ON THE INHALATION OF THE VAPOUR OF ETHER IN SURGICAL OPERATIONS

By JOHN D. SNOW

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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 circumstances. 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 the 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 excitatory 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 becomes 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 circum-

stances. 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 the 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.

(To be continued)