ON CHLOROFORM AND OTHER ANÆSTHETICS
THEIR ACTION AND ADMINISTRATION

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The most convenient position in which the patient can be placed whilst taking chloroform is lying on the back, or side, as he is then duly supported in the state of insensibility, and can be more easily restrained if he struggle whilst becoming insensible. The semi-recumbent posture on a sofa does very well, and there is no objection to the sitting posture, when that is most convenient to the operator. In that case, however, the patient should be placed in a large easy chair with a high back, so that the head as well as the trunk may be supported without any effort, otherwise he would have a tendency to slide or fall when insensible. It has been said that it is unsafe to give chloroform in the sitting posture, on the supposition that it would in some cases so weaken the power of the heart, as to render it unable to send the blood to the brain. Observation has proved, however, that chloroform usually increases the force of the circulation; and although the horizontal position is certainly the best for the patient under an operation in all circumstances, I consider that the sitting posture is by no means a source of danger, when chloroform is given, if the ordinary precaution be used, which would be used without chloroform—that of placing the patient horizontally if symptoms of faintness come on. I have preserved notes of nine hundred and forty-nine cases in which I have given chloroform to patients in the sitting posture, and no ill effects have arisen in any of these cases.

The person who is about to inhale chloroform is occasionally in a state of alarm, either about the agent itself or the operation which calls for its use. It is desirable to allay the patients fears, if possible, before he begins to inhale, as he will then be able to breathe in a more regular and tranquil manner. In a few cases, however, the apprehensions of the patient cannot be removed, and they subside only as he becomes unconscious from the inhalation. It has been said that chloroform ought not to be administered if the patient is very much afraid, on the supposition that fear makes the chloroform dangerous. This is, however, a mistake; the danger, if any, lies in the fear itself. Two cases will be related hereafter in which the patients died suddenly from fear, whilst they were beginning to inhale chloroform, and before they were affected by it; but the probability is that, if they had lived till the chloroform took effect,
they would have been as safe as other patients who inhaled it. If chloroform were denied to the patients who are much afraid, the nervous and feeble, who most require it, would often be deprived of its benefits. Moreover, the patients would, either be prevented altogether from having the advantage of surgery, or they would be subjected to the still greater fear of the pain, as well as the pain itself; for whatever undefined and unreasoning fears a patient may have when the moment comes for inhaling chloroform, he has only chosen to inhale it on account of still greater fear of pain.

Fear and chloroform are each of them capable of causing death, just as infancy and old age both predispose to bronchitis, but it seems impossible that fear should combine with the effects of chloroform to cause danger, when that agent is administered with the usual precautions. Fear is an affection of the mind, and can no longer exist when the patient is unconscious; but the action of that amount of chloroform which is consistent even with disordered consciousness is stimulating, and increases the force and frequency of the pulse, in the same way as alcohol. I believe that no one would assert that a person would die the sooner of fright for having taken a few glasses of wine, or a small amount of distilled spirits, whatever might be the state of his health. When chloroform has been absorbed in sufficient quantity to cause unconsciousness, fear subsides, and with the fear its effects on the circulation. It is a subject of almost daily observation with me that the pulse, which is extremely rapid from some ill defined apprehension, when certain patients begin to inhale chloroform, settles down to its natural frequency after they have become unconscious.

The practice I have always followed has been to try to calm the patient, by the assurance that there was nothing to apprehend from the chloroform, and that it would be sure to prevent all pain; but where it has been impossible to remove the fears of the patient in this way, I have always proceeded to remove them by causing a state of unconsciousness. It would of course be wrong to choose a moment for beginning the inhalation, when fear was producing a very marked depression of the circulation. On feeling the pulse of a gentleman, about twenty-one years of age, in March 1855, who had just seated himself in the chair to take chloroform, previous to having some teeth extracted, by Mr. Thos. A. Rogers, I found it to be small, weak, and intermittent, and it became more feeble as I was feeling it. I told the patient that he would feel no pain, and that he had nothing whatever to apprehend. His pulse immediately improved. He inhaled the chloroform, had his teeth extracted, woke up, and recovered without any feeling of depression. Now if the inhalation had been commenced in this case, without inquiry or explanation, the syncope which seemed approaching would probably have taken place, and it would have had the appearance of being caused by the chloroform, although not so in reality.

**MODE OF ADMINISTERING CHLOROFORM**

The experiments previously related show that air containing rather less than two grains of chloroform, in one hundred cubic inches, is capable of causing a state of insensibility, sufficiently deep for surgi-
cal operations; but in a creature the size of the human being, an inconvenient length of time would be occupied in causing insensibility with vapour so much diluted. About four cubic inches of vapour, or rather more than five grains of chloroform to each hundred cubic inches of air, is the proportion which I have found most suitable in practice for causing insensibility to surgical operations. In medical and obstetric cases, it should be inhaled in a more diluted form.

Dr. Simpson recommended chloroform to be administered on a handkerchief—the method in which sulphuric ether was administered by Dr. Morton, in the first case in which he exhibited that medicine. The objection to giving chloroform on a handkerchief, especially in surgical operations, where it is necessary to cause insensibility, is that the proportions of vapour and of air which the patient breathes cannot be properly regulated. Indeed, the advocates of this plan proceed on the supposition that there is no occasion to regulate these proportions, and that it is only requisite that the patient should have sufficient air for the purposes of respiration, and sufficient chloroform to induce insensibility, and all will be right.* The truth is, however, that if there be too much vapour of chloroform in the air the patient breathes, it may cause sudden death, even without previous insensibility, and whilst the blood in the lungs is of a florid colour. Chloroform may indeed be inhaled freely from a handkerchief without danger, when it is diluted with one or two parts by measure of spirits of wine, but the chloroform evaporates in largest quantity at first, and less afterwards, until a portion of the spirit is left behind by itself. The process, however, of inhaling chloroform from a handkerchief is always uncertain and irregular, and is apt to confirm the belief in peculiarities of constitution, idiosyncrasies and predispositions, which have no existence in the patient.†

The most exact way in which it is practicable to exhibit chloroform to a patient about to undergo an operation, is to introduce a measured quantity into a bag or balloon of known size, then to fill it up by means of the bellows, and allow the patient to inhale from it; the expired air being prevented from returning into the balloon, by one of the valves of the face-piece to which it is attached. I tried this

* According to Professor Miller, chloroform was given, at one time, in the Royal Infirmary of Edinburgh, in a somewhat slovenly, and not very cleanly manner; he describes the means of applying it as, "anything that will admit of chloroform in vapour being brought fully in contact with the mouth and nostrils a handkerchief, a towel, a piece of lint, a worsted glove, a nightcap, a sponge." He says, "In the winter season, the glove of a clerk, dresser, or onlooker, has been not unfrequently pressed into the service. . . . The object is to produce insensibility as completely and as soon as we can; and there is no saying, a priori, whether this is to be accomplished by fifty drops or five hundred. We begin with generally two or three drachms spilt on the handkerchief or lint; and we refresh that, or not, from time to time, as circumstances require." Surgical Experience of Chloroform, Edin., 1848, pp. 16 and 17. The italics are not in the original.

† Curious arguments are sometimes used in support of the idea of peculiarities and idiosyncrasies. A medical man informed me, one day, that he had seen a patient inhale an ounce of chloroform without any effect. I expressed my opinion that if she had taken the vapour of one drachm into her lungs within four minutes, or the vapour of a little more than half a drachm within two minutes, she would have been insensible; and that the chloroform had mostly evaporated into the room, without entering the patient's lungs. Then, he said, it would have made all of us insensible. Now to change the air of a moderately sized room of twenty feet square and ten feet high, uniformly with only a grain and a half of chloroform to each hundred cubic inches, so that, if all crevices were closed, a person inside might in course of time, absorb about eighteen minims of the medicine, and be rendered insensible, would require nearly fifteen pounds of chloroform.
plan in a few cases, in 1849, with so much chloroform in the balloon as produced four per cent. of vapour in proportion to the air. The effects were extremely uniform, the patients becoming insensible in three or four minutes, according to the greater or less freedom of respiration; and the vapour was easily breathed, owing to its being so equally mixed with the air. I did not try, however, to introduce this plan into general use, as the balloon would sometimes have been in the way of the surgeon, and filling it with the bellows would have occasioned a little trouble. It seemed necessary to sacrifice a little of absolute perfection to convenience, and I therefore continued the plan which I had already followed.

The great point to be observed in causing insensibility by any narcotic vapour, is to present to the patient such a mixture of vapour and air as will produce its effects gradually, and enable the medical man to stop at the right moment. Insensibility is not caused so much by giving a dose as by performing a process. Nature supplies but one mixture of diluted oxygen, from which each creature draws as much as it requires, and so, in causing narcotism by inhalation, if a proper mixture of air and vapour is supplied, each patient will gradually inhale the requisite quantity of the latter to cause insensibility, according to his size and strength. It is indeed desirable to vary the proportions of vapour and air, but rather according to the purpose one has in view, whether medicinal, obstetric, or surgical, than on account of the age or strength of the patient; for the respiratory process bears such a relation to the latter circumstances, as to cause each person to draw his own proper dose from a similar atmosphere in a suitable time.

The inhaler represented in the adjoining engraving is, with some slight alterations, the same that I have employed since the latter part of 1847. It is made of metal, and consists of a double cylinder, the outer space of which contains cold water, and the inner serves for the evaporation of the chloroform which the patient is to breathe. Into the inner part of the cylinder there is screwed a frame, having numerous openings for the admission of air, and four stout wires which descend
nearly to the bottom of the space, and are intended to support two coils of stout bibulous paper, which are tied round them, and reach to the bottom of the inhaler. In the lower part of this paper four notches are cut, to allow the air to pass in the direction indicated by the arrows. As the quantity of chloroform which is put in should never fill the apertures or notches, the air which passes through the inhaler meets with no obstruction whatever. There is a glass tube communicating with the interior of the inhaler, and passing to the outside, to enable the operator to see when the chloroform requires to be renewed. The elastic tube which connects the inhaler to the face-piece is three-quarters of an inch in internal diameter, to allow the passage of as much air as the patient can possibly breathe. On the introduction of the practice of inhaling sulphuric ether there was no tubing in this country fit to be breathed through; that in ordinary use was only about one-third, or three-eighths of an inch in diameter,—not more than a quarter of the proper calibre.

The face-piece, to include both the mouth and nostrils, of which that shown in the engraving is one of the modifications, is one of the greatest mechanical aids to the process of inhalation which has been contrived in modern times. Dr Francis Sibson is its inventor. Dr Hawkesley did indeed contrive a very similar one about the same time as Dr. Sibson,—early in 1847,—but he did not make it known. Dr. Ingen Housz made patients inhale oxygen through the nostrils by means of a bottle of India rubber with the bottom cut off; and Mr. Waugh, of Regent Street, had more recently contrived a mouth-piece to be adapted outside the lips, but the usual practice of inhalation previous to 1847, was for the patient to draw in the medicated air by means of a tube placed in the mouth. This led generally to great awkwardness at first, as the patient usually began to puff as if he were smoking a pipe; and it had the further inconvenience, in the administration of ether, that the tube dropped from the mouth, and the patient began to breathe by the nostrils, just as he was getting unconscious. The sides of the face-piece delineated in the engraving are made of thin sheet lead, which is pliable, and enables it to be adapted exactly to the inequalities of the face and the patient can breathe either by the nostrils or mouth, just as his will, or instinct, or other nervous functions, determine.

I have introduced two valves into this face-piece, one which rises on inspiration, to admit the air and vapour from the inhaler, and closes again on expiration, and the other which rises to allow the expired air to escape. I contrived the latter valve to turn more or less to one side, as indicated by the additional line in the engraving, and thus admit more or less of the external air to dilute still further that which passed through the inhaler, and become charged with vapour. By this means the patient can begin by breathing air containing very little vapour, and more and more of the air which has passed over the moistened bibulous paper can be admitted, as the air passages become blunted to the pungency of the vapour.

The object of the water bath is to supply the caloric which is rendered latent, and carried off, as the chloroform is converted into vapour, and thus to render the process of inhalation steady and uniform.
Without the water bath, the evaporation of the chloroform would soon reduce the temperature of the inhaler below the freezing point of water, and limit very much the amount of vapour the patient would inhale; and if the apparatus were warmed by the hand, the temperature would be too high, and the amount of vapour too great. A medical author of great reputation in Paris sent to inquire at what temperature I used the water bath, and being informed, at the ordinary temperature, published his opinion that it had no effect, and might as well be left off. He appeared not to have considered the relations of heat, either to liquids or vapours.

In arranging the bibulous paper in the inhaler, it is my object to contrive that the air passing through, in the ordinary process of inhalation, and at the ordinary temperature of about 60°, shall take up about five per cent. of vapour. This quantity can be diminished, as much as is desired, by turning the expiratory valve on the face-piece a little to one side; and in winter I usually place a short coil of bibulous paper against the outer circumference of the inside of the inhaler, in addition to the central coils which are delineated.

I commonly put two, or two and a half, fluid drachms of chloroform into the inhaler at first. About a drachm of this is absorbed by the filtering paper, and the rest remains at the bottom of the inhaler; and in a protracted operation, when it is seen, by means of the glass tube, that the latter part of the chloroform has disappeared, more is added, by a drachm or so at a time, to prevent the paper ever becoming dry. Mr. Matthews, 8, Portugal Street, Lincoln's Inn Fields, makes the inhaler. There are smaller face-pieces for children. The patient never inhales in so upright a posture as the artist has represented.

There are several other kinds of apparatus in use for the inhalation of chloroform. The most usual consist of Dr. Sibson's face-piece more or less altered, and with a small piece of sponge placed inside. The apparatus which is in most reputation on the continent is that of M. Charrière; it consists of a glass vase with suitable valves, and a fabric for exposing a surface wetted with chloroform to the air which passes through it.

M. Duroy, of Paris, has contrived an ingenious, but very complicated apparatus, which he calls an anaesthesimeter. The object of it is to regulate the amount of chloroform which is inhaled in a given time, and this can be varied from four to sixty drops in the minute; but the experiments which I have related show that the quantity of chloroform employed is not so important as the proportion of it in the inspired air; and although each of these circumstances has considerable influence over the other, in many cases there are conditions in which no regular relation exists between them. For instance, if the inhaler were supplied with sixty drops of chloroform per minute, these sixty drops weigh twenty grains, and produce 15.3 cubic inches of vapour; and if an adult patient were breathing the average quantity of four hundred cubic inches per minute, the air he would breathe would contain nearly four per cent. of vapour, which would answer extremely well; but if the breathing were slow or feeble, or if he should hold his
breath for an interval and commence again, he might breathe air much more highly charged with vapour. Indeed it would depend on the amount of surface moistened with chloroform, the temperature of the air, and other physical conditions, whether or not the air he inhaled might not be charged with chloroform to a dangerous degree; whilst, on the other hand, if the breathing were deep and rapid, as often happens whilst the patient is getting slightly under the influence of the chloroform;—if, for instance, the patient were to breathe at the rate of 1,600 cubic inches, instead of 400, the air he would inhale would contain less than one per cent. of vapour, and he would not become insensible with the utmost supply of the anaesthetometer, till his breathing should be moderated. M. Duroy also follows the rude and objectionable plan of using a nose clasp, and thus compelling the patient to breathe by the mouth alone.

It is advisable to request the patient to breathe gently and quietly, when he commences to inhale chloroform; in other words, to do nothing but conduct himself as if he were about to fall asleep naturally; for, if he breathes deeply, the vapour feels much more pungent than it otherwise would do, and is apt to excite coughing, or a feeling of suffocation.

In using the inhaler described above, the patient should commence to inhale with the expiratory valve of the face-piece turned to one side, and it should be gradually advanced to the required extent, over the opening it is intended to cover, as the sensibility of the lungs becomes diminished. Not only patients with phthisis or bronchitis, but many sensitive and irritable persons with sound lungs, have a great intolerance of the vapour of chloroform at first, on account of its pungency; and it is necessary to occupy two or three minutes in gradually commencing the inhalation, before the patient makes any appreciable progress towards insensibility. In administering chloroform to children also, it is desirable to begin very gently; by this means, and with a little persuasion, one generally succeeds in getting them to inhale voluntarily; although, occasionally, it is necessary to use a little force to accomplish one's purpose.

(To be continued)