ETHER ANAESTHESIA

1842 – 1900*

By

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Pre-anaesthetic History

The first man to give an unequivocal description of the distilling of ether from sulphuric acid and alcohol was Valerius Cordus,¹ about the year 1540. Cordus called ether "sweet oil of vitriol," and his account of his method of preparing it and of its properties (see Fig. 1) has been translated by Guy K. Tallmadge as follows:

"Take six fluid ounces of strong, very biting, thrice purified wine, and the same quantity of sour oil of vitriol. Mix in a Venetian glass, and place in a small gourd with a narrow mouth, and seal the mouth with clay. Set aside thus for a whole month, or two. Then pour out into a gourd to which should be immediately connected, and sealed by the heat of the fire, an alembic (that is, *ein kolb mit einen angeschmeltzen helm*), which we illustrate below; now place in a small furnace and half cover it with ashes. After this, apply a receiving vessel and carefully close the joint with clay, and extract the six fluid ounces of strong wine which you added. But, so that this may be done safely, place into a bath of Maria: thus the wine alone will ascend, without the oil. When you shall have extracted in the bath the six fluid ounces of strong wine which had been added, place the residue in the furnace so that sand is heaped up to the middle part of the gourd, and, having applied a new, small, empty receiving vessel, carefully seal the joint with clay. Now make a slow fire, and slowly extract all of the moisture which remains in the gourd, until liquid no longer appears in the bottom, always using the greatest care and watchfulness that you so moderate the fire that the boiling liquid never reaches the tube of the alembic. . . . When you have completed the slow extraction, at once remove the receptacle, with its liquid, and you will see that it contains two substances, namely, an aqueous liquid and an oily, fatty one. You should separate one from the other at once, however, so that no aqueous substance remains in the oil, for that water spoils the oil. The oil itself generally floats upon the water, especially if the wine shall have first been entirely extracted upon the bath, but you can easily distinguish the oil from the water

by touch. For the oil is greasy; the water not at all so. Then preserve the separated oil for further use.

The Properties of the Substance which has been Separated

"It has all of the properties of sulphur, but all of them are more pronounced because it penetrates liquids more easily, and hastens actions, which sulphur cannot do because it is impeded by its own solidity and dryness, by which it is less penetrating. This, indeed, this oil can do better than sulphur, wherefore it is especially valuable for all putrefactions in the body, and particularly for the plague. It draws the pus and mucus from the lung in pleurisy, peripneumonia and hacking cough, for it may be securely taken internally, and without any danger. It does not cause stones to form, either in the kidneys or in the urinary bladder; it heals an exulcerated urinary bladder. Its dose is one or two drops, or three mixed in a moderate quantity of wine. It may be mixed, moreover, into pills and electuaries made of sugar. It must be carefully preserved, however. For only a little is got from a pound of sour oil of vitriol, and because of the tenuity of its nature it easily evaporates."²

The name *ether* seems first to have been applied to the liquid by August Siegmund Frobenius.³ He demonstrated various of its properties, real and imaginary, before the Royal Society during February of the year 1730. Among Frobenius's experiments on that occasion was one to show "that this *Æther* may be preserved best . . . under the Receiver in *Vacuo*, whereas on the contrary, exposed to the open Air, its Parts soon evaporate, and its whole Bulk . . . vanishes." Upon which the Royal Society's reporter commented, "This experiment fail'd remarkably." In another experiment with ether Frobenius showed that "a little of it poured on the Surface of the Hand, affects it with a Sense of Cold equal to that from the Contact of Snow, and blow upon it but once or twice with your Mouth, immediately your Hand becomes dry. Beware however of approaching a lighted candle with your Hand thus wet, lest it take Fire and burn you"—to which account is appended the comment, "Succeeded."

During the last decade of the eighteenth century, after Lavoisier had elucidated the true nature of respiration and had shown the part played in it

*Some of the material relating to inhalation anaesthesia contained in this article is based on Dr. Duncum's book, *The Development of Inhalation Anaesthesia with Special Reference to the Years 1846–1900*, now in course of publication by the Oxford University Press for the Wellcome Historical Medical Museum.

by oxygen and carbon dioxide, and after Priestley had inhaled oxygen, a new therapeutic vogue came into being. This was pneumatic medicine, in which various gases and vapours—among them sulphuric ether—were inhaled in order to cure not only physical complaints, particularly pulmonary ones, but also such mental ailments as melancholy. Pneumatic medicine had its origins in part in the very brilliant circle of learned men centred in Birmingham, of whom Priestley was one. It culminated in the founding by Thomas Beddoes, of the Pneumatic Institution at Clifton, Bristol.

Describing, for example, the method of inhaling ether devised by the physician R. J. Thornton, about 1795, Beddoes wrote:

"The manner of inhalation is very simple. Two tea-spoonfuls of æther are put into a tea pot. This is held near a candle, and the thumb is put over the spout. When the vapour begins to press on the thumb, it [the spout] is transferred to the mouth, and air is drawn into the lungs. This is repeated until the whole be consumed, or ease acquired."⁴

Beddoes added a warning that "the vapour of æther is inflammable in air."

After Humphry Davy's demonstrations at the Pneumatic Institution (of which he became Superintendent in 1798, at the age of nineteen) that inhaled nitrous oxide—in addition to other, more weighty, physiological considerations—was capable of inducing a state which was both pleasurable to the subject and entertaining to onlookers, the "laughing gas" was very frequently inhaled for amusement's sake.

A similarity in the effects of nitrous oxide and of ether vapour when inhaled was pointed out in 1818 in the *Journal of Science*, of which Michael Faraday was then editor.

"When the vapour of ether mixed with common air is inhaled, it produces effects very similar to those occasioned by nitrous oxide. A convenient method of ascertaining the effect is obtained by introducing a tube into the upper part of a bottle containing ether, and breathing through it; a stimulating effect is at first perceived at the epiglottis, but soon becomes very much diminished, a sensation of fulness is then generally felt in the head, and a succession of effects similar to those produced by nitrous oxide. By lowering the tube into the bottle, more of the ether is inhaled at each inspiration, the effect takes place more rapidly, and the sensations are more perfect in their resemblance to those of the gas. . . .

"It is necessary to use caution in making experiments of this kind. By the imprudent inspiration of ether, a gentleman was thrown into a very lethargic state, which continued with occasional periods of intermission for more than thirty hours,

and a great depression of spirits; for many days the pulse was so much lowered that considerable fears were entertained for his life."⁵

These effects were quoted in 1839 by the pharmacologist, Jonathan Pereira,⁶ and he recounted also that "the chemist Bucquet, who died of schirrhous of the colon, with inflammation of the stomach and of the intestines generally, took, before his death, a pint of ether daily to alleviate his excruciating pains."

Referring to the inhalation of ether vapour, Pereira noted its use "in spasmodic asthma, chronic catarrh, and dyspnoea, whooping cough, and to relieve the effects caused by the accidental inhalation of chlorine gas." He stated that the physiological effects "have not been determined," and described how, after giving fifteen drops to a young rabbit, its death took place within an hour. "The symptoms were indisposition to move, apparent tendency to sleep, followed by incapacity of supporting the erect position, occasional convulsive movements, grating of the teeth, and insensibility."

The Trial of Ether as an Anaesthetic

At the time when Pereira wrote, and during the next few years, the inhalation both of nitrous oxide and of ether vapour not for therapeutic reasons, but as a form of entertainment was extremely popular, especially in the United States of America. Indeed, in May 1846, the *Lancet* quoted the *Western Journal* in which "Dr. Miller calls attention to the pernicious effects of the inhalation of this vapour [ether]—a habit which seems to prevail among young persons in some districts of the United States."⁷

Such an ordinary gathering and its very unusual results were described by the young general practitioner Crawford Williamson Long:

"In the month of Dec. 1841, or in Jan. 1842, the subject of the inhalation of nitrous oxide gas was introduced in a company of young men assembled at night in the village of Jefferson, Ga., and the party requested me to prepare them some. I informed them I had not the requisite apparatus for preparing or preserving the gas, but that I had an article (sul. ether) which would produce equally exhilarating effects and was as safe. The company were anxious to witness its effects, the ether was introduced and all present in turn inhaled. They were so much pleased with its effects that they afterwards frequently used it and induced others to do the same, and the practice soon became quite fashionable in the county and some of the contiguous counties.

"On numerous occasions," Long added, "I inhaled ether for its exhilarating properties, and would frequently, at some short time subsequent

to its inhalation, discover bruised or painful spots on my person which I had no recollection of causing and which I felt satisfied were received while under the influence of ether. I noticed my friends while etherized received falls and blows which I believed were sufficient to produce pain on a person not in a state of anaesthesia, and on questioning them they uniformly assured me that they did not feel the least pain from these accidents. Observing these facts I was led to believe that anaesthesia was produced by the inhalation of ether, and that its use would be applicable in surgical operations."⁸

How Long then, in March 1842, poured ether on to a folded cloth and caused the boy, James Venable, to inhale the vapour so that he became sufficiently insensible to allow two small tumours to be painlessly removed from his neck is well known. So also is the not dissimilar sequence of events which, in December 1844, led Horace Wells to conceive and put into practice the idea of inhaling nitrous oxide to obtund the pain of dental extractions. That he should have failed to produce satisfactory anaesthesia in his patient during the demonstration at the Massachusetts General Hospital in Boston, arranged through his former dental partner, W. T. G. Morton, was a piece of extremely bad luck.

When in the summer of 1846 Morton himself decided to experiment in obtunding the pain of tooth extractions, it is not so very surprising that he should have chosen sulphuric ether as his anodyne agent. Indeed, he had actually used liquid ether in 1844, at the suggestion of his former chemistry tutor, C. T. Jackson, as a local application to deaden pain in a tooth.

In his first clinical trial of etherisation, when on September 30, 1846, he painlessly extracted Eben Frost's aching tooth, Morton poured the ether on to a folded cloth. He had for some time past been trying to adapt various pieces of apparatus for administering ether and, not finding the folded cloth method entirely satisfactory, he redoubled his efforts to devise a satisfactory inhaler.

At the very last minute before his all-important demonstration of etherisation at the Massachusetts General Hospital, on October 16th, Morton, with the assistance of the Boston physician, Augustus A. Gould, designed and had made "a small two-necked glass globe" to contain an ether-soaked sponge. H. J. Bigelow, who was present at the demonstration on October 16th, described the working of the inhaler as follows:

"One aperture admits the air to the interior of the globe, whence, charged with vapour, it is drawn through the second into the lungs. The inspired air passes through the bottle, but the expiration is

diverted by a valve in the mouthpiece, and escaping into the apartment is thus prevented from vitiating the medicated vapour."⁹

The fact that this inhaler (which was 10 cm. in diameter) was held in the administrator's warm palm, which automatically aided the vaporisation of the ether, was an accidental but a very important point in its favour.

Very soon after Morton's public demonstration, various distinguished men in Boston sent word of the great surgical innovation, etherisation, to their friends in the Old World.

The first to receive the news in England was Francis Boott, of Gower Street, London, and he and a dentist named Robinson lost no time in administering ether to a young lady for the extraction of a tooth. Boott also passed on the news to the surgeon, Robert Liston.

An eye-witness named Forbes described how, on December 22, 1846,

"in the theatre of University College Hospital, Mr. Liston amputated the thigh of a man previously narcotised by inhalation of the ether vapour. Shortly after being placed on the operating table the patient began to inhale [from an apparatus prepared by Squire (Fig. 2)], and became apparently insensible in the course of two or three minutes. The operation was then commenced, and the limb was removed in what seemed to us a marvellously short space of time—certainly less than a minute, the patient remaining, during the incisions and the tying of the arteries, perfectly still and motionless. While the vessels were being secured, on being spoken to he rose partially up (still showing no signs of pain) and answered questions put to him in a slow drowsy manner. He declared to us that at no part of the operation had he felt pain, though he seemed partially conscious; he had heard some words, and felt that something was being done to his limb. He was not aware, till told, that the limb was off, and when he knew it, expressed great gratification at having been saved from pain."¹⁰

In France the first trial of etherisation was made by the surgeon, J. F. Malgaigne, towards the middle of January 1847. He described at a meeting of the Académie de Médecine in Paris, how—having no such inhaler as was used in America and England—he took a simple tube into which he put some ether and then introduced the end of it into the patient's nostril, the other nostril being plugged. "I took care," said Malgaigne, "that inspiration took place with the mouth closed, expiration with the mouth open."¹¹ Several of Malgaigne's colleagues subsequently followed his example in making their patients inhale ether vapour through one or both nostrils. Others preferred to use the American and English types of sponge-filled flask.

In the meantime Morton had taken out a patent to cover the use of etherisation and its administration by any such means as his inhaler. At the Massachusetts General Hospital, John Mason Warren in February 1847 decided, in view of the patent, to abandon the use of any inhaler and instead to pour the ether directly on to a small bell-shaped sponge which was then held firmly over the patient's nose and mouth.¹²

This procedure proved so simple and so effective that it was widely adopted in the United States. Indeed, from that time until the close of the nineteenth century, a sponge or a sponge enclosed in a folded towel was there the method of administration almost exclusively used.

In this way the Americans had found a means of avoiding the worst difficulties of etherisation; but in Great Britain and on the European Continent anaesthesia was becoming less and less satisfactory as inhalers grew more complicated. Summarising the common faults of these early inhalers John Snow, famous to-day as the first specialist anaesthetist, wrote:

"When the inhalation of ether was first commenced, the inhalers employed consisted generally of glass vases containing sponge, to afford a surface for the evaporation of the ether. Both glass and sponge being very indifferent conductors of caloric, the interior of the inhalers became much reduced in temperature, the evaporation of ether was very much checked, and the patient breathed air much colder than the freezing point of water, and containing very little of the vapour of ether. On this account, and through other defects in the inhalers, the patient was often very long in becoming insensible, and, in not a few cases, he did not become affected beyond a degree of excitement and inebriety."¹³

Inhalers intended to overcome these defects had been produced, but until the principles laid down by Snow himself began to be appreciated, designers often showed themselves more remarkable for ingenuity than for insight into the problems of ether vaporisation and inhalation.

At a meeting of the Westminster Medical Society on January 16, 1847, Snow read a paper on the vaporisation of ether, in which he is reported to have said that

"the great effect of temperature over relations of atmospheric air with the vapour of ether, had apparently been overlooked in the construction and application of the instruments hitherto used. . . . The operators did not at present know the quantity of vapour they were exhibiting with the air; it would vary immensely according to the temperature of the apartment."

Snow gave a table setting out the volumes of ether vapour which, at different temperatures, one hundred cubic inches of air would contain.

"He (Dr. Snow) was getting an instrument made which would enable the surgeon, merely by placing it in a basin of water, warmed or cooled to a given temperature, to administer an atmosphere of any strength he wished, and by this means to gain correct experience to guide him in future."¹⁴

A week later Snow showed his first ether inhaler at the Westminster Medical Society; and during the spring of 1847 he continued to improve it (see Fig. 3a). One of the biggest of these improvements was the adoption of a valved facepiece (see Fig. 3b) (based on a valveless facepiece invented by Francis Sibson) instead of the usual mouth-tube and nose-clip.

Notwithstanding the fact that some administrators were beginning to master the technique of etherisation, when Professor J. Y. Simpson, in November 1847, described the simplicity with which the far more potent anaesthetic, chloroform, could be administered from a folded cloth, the use of ether was immediately and generally discarded.

In England ether anaesthesia was neglected during the next twenty-five years; on the Continent of Europe as a whole, it remained in disrepute until the last decade of the nineteenth century; even in Boston it was for a short time discarded. Besides the Americans in the Northern States of the Union, only the surgeons of Lyons—and following their example, the surgeons of Naples—soon returned to the use of etherisation, after deaths from chloroform had begun to occur. In the Austrian Empire, and in Vienna in particular, a compromise was made, and mixtures containing chloroform and ether in varying proportions, were preferred to the use of either agent alone.

It seems probable that the reason why the surgeons of Lyons returned so readily to the use of ether was because, before the introduction of chloroform anaesthesia, they had been using an effective method of etherisation. This was Roux's *sac*, "a bag, made like a lady's reticule, its opening being dilated or contracted by the drawing or loosing of the strings around it, and lined by a pig's bladder. . . . In using this apparatus, the mouth and nostrils are both placed in the sac drawn over them, and inhalation goes on with the ether vapour given off from sponges soaked in ether, and placed in the bladder."¹⁵

Before the inhalation of ether was superseded by that of chloroform, a few interesting experiments on rectal etherisation were made in the laboratory and clinically. In France Marc-Dupuy, injecting liquid ether mixed with water into the rectums of dogs, found that anaesthesia was rapidly established and caused but slight inflammation of the rectal mucous membrane. He came to the conclusion that this method of rectal administration was likely to prove safer than inhalation of the

vapour.¹⁶ In Russia, the surgeon, Nikolai Ivanovich Pirogoff, after experimenting on animals, evolved a satisfactory method of introducing ether vapour into the rectums of his patients. After washing out the rectum, he introduced into it one end of a rubber catheter, the other end being connected to a small container surrounded by a warm water-jacket, so that the liquid ether put into it should be immediately vaporised. He claimed that anaesthesia was established in from three to five minutes and that there were no undesirable after effects.¹⁷

The intravenous injection of ether, also, was tried on dogs, but the results were not very encouraging. The physiologist, P. J. M. Flourens,¹⁸ in 1847, found that the dogs became "drunk" but not insensible, and Thomas Nunneley, of Leeds, two years later reported only that after the injection of sulphuric and of acetic ether "the symptoms preceding death, and the appearance presented afterwards, do not differ materially from those caused by inhalation."¹⁹ Although P. C. Oré, of Bordeaux, used the intravenous injection of chloral hydrate successfully in a few cases during the early eighteen-seventies, it was not until 1909, after Ludwig Burkhardt had devised a satisfactory method of administering ether intravenously, that this method of anaesthesia was adopted in practice.

The Interim Period

While Lyons and Naples remained, during the eighteen-fifties and sixties, the only two cities in Europe where ether as the sole anaesthetic was regularly used in preference to chloroform, in 1861 Thomas Jones gave ether a re-trial at St. George's Hospital in London.

Some years afterwards he wrote:

"Although it was administered on a large conical sponge (a very objectionable mode), I succeeded in almost all cases in producing the necessary degree of narcotism. It was given for several capital operations, and in cases requiring careful dissection, such as herniae, with complete success. In the following year I discontinued its use, however, in the operating theatre, on account of the inconvenience occasioned to those present, by the smell of the vapour, and from the time it took in some cases to get the patient under its influence. . . . I, however, continued its use in cases which were considered unsafe for chloroform, such as for those in a state of collapse from severe accidents."²⁰

In 1864 the committee appointed by the Royal Medical and Chirurgical Society, to investigate the physiological action of chloroform anaesthesia, made its report. As a result of comparative series of experiments, using chloroform and ether, the following conclusion was reached: "It is . . .

extremely desirable to obtain an anaesthetic agent which shall be capable of producing the requisite insensibility, and yet is not so dangerous in its operation as chloroform.

"Ether, to a certain extent, fulfils these conditions, but its odour is disagreeable, it is slow in its operation, and gives rise to greater excitement than chloroform. The committee therefore concur in the general opinion which in this country has led to the disuse of ether as an inconvenient anaesthetic."

As a compromise the committee suggested that mixtures of chloroform and ether should be used, and in particular recommended the A.C.E. mixture which consisted of one part alcohol, two parts chloroform, and three parts ether.²¹

Although such mixtures did not immediately become popular, a few people began to use a chloroform and ether sequence, inducing anaesthesia with the more easily-manageable agent chloroform, and maintaining it with the safer agent ether. Not long after the introduction of nitrous oxide into English dental practice in 1868, J. T. Clover began to use his famous "gas and ether" anaesthesia.²²

An unsuccessful attempt to arouse English interest in ether as the sole anaesthetic, administered by the American method, was made by J. Warrington Haward, in 1871.²³ In the following year, however, B. Joy Jeffries, an ophthalmic surgeon from Boston, Massachusetts, came to London to attend a conference. He also came determined to convince the English chloroformists of the error of their ways.

Jeffries opened his campaign by reading a paper on "Ether in Ophthalmic Surgery," in which he described the American procedure:

"A towel rolled into a cone, with a napkin or sponge pushed to the top of the inside, is all we need to pour our ether on, whilst our fingers can mould it over any mouth and nose. . . . Now if the patient is warned that the ether will choke him, and told when this occurs to take long breaths to relieve it, and not struggle and endeavour to push away the sponge, many will go to sleep quietly and without trouble to themselves or the surgeon. . . . When the patient, whether old or young, struggles, and asks for a respite and fresh air, do not yield. Hold them down by main force, if necessary, and at any rate, keep the sponge tight over the mouth and nose till they finally take long breaths and then go off into ether-sleep."²⁴

The London chloroformists were a little startled by Jeffries's methods, but at the same time they were compelled to recognise the fact that, given in this way, ether could be a very efficient anaesthetic agent.

During the autumn of 1872 the British Medical

Association, through the medium of its journal, encouraged anaesthetists to make a fresh trial of etherisation, and by 1873 the revival of its use was well-established in England.

The Use of Ether Anaesthesia Re-established

During the first few months of the revived use of etherisation, variants of the American method of enclosing a sponge in some kind of cone—made, for example, from a folded towel, from felt, or from cardboard—were by far the most commonly used, and this was to be expected. But gradually the English preference for mechanical inhalers began to reassert itself. Unlike the inhalers of 1847, which aimed at diluting each breath of ether vapour with atmospheric air, the majority of inhalers designed during the eighteen-seventies made use of re-breathing. Of these inhalers the two best-remembered to-day are Clover's "portable regulating inhaler"²⁵ (see Fig. 4), and Ormsby's inhaler²⁶ (see Fig. 5), which were first described in the medical journals early in 1877.

At the time when the English were thus enthusiastically rediscovering the advantages of ether anaesthesia, France and Germany were recovering from the effects of the Franco-Prussian War, and it seems likely that this was a strong reason why the general revival of etherisation on the European Continent was delayed for more than fifteen years longer.

In 1877, however, the surgeon, Gustave Julliard, of Geneva, after a death from chloroform had occurred in his practice, abandoned the use of that anaesthetic and adopted ether. He administered it from a large, wire frame, the outside of which was covered with waxed cloth to make it impermeable to air, the inside with surgical gauze on to which the ether was poured. This mask was subsequently modified by F. L. Dumont, of Berne, who added a hinged, inner frame (to allow soiled gauze to be changed more easily) and attached a rosette of flannel to the gauze to receive the dose of ether (see Fig. 6). The mask did not fit the face accurately, and when it was desirable to deepen anaesthesia a folded towel was laid round the rim to reduce the amount of air filtering in. But as in any case the carbon dioxide accumulating under it was considerable, it was also necessary to turn the mask aside from the face at intervals throughout administration, as is shown in Fig. 6.²⁷

The use of Julliard's method of etherisation slowly spread northward into south Germany, and it was adopted in particular by Bruns and Garré, at Tübingen, during the late eighteen-eighties.

At the beginning of the eighteen-eighties ether

anaesthesia had been adopted independently by the surgeon, Oscar Wanscher, of Copenhagen. He administered ether both rectally,²⁸ by a method which was in principle that used by Pirogoff in 1847, and by inhalation, using an inhaler based on Ormsby's, but without any air inlet or sponge, the liquid ether being poured straight into the bag.²⁹

A colleague of Wanscher's, Axel Yversen, visiting Lyons in 1884, asked the surgeon, Daniel Mollière, whether he administered ether rectally. This prompted Mollière to try the rectal route and his success attracted some attention in the United States. In a leading article, the *Boston Medical and Surgical Journal*, in May 1884,³⁰ stressed the particular usefulness of rectal etherisation in leaving the surgeon a clear field in operations involving the head and neck. It was this consideration, also, which led D. W. Buxton to develop his own method of rectal etherisation about 1890.³¹

As for Wanscher's method of inhaling ether, his first convert to it outside Denmark was the gynaecologist Landau, of Berlin, whose clinic Wanscher visited during the early part of 1890.

In August 1890, the Tenth International Congress of Medicine was held in Berlin, and in the course of the proceedings the American pharmacologist, Horatio C. Wood, read a paper on anaesthesia, in which he emphasised, with statistical details, the far greater safety of etherisation as compared with chloroform anaesthesia.³² This paper made a great impression upon the Germans, and Ernst Gurlt was commissioned by the German Surgical Society to compile independent statistics relating to the safety of the two agents. These were published annually.³³

Gurlt's results weighed heavily in favour of ether, and by 1894, as an outcome of his investigation, a number of German surgeons were trying ether anaesthesia either by Julliard's method or by Wanscher's. Following the German example, about 1895 a few French surgeons, the Lyonnais apart, began tentatively to use ether.³⁴

The last major development in ether anaesthesia which had its beginnings during the first fifty years of anaesthetic practice was the adoption of the open drop method.

As long ago as 1862 Thomas Skinner,³⁵ of Liverpool, had introduced the use of a small, wire face-mask, covered with woollen fabric, on to which chloroform was dropped from a specially adapted bottle; and this simple and effective method had proved popular, particularly in Germany.

In 1874 the American, O. H. Allis, had introduced the use of what he claimed was an open ether inhaler.³⁶ It consisted of a leather cover, shaped rather like a detachable shirt-cuff, enclosing a similarly shaped, oval, metal cage, its internal space being occupied by layers of bandage threaded

across and across round the bars of the cage. One of the open ends of this inhaler was applied to the patient's face, and through the opposite end ether was dropped on to the stretched layers of bandage. There was, however, a considerable dead-space in this inhaler.

It was not until some twenty years later, about 1895, that another American, L. H. Prince, of Chicago, thought of adapting for etherisation the open drop method used for chloroform anaesthesia.

"During the past two years," he wrote in 1897, "I have been using an ordinary Esmarch's chloroform mask for administering ether, and have found that, as a rule, it answers the purpose very well indeed, with the single exception that the small surface area delays the production of complete anaesthesia in some cases. I am having made a mask, similar in principle to the Esmarch, with some modification in size and shape, that I feel confident will answer the purposes of both chloroform and ether administration, at least until something better is presented."³⁷

In America the open drop method of administering ether was developed at the Mayo Clinic during the first ten years of the present century, and it was adopted in England about 1908, an early advocate being H. Bellamy Gardner.

During the opening years of this century open drop ether was independently adopted by one or two German surgeons, notably C. Hofmann,³⁸ of Cologne, and Oscar Witzel, of Bonn.³⁹

Despite this new development, German interest in inhalation anaesthesia, and in ether anaesthesia in particular, had been declining since about 1895. In the upper-abdominal surgery which German surgeons were then increasingly undertaking, post-operative chest complications were extremely liable to follow, and a ready explanation for their occurrence appeared to lie in the use of ether anaesthesia. This explanation was widely accepted although Campiche, of Lausanne, pointed out in

1902, that chest complications, far from being primarily due to the anaesthetic, were associated with certain types of surgery in which post-operative pain deterred the patient from ridding himself of bronchial secretions by coughing.⁴⁰ Furthermore, the specialist anaesthetist was unknown on the European Continent, and the amount of skill shown by the inexperienced young house surgeons, to whom the task of administering chloroform or ether was relegated, was often inadequate. From the early eighteen-nineties onwards a reasonably satisfactory way out of this difficulty was found—the surgeons themselves prepared a painless operating field. This they did either by adopting Schleich's method of infiltration anaesthesia or, after 1899, by using Bier's spinal anaesthesia, and a little later still, regional anaesthesia.

The example set in Germany was generally followed on the Continent, and a similar system had been adopted in the United States, although there the idea of training and employing specialists was at the same time growing in favour.⁴¹

In Great Britain the Scots remained as they had always been, content with chloroform. But to the English professional anaesthetist at the close of the nineteenth century, ether was still the anaesthetic of choice in major surgery. The Continental and American highly technical methods of local and regional anaesthesia not unnaturally made little appeal to him, trained as he was in the refinements of inhalation anaesthesia. Nevertheless, he was not so much looking forwards as backward—to chloroform anaesthesia. Whereas no important new type of inhaler had been designed for ether since Clover and Ormsby had launched theirs in 1877, the year 1903 saw the Harcourt inhaler which, by limiting the amount of chloroform in the inhaled mixture to a maximum of 2 per cent was, it was hoped, about to make chloroform anaesthesia safe at last.

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Illustrations

ETHER ANAESTHESIA, 1842-1900

By

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FIG. 1.—Valerius Cordus's description (circa. 1540) of the preparation and properties of sulphuric ether.

FIG. 2.—The inhaler used by Boott and Robinson in December, 1846, for the first dental operation performed on an etherised patient in England.

- A. The Urn with its stopper, into which the ether is poured.
- B. Valve which admits the air.
- C. Contains sponge saturated with ether.
- D. Valve which opens at each inspiration, and closes at each expiration.
- E. Ferule for regulating the quantity of atmospheric air admitted.
- F. Valve for the escape of expired air.
- G. Mouth-piece.
- H. Lower vase.
- I. Spring for closing the nose.

FIG. 3.—Squire's Ether Inhaler (December, 1846).

FIG. 4a.—Snow's Ether Inhaler (1847) assembled, showing: A, the carrying case, serving also as a water-bath; B, the vaporising chamber (see also Fig. 3b); C, opening into which was screwed the air-inlet tube D; E, opening above B, from which the flexible tube F, led the ether-air mixture to the facepiece G, in the floor of which can be seen the inspiratory flap-valve H; I, the facepiece removed (see also Fig. 4b); S, diagram of the vaporising chamber B, showing the direction of the air flow.

FIG. 4b.—Details of Snow's Ether Inhaler. The facepiece, showing how the expiratory flap-valve could be turned aside (position shown in dotted outline) further to dilute the ether-air mixture.

Above.—The spirally coiled baffle-plate of the vaporising chamber which directed the current of air over the surface of the liquid.

FIG. 5.—Clover's "Portable Regulating Ether Inhaler" (1877).

FIG. 6.—Ormsby's Ether Inhaler (1877). Diagram showing: B, bag; C, cage holding sponge, S; O, opening of air-inlet tube, Fu; Sl, slot in Fu, opened or closed by the slotted cap, Ca.

FIG. 7b.

FIG. 7c.

FIG. 7a.

FIGS. 7a, b and c.—Dumont's modification of Julliard's Ether Mask, showing (a) the hinged, inner frame to hold in place the gauze and flannel rosette on to which the anaesthetic dose was poured; (b) the mask, with its impermeable cover, resting lightly on the face, and (c) the mask turned aside during administration, to allow the accumulated exhaled mixture to escape.

FIG. 8.—Wanscher's Ether Inhaler, based upon Ormsby's.

FIG. 9.—Skinner's Chloroform Mask, 1862, prototype of the open drop mask.