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ANESTHESIA FOR NURSES

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BY

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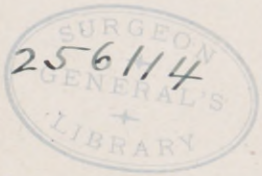

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TO MY WIFE

PREFACE

The object of this little volume is to present to the nurse, in concise form, the essentials of anesthesia, from the nurse's standpoint; in order that she may have a sufficient knowledge of those anesthetics in ordinary use to understand somewhat of their application, the difficulties and dangers that may beset the path of those administering these powerful drugs, and the methods of combating these difficulties.

The nurse should familiarize herself with everything that pertains to the preparation—both physical and mental—of the patients before operation, and to all that conduces to their well-being afterwards. During the period devoted more particularly to the care of surgical patients and to surgical training in the operating room, this book, it is hoped, will be found of the greatest use; its perusal assisting in the ready acquirement of knowledge by the explanation of, and reason given for, the various steps taken. With the method of handling and the safety of the patient under anesthesia well considered and the needs of surgeon and anesthetist for the particular operation and type of patient in hand already known, the nurse has a decided advantage over the one who appears for the first time in an operating room ignorant of the services which are likely to be required of her.

In the sparsely settled districts of the Western States and the Canadian West where doctors are few and far apart, nurses are provided in the various districts, in some instances subsidized by the government, others are supported by the Red Cross, and in Canada there exists also the "Victorian Order of Nurses" engaged in this

work. A doctor visits the district at intervals, or if specially called for, from the nearest telephone office (recently the radio has been used for this purpose). In difficult obstetrical cases and in surgical cases where it is impossible to remove the sufferer to a hospital, the doctor is alone except for the one nurse; his nearest confrere may be forty to fifty miles distant, often farther. An anesthetic is required, the nurse is the only person who possesses any knowledge whatever in this direction. It would, therefore, seem that all nurses so situated should have some special training in anesthesia in order to safeguard the lives of those in remote districts and also to relieve the mind of the one medical man from anxiety as to the anesthetic, in order that he may devote his attention solely to the operative work. The same pertains to those nurses working among the natives of China and India as missionaries.

Any nurse ambitious to take up anesthetics as a profession with the object of practising in the hospitals of centers where men and women qualified in medicine are available, I would refer to what is considered in my book on "The Science and Art of Anesthesia" as the minimum necessary knowledge required by an anesthetist.

1. To be able to make an adequate preliminary examination, or to properly interpret and correlate the findings of others and direct the patient's preparation.

2. To choose the most suitable anesthetic and produce a smooth and pleasant induction.

3. To maintain the patient on the least amount of anesthetic consistent with the surgical procedure.

4. To instantly recognize and be prepared to remedy with quiet confidence any untoward symptom which may arise.

The above presupposes a knowledge of anatomy, medicine, physiology, pharmacology, chemistry, biochemistry, physics, surgery (so far as the effects of trauma on various tissues and the different stages of each operation are concerned).

I would therefore earnestly recommend any nurse filled with a desire to adopt the specialty of anesthesia to first take the medical course at some good university. The love of this branch of medicine which lures them to its fold has been felt by many before, as note the number of women with degrees in medicine, who having embraced this specialty, have become famous over the length and breadth of this continent.

It must be clearly understood that where the pronoun "he" is used in speaking of the anesthetist "he or she" is intended; the former term being used only for convenience.

In conclusion I must express my thanks to Dr. Meredith, of the Winnipeg General Hospital, for the number of photographs taken of operating positions and also to those who have kindly loaned electrotypes of the various pieces of apparatus illustrated.

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CHAPTER I

HISTORICAL

From remote times attempts have been made to relieve pain. Our earliest ancestors little removed from the animal, exposed to the vicissitudes of climate, lacking all comforts as we understand them, no doubt possessed a nervous system unaffected by the smaller injuries and mishaps which overtook them and only suffered acutely as a result of some extreme injury or sickness.

As the nervous system of man developed and civilization advanced, injury and sickness became matters of more importance. The blessing, or curse, of a more highly organized nervous system, bringing with it a greater sensitiveness to injury, and a consequent demand for relief of the pain experienced, caused man to look for means of palliation or cure. Thus it happens that from very early times we have records of attempts to relieve the suffering caused by injury or that of the necessary operation required as a result of injury or disease.

The Babylonians used pressure on the carotid arteries which in a short time, from anemia of the brain, rendered the patient insensible, when an operation of short duration could be performed without distress to the subject, except that caused by the method of obtaining anesthesia. It will be recalled that more recently this method of rendering their victims unconscious and easy

to rob was practiced by thugs, who were only dissuaded from their "gentle pastime" when the lash was instituted as a routine punishment for this offence.

The juice of certain plants as Atropa Mandragora (Mandrake) hemp, aconite, belladonna, bryony, henbane, opium, etc., have been used singly or in various mixtures from very early times and until early in the nineteenth century were, together with the use of hot and cold applications, the only means of relieving pain; for in spite of the fact that ether had been prepared by Valerius Cordus as far back as 1540 its anesthetic properties were not utilized until three centuries later.

Many references to the use of these drugs to relieve pain are found in literature from Homer to Shakespere, e.g., Du Bartas, 1592, makes the following allusion to the use of such drugs:

"Even as a surgeon minding off to cut
Some cureless limb: before in use he put
His violent engines in the victim's member,
Bringeth his patient in a senseless slumber:
And griefless then (guided by use and art)
To save the whole, saws off the infected part."

The beginning of the 19th century foreshadows the dawn of modern anesthesia.

In 1800 Humphrey Davy, a young chemist, employed at Dr. Beddoes' so-called Medical Pneumatic Institute, Bristol, England, where attempts were made to cure disease by the inhalation of various gases, among those used being nitrous oxide which had been discovered by Priestley in 1776, having an inflammation of the gums which caused him great pain, found that the inhalation of the gas gave complete relief.

He drew attention to this fact in his writings but without apparent result. Later Faraday, 1818, drew

attention to the fact that the vapor of ether mixed with air produced a similar effect and in 1824 Hickman, a surgeon of London, commenced a series of experiments on animals publishing his results in 1828 on "a method of suspending sensibility by the methodical introduction of certain gases into the lungs during which the most delicate and dangerous operations are performed without producing pain in the individuals submitted to them."

Little notice was taken of the work of Davy and Hickman in Europe and it remained for Long, Wells and Morton in the United States to successfully bring this epoch-making discovery to the public notice, the latter giving the first successful public demonstration of ether anesthesia at the Massachusetts General Hospital in 1846. A few weeks later it was used successfully at University College Hospital, London, and in a short time knowledge of this discovery was world-wide.

At first nitrous oxide was administered pure or with a little air. This permitted its use only for a short operation of not more than one or two minutes' duration. It was not until 1868 that it was used mixed with oxygen instead of air by which means it was possible to prolong the administration for the time required to perform major operations.

Ether was found to have certain disadvantages which caused Dr. J. Y. Simpson of Edinburgh, to look about for a more easily administered and if possible safer substance. Mr. Waldie, a chemist of Liverpool, suggested chloroform which had been discovered in 1837. Waldie having prepared some of this drug Dr. Simpson used it in 1847 and found certain advantages in its use over ether, such as its being less irritating and more pleasant to inhale. It was thought at first to be quite safe, but this conception was soon shattered by the death

of Hannah Greener two months later. This was speedily followed by other deaths and a controversy began regarding the relative merits of ether and chloroform which has lasted to the present day. While the exponents of ether claimed it was far safer than chloroform, those in favor of the latter drug claimed that the death rate from pulmonary disease, pneumonia, pleurisy, etc., after ether made it the most dangerous drug.

Ethyl chloride was discovered in 1847 and used considerably for a few years. It fell into disuse, however, to be revived some fifty-five years later, since when it has come into common use.

Other of the volatile hydrocarbon compounds as ethylene, methylene chloride, carbon tetrachloride, etc., were tried in the early days of anesthesia but fell into obscurity on account of their supposed or real dangerous qualities. Some, for example ethylene and methylene chloride, have recently been revived, but have had only a limited trial so that it is still too early to prophesy as to their future fate. By the use of nitrous oxide-oxygen, ether, ethyl chloride and chloroform, or mixtures of these, the anesthetist possesses an armamentarium which, used with skill and care, will be difficult to displace.

Improvement in apparatus for the administration, together with improvement in purity of the anesthetics used, has continued since their advent; the most pronounced improvement of recent years being in apparatus for the administration of nitrous oxide-oxygen which has now reached a high degree of efficiency.

The epoch-making discoveries of Lister, which caused surgery to become immeasurably safer than formerly, together with efficient modern anesthesia, has made common an infinity of operative procedures once considered impossible.

CHAPTER II

PHYSIOLOGY

We shall now proceed to deal briefly with the methods by which the anesthetics referred to in the previous chapter gain entry into the organism and produce the necessary state of insensibility to pain. It is a well-known fact that plants or flowers placed in an atmosphere of one of the volatile anesthetics cease to grow, or the blooms to develop further, until the anesthetic is removed. A frog having half its body immersed in chloroform water will become anesthetized, the absorption of the anesthetic through the skin being more rapid than its elimination by the lungs.

This simple process of imbibition cannot be used in the human subject, however. The absorption and elimination of an anesthetic becomes a much more complicated matter when one has to deal with a complex organism such as man. However desirable it may be to simply bring about a condition of insensibility in the nerve centers, controlling the parts which are the seat of operation, this cannot be accomplished without at the same time affecting other parts of the nervous organism and also all other important organs of the body. As we shall see later, the liver, kidneys, stomach, etc., are all affected in a greater or less degree by the administration of these volatile substances and on a judicious selection of the most suitable anesthetic and its method of administration depends the welfare of the subject.

The entry of a volatile gas into the body may be by way of the respiratory system, by passage into the rectum, or by a solution given intravenously; the most uni-

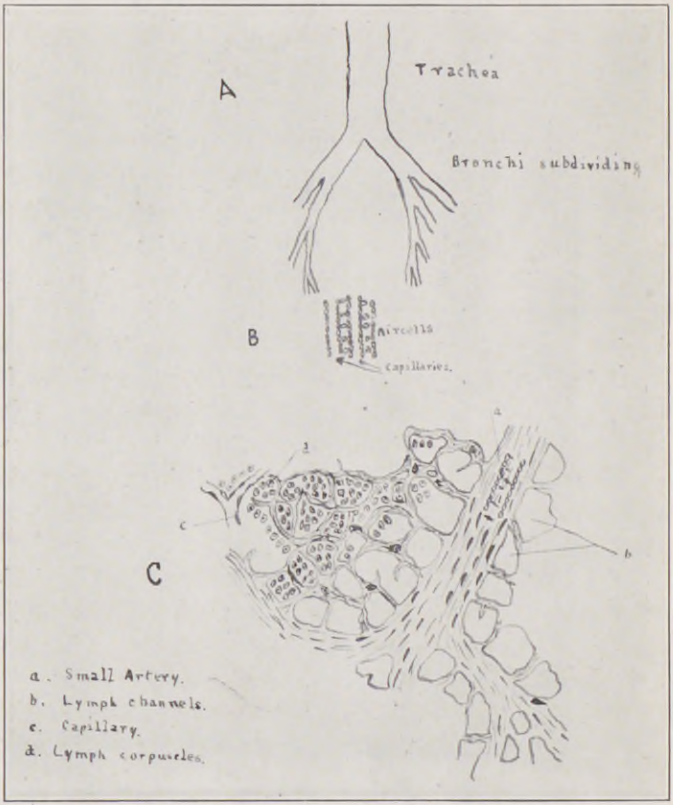

Fig. 1.—Schematic. (*A*) Trachea and larger bronchi showing how these subdivide until they reach microscopical dimensions and finally end in the alveoli (*B*), the walls of which are composed of a single layer of cells, outside of which the capillaries ramify. The anesthetic vapor passes from the mouth through the trachea and bronchi until the small air cells are reached; here it passes through the cell wall to the blood contained in the capillaries until the tension of the gas in the blood stream equals that in the air cells. The capillaries merge into larger and larger vessels, finally carrying the anesthetic impregnated blood to the heart whence it is driven through the whole circulatory system, the vessels of which gradually subdivide until ultimately they become the systemic capillaries, reaching all parts and organs of the body. Here we have a condition analogous to that in the lungs (*C*); capillaries containing anesthetic-laden blood with lymph channels in close contact, the vapor passes through the wall of the capillaries to the lymph by which it is conveyed to all the tissues of the body and absorbed in various ratios as described in Chapter II.

versal being by the respiratory tract and here we must consider the means by which, when a volatile anesthetic is inhaled, it reaches the nervous mechanism and other parts of the body.

Nitrous oxide and ethyl chloride are vapors at ordinary room temperature. Ether and chloroform, on the other hand, are liquid at the ordinary temperature; but as the former boils at 96° F., the latter at 142° F. they are sufficiently volatile to be readily changed into vapor when dropped or poured onto one of the various inhalers used for their administration. The vapor being drawn into the lungs during inspiration reaches the minute air cells; although these are only .2 mm. in diameter, their large number, some seven hundred million, provides an absorbing surface of about one thousand square feet. The walls of these cells are formed of only one layer of endothelial cells; on one side is air containing the anesthetic vapor, on the other side are the capillaries through which rushes the blood eager to give off the excess carbon dioxide it has absorbed from the tissues and to take up oxygen for the use of all the tissues of the body. This is its normal function, but just as carbon dioxide and oxygen readily pass through the moist endothelial layer so likewise will other gases; therefore in addition to the normal exchange of gases always going on in the air cells, when another gas, be it the vapor of nitrous oxide, ether, chloroform or other drug, is contained in the air cell, this is also absorbed by the blood and carried to the various parts of the body in a manner similar to the above. All parts of the blood do not absorb these gases equally, the proteid material—the red corpuscles—carrying much more than the plasma. Neither is the percentage carried by the corpuscles and lymph in the same proportion for all

anesthetics; e.g., chloroform is carried by the corpuscles nine times as readily as by the plasma while in the case of nitrous oxide the solid and fluid portions of the blood absorb the gas almost equally.

From the blood the anesthetic gases are absorbed by the lymph and by this fluid, which bathes all the tissues of the body, are distributed to every portion of the organism.

All tissues do not absorb the anesthetic gases with equal readiness. As fats are dissolved by ether and chloroform and readily absorb these drugs it is obvious that nerve tissue, which is largely composed of lecithin,

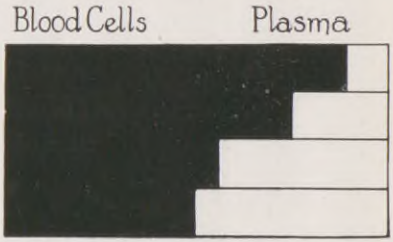

Fig. 2.—Shows relative quantity of anesthetic held by the blood cells and plasma.

a fatty substance, will show a greater avidity in absorption of the gases than will muscle, for example. The other fats of the body also display this eagerness to absorb anesthetics.

The higher centers of the brain, those of volition and sensation, are fortunately affected before the involuntary centers of respiration and circulation contained in the medulla. Were this not the case, anesthesia, as we know it, would be impracticable. The higher centers of volition and sensation contained in the cerebrum become anesthetized while the medulla is still intact and so the vital functions of respiration and circulation are

carried on while the nerves and most of the brain are, so to speak, in a state of slumber and so prevented from conducting or recording sensations of pain, thus enabling operative procedures to be carried on in any part of the body.

All anesthetic gases are not absorbed by the blood at the same rate. The more volatile gases, those which boil at a lower temperature, are absorbed more rapidly than those which require a higher temperature to volatilize. Nitrous oxide boiling at −92° C. produces its effects with great rapidity. Chloroform, at the other end of the scale, requires a much longer time for absorption. For the same reason, when the administration of an anesthetic is discontinued, the elimination of the drug and the consequent recovery of consciousness by the patient is most rapid in the case of nitrous oxide, being as a rule not more than thirty to sixty seconds while in the case of ether or chloroform several hours may elapse before consciousness is fully regained. It has been shown that nitrous oxide is absent from the blood a few minutes after its administration is discontinued, ethyl chloride is almost all eliminated within five minutes, none being found after ten minutes, while traces of ether and chloroform can be found in the blood seven hours after administration has ceased.

An exceedingly important consideration is the effect of an anesthetic on the muscle of the heart. This is not the same for all. Nitrous oxide and ether have no direct poisonous action on the heart muscle while, on the other hand, chloroform and ethyl chloride have a direct poisonous action on the heart muscle itself though the effect of the latter is slight, being only one-nineteenth that of the former. It is obvious that where the heart is acted upon directly by a poison the muscle fibers are

weakened and the organ rendered unable to withstand any unwonted strain thrown upon it as satisfactorily as would the unaffected heart. It follows then that a heart, the subject of some serious lesion, or that may during the course of an operation be subjected, either by prolonged operation, hemorrhage or other cause to an increased strain, may lack the necessary resiliency and fail in its action if already weakened by the effect of such an anesthetic; while, on the other hand, if another anesthetic—not possessing this poisonous effect on muscle fibers—be selected the strain of operation may be successfully withstood. Other things being equal, those anesthetics lacking this deleterious quality are the safer for the patient.

Fatalities from anesthetics do not, however, usually result, at least primarily, from stoppage of the heart. Respiration as a rule first fails, stoppage of the heart following, usually a minute or two later; the heart being in a condition of overdilatation. Death may result, however, from primary stoppage of the heart, particularly with chloroform or ethyl chloride, where the anesthetic is presented in such concentration that the blood pouring through the lungs becomes highly charged with the vapor which is carried immediately to the heart; that organ, being filled and its vessels supplied with this blood, may be rapidly paralyzed from the poison and cease to beat, although the concentration in other parts of the body is insufficient for complete anesthesia. This latter condition may be brought about rapidly or more slowly. It is sometimes produced rapidly when the patient in the case, usually a child, has a fit of sobbing during which the lungs are emptied until the desire for air becomes acute. A long gasping inspiration then occurs, followed quickly by another, taking in a

large quantity of anesthetic vapor and if the mask is not removed or the vapor much diluted we have the above condition produced; occasionally an adult under the stimulation of ether or nitrous oxide or in his desire to follow out the ill-advised directions previously given by some one to breathe deeply, can produce the same condition. This condition may also be brought about more slowly. Here there is usually a gradual slowing and decrease in volume of the respiration due to the effect of an unnecessarily large dose of the anesthetic on the respiratory center which, as stated earlier, will become paralyzed if the anesthetic is pushed beyond that quantity necessary to render the higher centers inert. The increased concentration in the blood weakens the heart's action, with a consequent slowing of the passage of the blood through the lung capillaries where it is left in more prolonged contact with the vapor in the air cells and therefore has time to absorb still more anesthetic. This is carried to all parts of the body including the respiratory center which is finally paralyzed by the increasing concentration and respiration ceases. The heart laboring under its increasing load of blood and weakened from want of oxygen finally stops in the condition stated above. This process may occur very slowly and be unnoticed for some time unless the anesthetist is very watchful of the case in hand.

If for any reason an overdose of anesthetic has been given, steps must at once be taken to remedy the evil. If slight, and the respiration still proceeds though weak, removal of the anesthetic and friction of the lips and face with a towel or piece of gauze will generally cause restoration with no disturbance of the operation; indeed the stimulus of operative procedures may be welcomed as an added incentive to deeper respiration. Should the

Fig. 3.

Fig. 4.

Figs. 3 and 4.—Sylvester's method of artificial respiration. The patient's head is brought over the end of the table so as to be in a slightly dependent position as this tends to keep open a free airway. It is best to introduce a gag between the teeth and draw the tongue forward with a tongue forceps if the above does not insure a proper airway. Sometimes rhythmical traction on the tongue, alone, will establish respiration (Laborde's method). The administrator stands at the head of the patient and grasping the arms at the elbows presses them firmly and steadily against the sides of the chest (Fig. 3). This usually causes an expiration: but should it fail to do so, forcible pressure below the costal margin and directly towards the diaphragm may be brought to bear, preferably by a second person if one is available, synchronous with the pressure on the chest wall. After the arms have been pressed

situation be more serious, e.g., respiration totally in abeyance, more active measures will be necessary, artificial respiration, usually by Sylvester's method, as the patient is generally in the prone position lying on the back. If the patient is lying on the face, Schaefer's method may be used. Care should be taken on commencing artificial respiration that the first movement be that of expiration in order to empty the lungs of the strongly saturated air and leave all the space possible for the next inhalation of pure air. If available a pulmotor or lungmotor should be utilized. Lacking these, oxygen should be introduced with inspiration, under a slight positive pressure if possible, so as to assist in expanding the lungs to get rid of any anesthetic still contained in the alveoli in order that the overcharged blood may begin at once to rid itself of the excess of anesthetic. If nitrous oxide-oxygen is being administered by a machine which can furnish a positive pressure of oxygen immediately, matters are much simplified. The lungs can be dilated by giving pure oxygen under a pressure of about 10 mm. then allowed to collapse by raising the facepiece, this being done some ten or fifteen times per minute. If such a machine is not available, a rubber tube from an ordinary oxygen tank can be introduced into the patient's mouth, the mouth covered by the hand, leaving just space for entry of the tube, the nostrils held close long enough to dilate the lungs; the hand is then raised to allow the lungs

against the sides for about two seconds, they should be brought deliberately towards the administrator so that they come into the long axis of the patient's body, on either side of his head (Fig. 4). In this way inspiration is effected. The arms should be kept extended for two seconds, to allow the lungs to fill, after which they may be brought to the sides again as in Fig. 3. These movements are to be repeated regularly and steadily about 12 to 15 times per minute, careful watch being kept for spontaneous respiration. If any signs of the latter appear, the natural movements should be supplemented by the artificial until the breathing has become thoroughly reestablished.

Fig. 5.

Fig. 6.

Figs. 5 and 6.—Schaefer's method of artificial respiration. The patient is laid face downward with the head turned to one side and the arms extended. The operator stands on one side the patient, facing towards the head, and places the inner sides of his wrists on the lumbar regions, in such a way that the thumbs are parallel to each other and to the spine, about three inches apart, while the fingers spread outward over the lower ribs of each side. Leaning forward, the operator throws the whole weight of his body onto his hands, thus compressing the patient's chest and causing expiration. After a second or two he leans back taking all his weight off his hands, but without removing them from their position; the elasticity of the patient's ribs then causes expansion of the thorax and inspiration ensues. This complete process is repeated twelve or fourteen times a minute.

to collapse and is afterwards reapplied. The effect is the same, though not so effectual as with the machine. Using a nitrous oxide-oxygen machine one cannot get too much pressure on the air cells, the oxygen escaping beneath the edges of the facepiece when the pressure reaches about 10 mm. These methods of using oxygen can, of course, be combined with pressure on the chest during expiration or with the use of artificial respiration. Here one must utter a warning against the manner in which oxygen is often used in the wards in cases of collapse, pneumonia, etc., though it may seem superfluous to some. One still finds nurses—and of course it is because they have been so instructed—administering oxygen from a tank with a funnel on the end of the rubber tube, the funnel suspended over the patient's face. The amount of oxygen received in this manner is ridiculously small, while the waste is appalling; in fact practically the whole is wasted. One of the methods mentioned above should be utilized whenever oxygen is indicated and in most cases it should be given under pressure as it is far more effectual. When respiration is restored and the color returns, it is well to reduce or withdraw the oxygen, temporarily at least, while holding it in readiness for reapplication if necessary. This, because if the patient is over-oxygenated and the carbon-dioxide content of the blood reduced below the point where it ceases to stimulate the respiratory center, that center will cease to act until the carbon-dioxide content of the blood has again increased to the physiologic point.

While these measures are under way, heat may be applied in the region of the heart; electricity, an intramuscular injection of pituitary extract, or in extreme cases an intravenous or intracardiac injection should

be administered as soon as possible; adrenalin may be used in the same manner, but its action is very evanescent and less effective. If the heart has actually ceased to beat, these measures will be of no avail. They should be tried if no beat can be observed, as the final movements of the heart before ceasing are very slight and may pass unnoticed, while an injection directly into that organ has a chance, though a small one at this stage, to be of benefit. Statements regarding revival of patients by injecting adrenalin into the heart after it has actually ceased to beat must be looked upon as unreliable. I have frequently tested adrenalin in this manner on the hearts of healthy animals, always without result where the heart movement had totally ceased; the heart of man is less likely to react to such stimulus than that of a healthy animal such as a dog, for example. If there has been much hemorrhage, saline should be administered intravenously if possible, but artificial respiration in some form should never be interrupted for anything else. If sufficient assistance is not available to do many things, artificial respiration must be maintained, by some one of the above methods, even to the neglect of all other remedies, as it is the most important single remedial measure.

The Cause of Narcosis

Ether and chloroform readily dissolve fats or lecithin and are easily absorbed by them. It is therefore to be expected that anesthetic gases are absorbed more readily by the fatty tissue of the body than by the muscular tissue. This is actually the case, the fats of the body during anesthesia containing 40 to 50 per cent more anesthetic than the muscles. Nerve tissue is composed principally of lecithin and shares, with the other fats

of the body, this selective action. One finds, then, that the brain, spinal cord and nerves are most readily affected by anesthetic vapors.

It has also been shown that the higher the organization of the nervous system, the less is the concentration of anesthetic vapor required to produce the condition of anesthesia, some of the lower forms of life requiring many times the concentration which would cause death in the human being.

The sensory nerves are paralyzed to a much greater degree than the motor. In surgical anesthesia the sensory nerves cease to carry impulses to the brain, though stimulation of motor areas of the brain will cause reflex effects in the muscles supplied by these areas. The higher centers of the cerebral cortex are those first affected, the last to be affected being the vital centers of respiration and circulation in the medulla. It is for this reason that, with all sensation in abeyance, the organism can still carry on those vital functions necessary to life and it is only when the concentration of anesthetic is increased so that the medulla is affected that these centers cease to function and death ensues.

In the first chapter mention was made of the custom in early times of using pressure on the carotid arteries to produce a temporary loss of consciousness. The reason for the occurrence of this condition, is that, when the blood supply is thus cut off, there is a lack of oxygen supply to the cells of the cerebral cortex which are exceedingly sensitive to any interference with the normal supply of this gas. In narcosis some of the oxygen in the tissues is replaced by the anesthetic vapor. If this condition is not maintained too long, or if by unnecessary concentration of the anesthetic vapor the oxygen is not displaced to too great an extent, the organism

recovers its vitality on withdrawal of the vapor. This would indicate that a degree of narcosis just sufficient to paralyze consciousness is the desirable one and not a deeper narcosis which completely inhibits oxidative processes and may thus, if prolonged, do permanent injury to the brain.

CHAPTER III

ETHER

Ether, ethyl oxide, $(C_2H_5)_2O$ is a colorless, transparent, mobile liquid, highly volatile, with a characteristic penetrating odor and burning taste. Its specific gravity is .720 at 56° F. It boils at 96° F. It is soluble in ten parts of water and mixes readily with alcohol, chloroform and most hydrocarbon compounds.

There are various methods of administration of this drug:

1. The open system.
2. The semiopen system.
3. The closed or rebreathing method.
4. With oxygen.
5. With nitrous oxide and oxygen.
6. Intravenously.
7. Rectal or colonic.
8. Intratracheally.
9. Intrapharyngeally.

The purely open system, i.e., with a few layers of gauze or one thickness of stockinette can be used only in very young children; the vapor obtained by this means being altogether too weak to produce satisfactory results in the adult. The method usually spoken of as "open ether" where the ether is dropped or poured on a mask covered with fifteen to twenty layers of gauze, often with a towel also wrapped about it, cannot be truly described as "open." This method should be classed with other "semiopen" methods, as that of Allis, Webster, etc., where with each inspiration through the

inhaler fresh air is admitted, no rebreathing being allowed, except the small quantity retained in the space under the mask, which is greater in many of the so-called open masks than in the two last named.

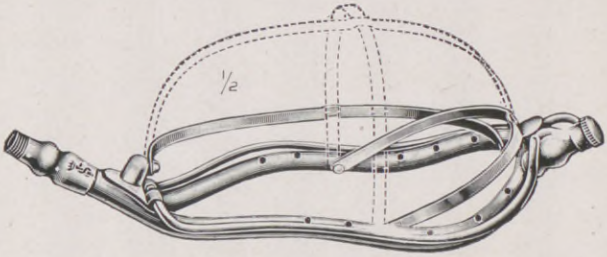

Fig. 7.—Gwathmey's mask for so-called open ether.

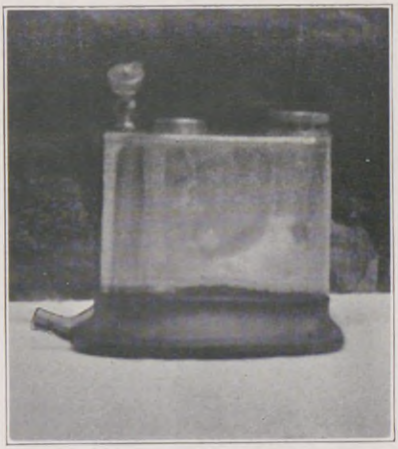

Fig 8.—Webster ether inhaler.

The closed method where the patient's exhalations are received in a rubber bag and rebreathed with the next inhalation is much less used than formerly, when it was the most universal method. Perhaps the best example of inhaler for this method is Hewitt's modification of

the Clover inhaler. These inhalers permitting rebreathing were obviously more difficult to keep clean than the semiopen type on account of their greater complication.

Oxygen may be administered with ether to considerable advantage in certain types, or in certain operations where there is a possibility of some obstruction to res-

Fig. 9.—Clover ether inhaler.

piration as in the operation for cleft palate, bronchoscopy, esophagoscopy, etc.; in the plethoric with thick, short neck, in those addicted to excessive indulgence in tobacco or alcohol, during prolonged or severe operations upon young or very old patients or those who have suffered from long illness, especially when combined with prolonged suppurative processes.

Most of the machines designed for administering nitrous oxide-oxygen in general surgical operations have some arrangement by which ether can be given with these gases when thought desirable.

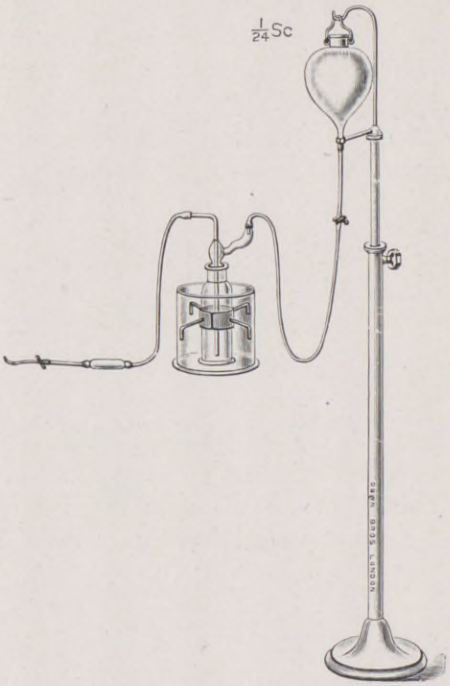

Fig. 10.—Schlesinger's apparatus for intravenous ether anesthesia.

The intravenous method of giving ether is not much used and need not be entered into in detail. A mixture of ether, usually five to ten per cent in saline is allowed to flow into a vein until anesthesia is established, then a smaller flow suffices to maintain that condition.

Rectal ether has practically fallen into disuse, its place being taken by the colonic method in which ether mixed

with olive oil is introduced into the bowel by means of a rectal tube. As the temperature of the bowel, 98.4° F., is above the boiling point, 96° F., of ether this drug is at first rapidly vaporized and absorbed; later, as the bowel becomes distended and cooler on account of the evaporation of the ether, absorption is rendered slower and has been shown to soon acquire a definite and fairly fixed rate.

The following is the method recommended. One hour before operation give slowly per rectum:

Chloretone five to twenty grs.
Oil-ether mixture two to four drams (oil 25% ether 75%).
Half an hour before operation by hypodermic injection.
Morphine gr. $\frac{1}{8}$-$\frac{1}{4}$.
Atropine gr. $\frac{1}{150}$-$\frac{1}{100}$.

Twenty minutes before operation administer the oil-ether mixture gradually, at the rate of one ounce per minute, through a funnel attached to the tube which is inserted four inches into the rectum.

1. Mixture for adults:

   Olive oil 2 ounces,
   Ether 6 ounces.

2. Mixture for weak anemic patients, the olive oil is increased and the ether decreased:

   Olive oil 45%
   Ether 55%

3. Mixture for children:

   Ether-oil equal parts.

Introduce one ounce of ether-oil mixture for every twenty pounds of body weight.

This method has been modified by the addition of paraldehyde to the mixture with a consequent lessening of the quantity of ether-oil required. The following is given in place of the No. 1 mixture an hour before operation:

Morphine hypodermically gr. ⅛

By rectum:

Paraldehyde	1 dram
Oil-ether	3½ drams

Then follow the previous treatment but only using one ounce of the oil-ether mixture to every forty pounds of body weight.

These enemata are, of course, given in bed, usually by the nurse on duty, the anesthetist being at the time probably engaged in the operating room. It is important that the matter of slow introduction of the mixture receive careful attention in order that none may be expelled, and also that great care be taken that the exact dose ordered be introduced, for as will readily be seen, the success of the method depends upon attention to these details.

About three minutes after introduction the odor of ether will be noticed on the breath, the drug being eliminated by the lungs and it is only due to the fact that absorption by the bowel is more rapid, at least at first, than elimination by the lungs—just as in the case of the frog immersed in chloroform water mentioned in our second chapter—that the body is kept anesthetized.

As will be surmised, the patient goes to the operating room either in a state of slumber or a condition approaching that state. In any event he may be expected to be asleep by the time preparations have been made

for the operation. It is obvious that in these cases there should be no delay in starting the operation at the specified time after introduction of the oil-ether mixture.

Should signs of overdose appear, a little of the mixture may be withdrawn by insertion of a rectal tube. If the anesthesia is too light hold a towel or pad of gauze

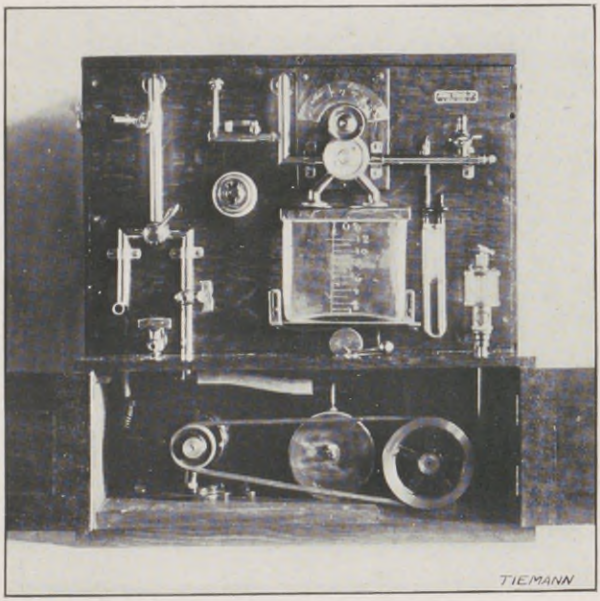

Fig. 11.—Elsberg's intratracheal apparatus.

over the mouth and nose to retain as much of the vapor as possible. It may be necessary in some cases to supplement the colonic ether by a little administered on a mask.

At the conclusion of the operation give a soap suds enema and massage the colon gently from right to left

in order to expel any liquid that remains. Introduce two to four ounces of olive oil and a pint of warm water, then withdraw the tube from the rectum.

Intratracheal anesthesia is so-called because the ether is introduced through a tube, usually a silk woven catheter, directly into the trachea. By this means a positive pressure, i.e., a pressure above that of the atmosphere, usually somewhere between 15 to 50 mm. of mercury above, is maintained by a machine which pumps in a predetermined mixture of air and ether. The object is to keep the lungs inflated in operations necessitating opening of the pleural cavity; as otherwise, when this cavity is opened, the lungs will collapse and though the chest movements of respiration may continue for a short time, as no air can enter the collapsed lungs, asphyxia soon supervenes.

The introduction of the catheter, which is generally performed with the help of a laryngoscope, though some introduce it by touch and so eliminate this portion of the apparatus, is the only difficult point relating to this method and with practice the necessary skill is soon acquired.

The patient must be placed in a condition of deep anesthesia, the head extended. Some prefer to have it brought over the end of the operating table and supported by an assistant; this duty may often devolve upon a nurse. A mouth gag is introduced and opened, not too widely. The laryngoscope is pushed along the posterior wall of the pharynx until the epiglottis is seen, the latter is pulled well forward by the tip of the instrument and the glottis exposed. The catheter is then inserted between the vocal cords and pushed down the required distance. Air will now be noticed to pass through the tube with each inspiration. The laryngo-

scope is removed, the tracheal tube connected with the air tube leading from the machine, and the required

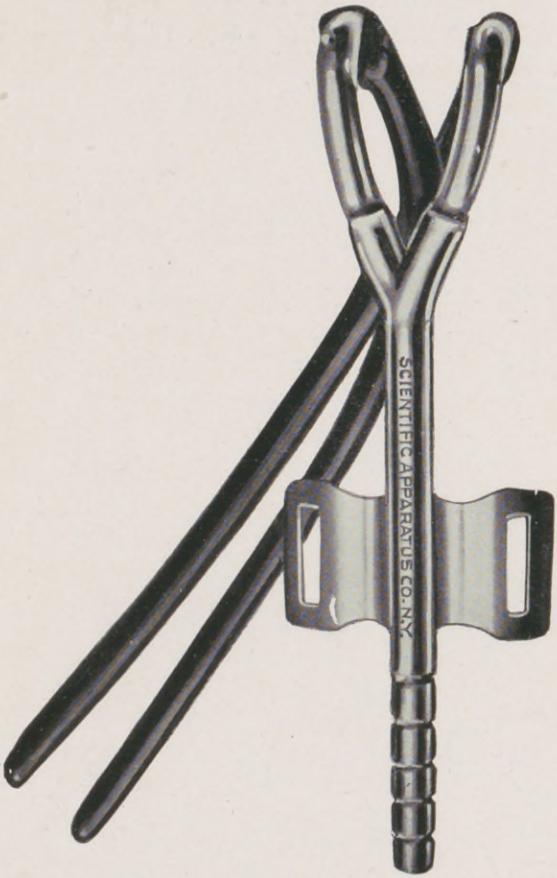

Fig. 12.—Connell's tube and catheters for intrapharyngeal anesthesia.

pressure supplied, which must be sufficient to provide enough air for the patient's requirements. It is seldom necessary to go higher than 30 mm. pressure. Should

a fit of coughing ensue, it is due either to too light anesthesia or insertion of the tube too far, viz., to the bifurcation of the trachea. The remedy for the first condition is, of course, more ether; for the latter condition withdraw the tube about an inch, when the irri-

Fig. 13.—Connell's intrapharyngeal tubes *in situ*.

tation will cease. The face should show a pink color and the pulse be of good quality throughout.

The catheter used for an adult is usually size 22 to 24 French. It is better to err on the small side rather than have one too large as it is important to have sufficient space between the catheter and the wall of the trachea to permit of a free return flow of air. One must

also be careful that there is no compression of the trachea for the same reason.

As will be seen the constant return flow of air prevents any possibility of aspiration of blood, pus or mucus. Further, the normal efforts of respiration are lessened which tends to conserve the energy of the patient.

Intrapharyngeal insufflation is sometimes used in operations about the face and mouth. The tubes, catheters (about No. 18 French for adults, smaller for children), may be cut to a length of 13 cm. in the case of adults. These are best attached to a metal tube of the correct shape and made for the purpose, such as Connell's.

Care must be taken that the tubes are not too long, as they might in that event enter the esophagus and the mixture reaching the stomach cause dangerous dilatation of that organ.

The tubes are lubricated, best with the patient's saliva, and then carefully introduced to prevent injury, care being taken to keep near the floor of the nose. Should one nostril be blocked, both tubes may be inserted through the other if sufficiently wide. The anesthetic may be given by this means either at the ordinary pressure of the atmosphere or at a positive pressure of 20 to 40 mm. of mercury. By the latter method the outside air is excluded and a definite percentage mixture is administered.

Administration of Ether

The conditions arising from the administration of an anesthetic are divided, for the sake of convenience, into four stages. These divisions are purely arbitrary and used for the sake of convenience in describing condi-

tions; no definite line of demarcation can be demonstrated between the stages.

First Stage.—In the first stage owing to the irritating effect of ether vapor on the air passages a certain amount of discomfort is unavoidable. This can be reduced to a minimum by careful induction, the vapor being presented slowly at first and well diluted with air until symptoms of drowsiness appear. With too strong an anesthetic vapor at the beginning, particularly with the nervous or those with an irritable larynx, holding of the breath or spasmodic closure of the glottis may supervene with repeated acts of swallowing or coughing. Should the anesthesia proceed smoothly, however, the breathing becomes more accelerated and deeper, the pupils large and mobile, and the patient passes into the second stage.

Second Stage.—In this stage loss of consciousness takes place, sometimes abruptly. Although memory, intelligence and volition are in abeyance, the patient responds to stimuli. Questions asked may be answered but the answers are nonsensical. Shouting, struggling, singing or laughing, may occur particularly in alcoholics and vigorous muscular subjects. Those addicted to the use of tobacco in excess, owing partly no doubt to the extra irritability of the air passages, are very likely to stop breathing. At the same time a tonic muscular contraction occurs which may pass off when cyanosis becomes marked owing to the increased stimulation of the center from excess of carbon dioxide. In a few cases, however, the cyanosis deepens until extreme, if measures be not taken to prevent it. In fact in some of these cases it is necessary to withdraw the anesthetic altogether for a time until sufficiently good breathing is

established and then administer oxygen along with the ether.

The pupils are still mobile, but usually reach a wide degree of dilation, mucus and saliva are usually freely secreted, especially in young and florid subjects. The face and neck are flushed and sometimes bathed in perspiration. The conjunctivæ are injected.

If a closed inhaler has been used, or the air restricted by holding the breath from any cause, such as the closure of glottis before mentioned, a varying degree of cyanosis will be present, but unless this becomes severe, there should be no discontinuation of the strength of vapor. Clenching of the teeth may occur from masseteric spasm, and in some types a tonic or clonic spasm may occur. A tonic spasm of the whole muscular system preventing ingress of air to the lungs may occasionally, at this stage, necessitate withholding of the anesthetic and even a recourse to some measure of artificial respiration, but as a rule by the development of cyanosis, the respiratory center is sufficiently stimulated to overcome any tendency towards this state reaching a danger point. Ether tremor occurs in a few cases at this stage but is overcome by a further administration of the anesthetic. As the inhalation proceeds the breathing grows more regular, often machine-like in character, 25 to 30 to the minute and stertor appears. The muscles become more flaccid and the third stage is reached.

Third Stage.—In the third stage operative procedure may be carried on. The pupils, previously dilated, have contracted and are usually between 3.5 and 4.5 mm. in diameter. The cornea is often insensitive to the touch, but may remain sensitive throughout the operation. Stroking the eyelashes may elicit reflex winking. This sign is not constant. The lid reflex is usually present;

though in profound anesthesia both these reflexes disappear and the eyelid stands staringly open from spasm of the muscles. At this stage a larger dose of the anesthetic will cause an increased size of the pupil, a smaller dose the opposite. Although the average pupil is of the size mentioned above, the anesthetist is often able to work with the pupil much smaller and still have an effective anesthesia. In a few instances, to abolish all reflex movement and produce complete muscular relaxation the anesthetic has to be pushed until the pupil is of larger size. This degree of anesthesia should, however, be of only short duration, effected for the purpose of overcoming an extra painful stimulus or to produce a greater temporary relaxation. The respiration is deep and stertorous; stertor usually increasing with a little more of the anesthetic, and decreasing with less. The respiration may indeed be so vigorous that the surgeon will complain of the extent of abdominal or thoracic movement. Occasionally, also, there is some tendency to rigidity of the recti abdominis necessitating pushing the anesthetic, or a change in whole or in part to C. E. mixture.

Circulation.—The pulse is full and bounding, usually increased in rate to between 80 and 110 per minute, the heart's action being apparently very vigorous. There is, however, no rise in blood pressure, the pressure remaining either normal, or dropping from 5 to 15 mm. of mercury. If cyanosis should occur the rate of the pulse may be increased to 160 or more. Profuse perspiration occurs in some subjects, the color of the face is usually florid, but in the closed type of etherization, or where there is any obstruction to breathing, a greater or less degree of cyanosis occurs.

The Fourth Stage is that of overdose; the signs of which are dilatation of the pupil, livid pallor of the face, the eyelids separated, and a weakened pulse; though the latter may not be greatly depressed at the beginning of overdose. Sometimes the respiration becomes Cheyne-Stokes in character. In most of the cases of overdose, breathing becomes progressively feebler; in others the regular deep stertor gives place to irregular, jerky, intermittent respirations; sometimes coming to a sudden standstill, after one of these gasps. If the organs of respiration and circulation are healthy at the moment respiration ceases, vigorous remedial measures taken at once usually suffice to restore the patient.

In subjects that are the possessors of fatty, dilated or otherwise diseased hearts, the circulation may fail at the same time as the respiration, and in some instances without an overdose. Any asphyxial element, by putting an additional strain on the circulatory apparatus, may readily cause this failure to occur. In these subjects it is necessary to exercise great care during the first and second stage so that no vomiting, struggling, or interference with free breathing be permitted.

Cerebral hemorrhage has occurred in the subjects of ether anesthesia, but this is very rare.

CHAPTER IV

NITROUS OXIDE

Nitrous oxide, often spoken of as laughing gas, has the chemical formula of N_2O.

When pure it is devoid of irritating properties. It

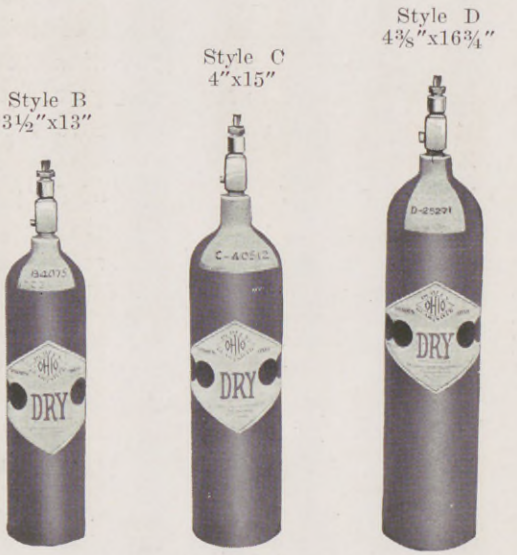

Fig. 14.—Nitrous oxide cylinders.

possesses a slight sweetish taste and is respired without discomfort in nearly all cases.

It is reduced to a liquid under pressure and stored in cylinders of vanadium steel. In this condition it is a colorless, very mobile body, having a specific gravity

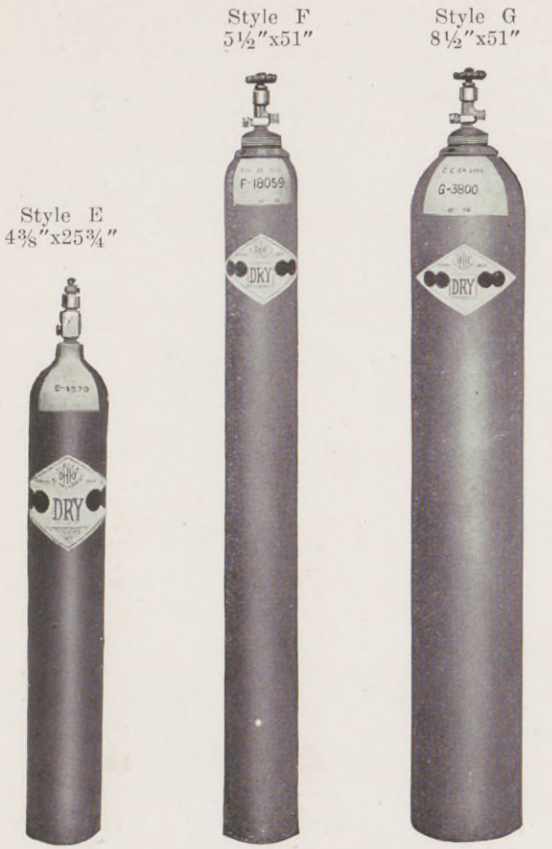

Fig. 14.—Nitrous oxide cylinders.

of .9369 at 32° F. One ounce of the liquid furnishes four gallons of the gas, United States measure, about 3¼ gallons Imperial measure. The pressure in a full cylinder is 1000 pounds to the square inch. This may be raised to a dangerous degree if the cylinder is placed

near a source of heat. The cylinders vary in size from the smallest, 25 gallons, to the largest which contains 3200 gallons. These containers always have a label which shows the weight of the cylinder empty and the weight when charged, the difference being the weight of the gas. The only method by which the remaining contents of a cylinder can be accurately estimated is by weighing it.

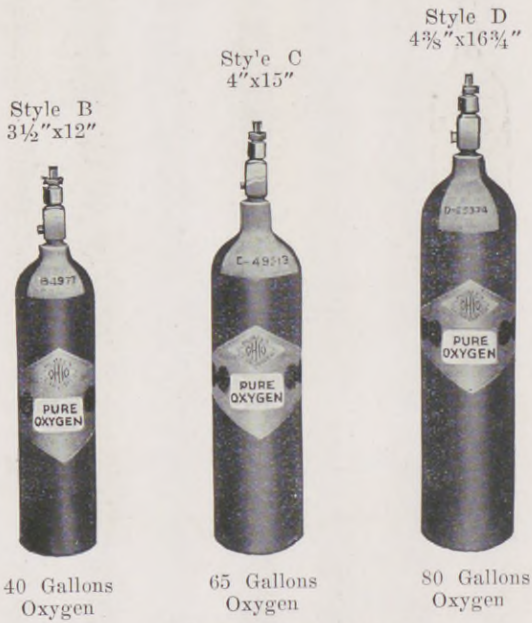

Fig. 15.—Oxygen cylinders.

Previous to 1868 N_2O was always given alone or with a little air. Since that time oxygen has been used with the gas. Used alone N_2O can be given only for very short operations, anesthesia being produced in 30 to 60 seconds and about the same length of time is available

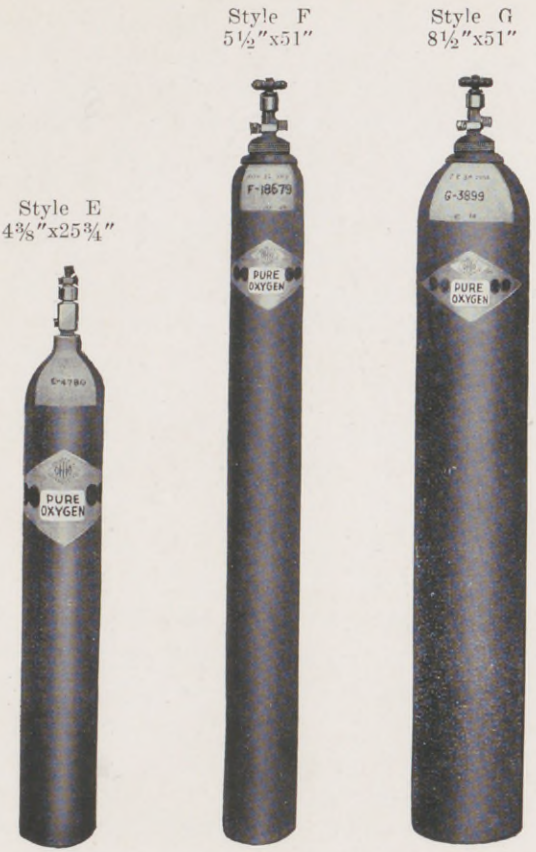

Fig. 15.—Oxygen cylinders.

for operation, sufficient to extract one or two teeth or for other short operation.

The reason that it is impracticable to give N_2O and air is that at least 40 per cent of the mixture must be composed of air to provide sufficient for existence. The

remaining 60 per cent N_2O is not sufficient to maintain anesthesia, 90 per cent to 92 per cent being required for this purpose in the majority of patients. Air is composed of four-fifths nitrogen, an inert gas; 40 per cent air contains only 8 per cent of oxygen. If, therefore, 8 per cent pure oxygen be used, the nitrogen of

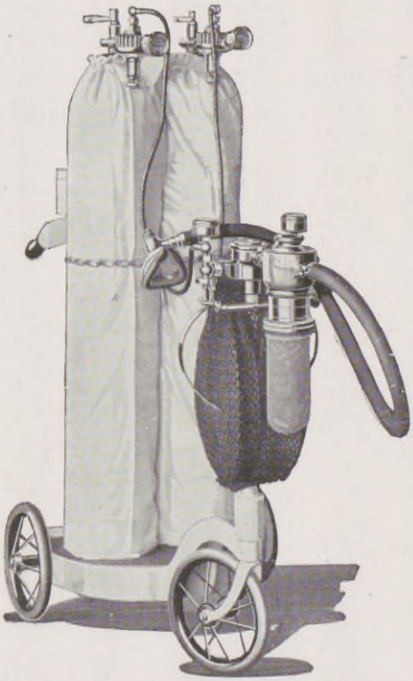

Fig. 16.—McKesson nitrous oxide-oxygen machine.

the air is eliminated and can be replaced by N_2O which gives a mixture of 92 per cent N_2O with 8 per cent oxygen, a quite workable mixture and one which will be found to suit most cases, though in some it will be found necessary to reduce the quantity of nitrous oxide with a consequent increase of oxygen in order to maintain a

desirable condition. By the use of oxygen with nitrous oxide we are now able to maintain anesthesia for operations of any duration.

Nitrous oxide is the most pleasant of all the anesthetics to inhale, but at the commencement, enough oxygen should be given in the mixture—5 per cent usually is sufficient—to prevent any feeling of suffocation which many do experience if the pure gas is presented at once. In a short time the patient reaches a state in which no discomfort is experienced if pure nitrous oxide be turned on for a short time. This, however, will seldom be found necessary, the patient passing into a satisfactory condition with the above mixture, which is modified as anesthesia progresses by increasing the oxygen to suit the needs of the case in hand.

Unlike ether, in nitrous oxide the stages of narcosis follow with such rapidity that the anesthetist must be always alert to note changes in color, etc., owing to the swiftness with which a fatal degree of anesthesia may be reached; although the safest anesthetic in the hand of the expert, it is the most dangerous one when in the hands of a novice.

The machine for administering the gas must be sufficiently flexible to permit of instant alteration in the relative quantity of the two gases, also it must be possible to at once give pure oxygen at a positive pressure should the need for this arise.

Some machines are arranged to permit of rebreathing a certain proportion of the gases exhaled. This conduces to economy and within bounds is of advantage especially when the exact quantity of rebreathing can be predetermined and the rebreathing bag fixed at this quantity, which in some machines is possible, without any admixture of carbon dioxide or other products of

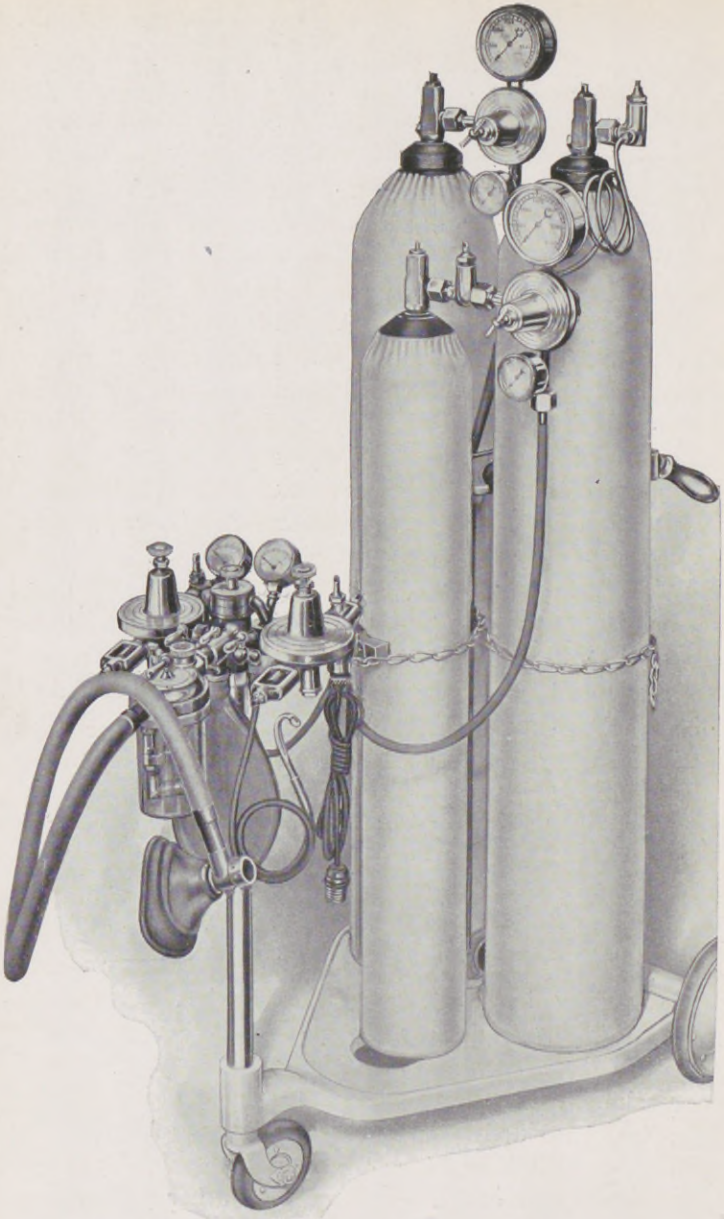

Fig. 17.—Heidbrink nitrous oxide-oxygen machine.

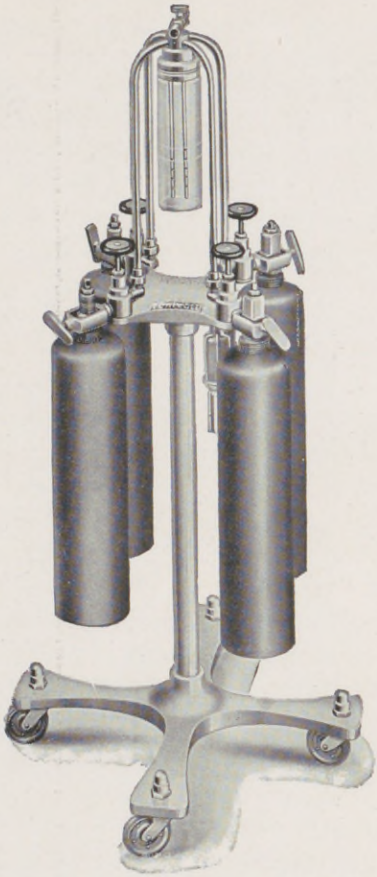

Fig. 18.—The Gwathmey nitrous oxide-oxygen apparatus. In this machine the two gases pass, each through a tube enclosed in the water bottle, the flow, and therefore the quantity used, being thus rendered visible.

exhalation. During normal inspiration one takes in 500 c.c. of air. Of this, 140 c.c. remain in the mouth, trachea and larger bronchi; being returned during expiration practically unchanged. If it be arranged that this 140

c.c. is caught in some retainer such as a rubber bag and the remainder of the exhaled air allowed to pass into the atmosphere, the 140 c.c. which first passed out of the air passages can be rebreathed with the next inhalation and therefore that quantity of fresh gas saved. Should the patient breathe very deeply at normal rate, or rapidly at the normal depth, more oxygen will be taken in than necessary with a resultant shallowness, or even a pause in respiration when the blood becomes so overoxygenated that the center fails to receive sufficient stimulation. To prevent this from occurring in such cases one has only to increase the amount of rebreathing to 200 c.c. or even 250 c.c., thus allowing some of the carbon dioxide content of the exhaled air to be saved and used again, the carbon dioxide thus inhaled keeping the blood content normal. It is quite easy in this manner to ward off any danger of overoxygenation.

Administered with oxygen, the phenomena of nitrous oxide anesthesia make their appearance much more slowly than when nitrous oxide is administered pure. An attempt, therefore, will be made to divide the induction period into stages, as in ether and chloroform anesthesia.

First Stage.—The patient almost invariably inhales the gas readily, the taste not being unpleasant. There is a feeling of warmth to the lips, an indescribable though pleasant numbness and thrill. The respiration is at first quiet, but later becomes deeper and more rapid. Tinnitus may be present and a feeling of fullness and expansion of the head occasionally occurs. The pulse is fuller, probably due to constriction of the systemic arterioles. The eyelids may show slight twitching, consciousness is usually lost in 20 to 30 seconds from the commencement of induction.

Second Stage.—If left perfectly quiet, the patient generally lies without movement. Symptoms of excitement are very rare. If roughly handled or hurt, however, he will at once resent it by movements of the limbs and ejaculatory remarks, more or less violent according to the nature of the patient and the stimulus. Gentle handling, however, is usually tolerated and, if judiciously performed, preparations for operation may be proceeded with during this and the following stage in most patients. Dreams are common during this stage and are usually of a pleasant nature. Erotic dreams are sometimes experienced for which reason, if for no other, there should always be a third person present in the room during an administration of this anesthetic. The pulse is still full, the pupils somewhat dilated and the conjunctivae sensitive to touch. Duskiness may be present during this stage, especially in florid or obese patients, not so frequently in the weak or anemic. The color depends on the amount of oxygen administered and this has, in the former type, to be kept at the minimum in order to produce an effective anesthesia. Near the end of this stage the eyelids may separate slightly. The power of hearing may persist throughout this stage.

Third Stage.—A slight stertor is usually present and may be the first indication of this stage; occasionally it may be absent altogether. The respiration, which may have been somewhat irregular, becomes regular and usually increases in rapidity. Feeble breathing generally indicates the approach of a stage of overdose. The circulation continues good throughout nitrous oxide anesthesia. In those with a normal pulse the rate usually does not increase beyond 110 and is often about 80. Where the pulse rate, owing to some intercurrent dis-

case, is rapid, say 120, before the anesthetic, it often reaches 150 or even 160 during the course of anesthesia. If the preanesthetic rapid pulse is due only to a nervous condition of the patient, it generally becomes slower under the influence of the anesthetic, the nervous system then being relieved of all disturbing influences.

The muscles of the extremities are usually flaccid but this is frequently not the case with those of the abdomen, especially the recti, which often retain considerable rigidity even in deep nitrous oxide anesthesia. Jactitations may appear, or even clonic movements, or rigidity of the limbs. These are asphyxial in nature and caused by an insufficient percentage of oxygen in the mixture administered. Indeed, it is claimed that by suddenly giving a large excess of oxygen for a short period, after pushing the nitrous oxide to the danger point, perfect relaxation may be obtained, which persists usually till the end of the operation; or if rigidity again ensues the process may be repeated with equal results. In deep nitrous oxide anesthesia the superficial plantar reflex is abolished, but the deep patellar reflex persists.

The pupils are generally dilated in deep nitrous oxide anesthesia. In some cases, however, even with a free administration, they remain of normal size or even contracted.

The corneal reflex is not so reliable a guide as with other anesthetics. It may persist with a fixed eyeball and dilated pupil. It is usually not necessary to carry the anesthesia to the point of loss of this reflex except in abdominal section.

The color of the features depends on the quantity of oxygen admixture with the nitrous oxide, and in muscular or obese subjects it is often difficult to maintain a good color with perfect anesthesia, except by the addi-

tion of a little ether. The importance of maintaining a good color, however, with nitrous oxide anesthesia is not so pressing as with ether and chloroform. A certain amount of duskiness may be permitted with safety and in fact is frequently necessary to obtain a satisfactory condition of anesthesia. One must, however, always have at hand a sufficiently good pressure of oxygen to be able to rapidly reoxygenate the patient in case of necessity. The color of the patient cannot invariably be taken as a guide to the depth of anesthesia. The amount of muscular relaxation present must be the chief guide as to the perfection of anesthesia and to obtain this it is necessary, as previously stated, to saturate the tissues with the "gas" and so, in the obese and muscular to have a condition of more or less cyanosis or, what is perhaps more advisable, to administer a little ether with the mixture which enables one to use a greater proportion of oxygen and so maintain a good color.

Surgeons, who have been in the habit of working with ether anesthesia may show uneasiness regarding the condition of the patient; this will be overcome with experience. Again there is apt to be more venous bleeding in this condition, which is a decided disadvantage, but must be taken into consideration with the other obvious advantages of the anesthetic. Another disadvantage of allowing an accumulation of carbon dioxide is that postoperative vomiting seems to be increased thereby.

Anoxemic jactitations may occur and can be controlled by the admission of more oxygen.

The contraindications to the use of nitrous oxide often enumerated are (1) Respiratory obstruction, e.g., large tonsils, tumor, or cellulitis of the neck, emphysema, empyema. (2) Pronounced arteriosclerosis or atheroma.

(3) High blood pressure. (4) Aneurysm. (5) Dilated or fatty heart or uncompensated valvular lesions. In some of these conditions, if not in all, a careful administration with sufficient oxygen renders this anesthetic at least as safe in its immediate effects as other inhalation anesthetics, and safer as to its remote effects.

The normal condition of the blood, its power to destroy harmful bacteria, etc., is not disturbed at all or only very slightly by this anesthetic, while in the case of ether the normal bactericidal power of the blood is not restored to its preoperative level for from two to five days. Nitrous oxide is therefore the most favorable anesthetic to use in cases of sepsis, anemia, chronic debilitated or chronic tuberculous patients. In those with recently healed tuberculous foci the vigorous respiration of nitrous oxide anesthesia is apt to break down the newly formed adhesions and disseminate the disease to healthy portions of the lung.

CHAPTER V

ETHYLENE

Recently another anesthetic, used as far back as 1848 but abandoned at that time as unsatisfactory, has been revived, and, though not at present freely used, is well thought of by some. This is ethylene, C_2H_4, which is a colorless gas with a peculiar sweetish odor. It is only slightly soluble in water but alcohol and ether absorb about two volumes of the gas. Its boiling point is 105° C., somewhat lower than that of nitrous oxide, but, unlike that gas, it forms an explosive mixture with three volumes of oxygen. It is a constituent of all anesthetic ethers and is said to be one of the principal ingredients to which ether owes its anesthetic properties.

Owing to its pleasant odor this gas is readily inhaled. The percentage of oxygen used with it is greater than with nitrous oxide, usually 18 to 20 per cent being required.

The blood pressure is unchanged or only slightly depressed, to an even less degree than with nitrous oxide-oxygen, and what is of much importance, greater relaxation of the muscles is obtained.

Vomiting occurs in about 15 per cent of the cases, but is seldom severe.

The patient recovers from the effects of the gas as rapidly as after nitrous oxide-oxygen, being quite rational in two or three minutes.

The degree of muscular relaxation is said to approach that of ether, while in method of administration and physical properties it most resembles nitrous oxide.

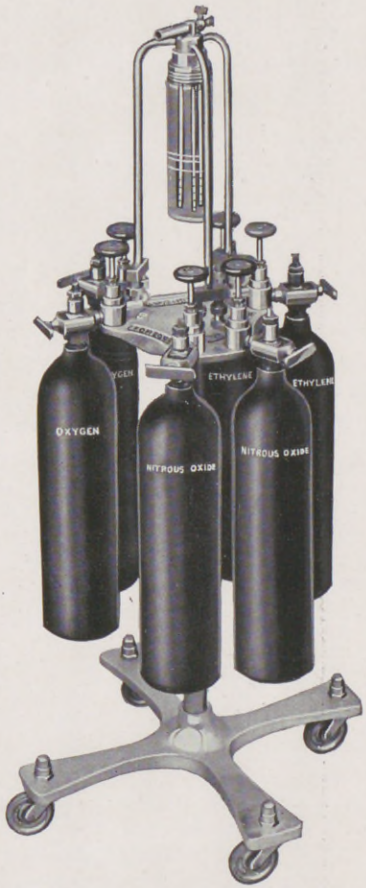

Fig. 19.—The Gwathmey nitrous oxide-ethylene-oxygen apparatus by which any of these gases, or any desired mixture of them, can be administered. The sight feed bottle, in this case, contains three tubes, from the openings in which the gases bubble through the water, the quantity of each used being thus made visible.

Whether it will oust either of these anesthetics from the favored position they now hold can only be settled by time and use. Until we possess records of a larger series

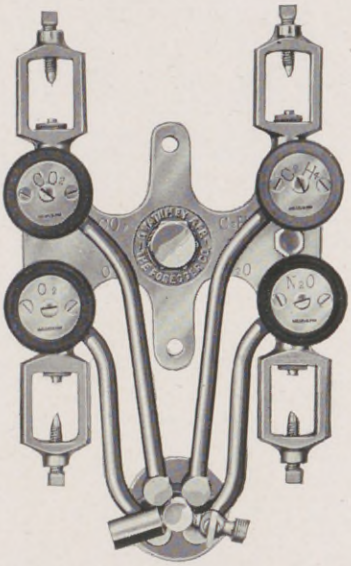

Fig. 20.—Top view of the "Seattle Model" Gwathmey apparatus showing arrangement of machine for the administration of nitrous oxide-ethylene-oxygen-carbon dioxide in any desired proportion.

of administrations from which to judge, it is impossible to state what position it is ultimately destined to hold in the future realm of anesthesia.

CHAPTER VI

CHLOROFORM

Chloroform is a colorless, transparent, mobile, volatile liquid with a pleasant, penetrating odor and a sweet fiery taste. Its specific gravity is 1.491, boiling point 142° F. It is soluble in cold water to the extent of one part in two hundred.

In the early days of chloroform anesthesia, it was customary to administer a strong vapor. This was later shown to be extremely dangerous, and various experiments led to the belief that the most dilute vapor capable of producing the necessary degree of anesthesia, in a reasonable time, should be used, and that on no account should a vapor of more than 4 per cent be administered; most cases being anesthetized with a 2 to 3 per cent vapor; while after induction was complete a .75 per cent vapor was usually sufficient to maintain a satisfactory degree of anesthesia.

To insure the greatest degree of safety possible, many inhalers have been designed to administer this drug in exact dosage, that of Vernon Harcourt being probably the most portable. This at first was designed to give a maximum strength of 2 per cent but later, on account of the length of time required to establish a satisfactory anesthesia in many cases, it was modified to give a maximum of 3 per cent.

The simplest to use and probably the most popular inhaler is an Esmarch mask which comprises a wire frame over which is stretched one layer of stockinette, the chloroform being administered on this drop by drop. A rough estimate of the percentage given can be ob-

tained, as by careful quantitative tests it has been shown that when the small square, measuring about one square inch, in the center of the mask is kept moist, about a 1 per cent vapor is inhaled; this is increased as the chloroform moistens a greater area; until, when

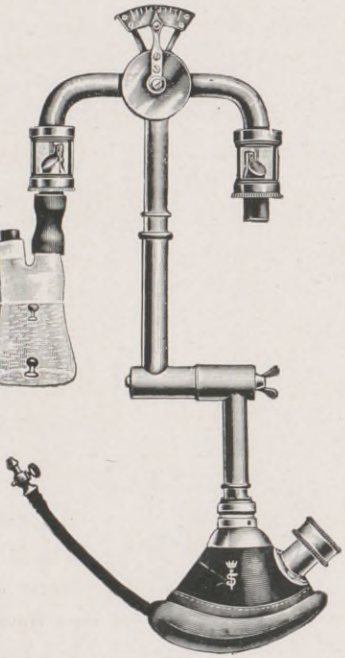

Fig. 21.—The Harcourt chloroform inhaler.

the whole surface of the mask is wet, the vapor reaches 4 per cent. In using this mask, therefore, it is advisable to always drop the chloroform on the center; the spread of the liquid can then be observed and an idea of the strength of vapor presented to the patient kept visible to the mind of the anesthetist.

First Stage.—The sweetish taste and odor of chloroform are usually found pleasant by the patient, and it is taken without discomfort, unless the vapor is presented too strongly at the beginning. It should be dropped very slowly at first keeping the vapor dilute, or holding of the breath, coughing and resistance may develop. These symptoms are almost invariably absent, however, in all but those addicted to the abuse of tobacco, alcoholics, the victims of drug habits, and nervous

Fig. 22.—The Esmarch chloroform mask and drop bottle.

children. Numbness, tingling of the extremities, flashes of light, buzzing in the ears, or louder noises of various kinds are mentioned as heard by the patient. The increased cardiac action may be complained of by some patients.

Second Stage.—The patient gradually loses consciousness of his surroundings and a period of excitement may ensue as described in the same stage of ether anesthesia. This is almost wholly confined, however, to the

types above mentioned. Any attempts at struggling should be controlled with the exercise of the smallest possible amount of force, care being taken not to compress the chest or abdomen. Should the breath be held long enough to bring on cyanosis it will be necessary to remove the anesthetic at an earlier period than in the case of ether on account of the effect of chloroform upon the heart. Fortunately, however, owing to the relative ease with which it is inhaled the above symptoms rarely appear.

In some patients, after induction has proceeded for a few minutes, a condition often described as "false anesthesia" occurs. The breathing becomes extremely shallow and the face pallid. This state is most commonly induced by too prolonged an administration of a weak mixture. Friction applied to the lips and face will sometimes produce deeper breathing, but if the condition becomes extreme, it may be necessary to withhold the anesthetic for a time, in which case the condition usually terminates in a fit of vomiting after which the patient progresses satisfactorily. There is sometimes danger of the inexperienced mistaking this condition for a deep, third stage degree of anesthesia and allowing the surgeon to commence his operation. The incision immediately results in active reflex movement and outcry, the aseptic preparations are disturbed, resulting in a delay, and often the necessity of replacing towels, etc., at the site of operation. It is important therefore that the anesthetist recognize this condition in time.

The pupils are generally mobile, more or less dilated and react to light, but often sluggishly, during this stage. As the end of this stage approaches they tend to contract and become less mobile.

Third Stage.—The third stage is the stage of complete anesthesia, the breathing becomes regular, quiet, or softly snoring. In the plethoric or fat subject it may be more stertorous. If the jaw falls back too much, it may be necessary to push it forward and in some cases to hold it forward during the whole period of anesthesia in order to maintain free respiration. Stridulous laryngeal breathing may occur in some cases, generally in children, and if pronounced, it usually indicates the necessity for less anesthetic.

As a rule the pulse approaches the normal in rate. In people with an abnormally slow pulse it usually remains slow during anesthesia, e.g., though the pulse in the average person is usually between 70 and 80, it may remain as slow as 40 throughout the whole administration in some cases, though this is exceptional. The blood pressure falls 15 to 30 mm. of mercury.

The eyeballs may be fixed, but usually one or both move slowly from side to side.

The pupil still reacts sluggishly to light unless anesthesia be very deep. It is slightly contracted in most cases, being from 1.5 to 3 mm. in diameter. Occasionally, particularly in old people, one may have a very small pupil, 1 to 1.5 mm. and still have satisfactory anesthesia; this may be on account of the lessened sensitiveness to stimuli in old age. Sometimes it is necessary to keep the pupil at 4 or 4.5 mm. for satisfactory anesthesia. After the operation has proceeded for 5 or 10 minutes the size of the pupil is a good guide to the depth of anesthesia, unless it is modified by some preliminary medication. The muscular system is relaxed, except in an occasional case where the recti abdomini may remain rigid. The rigidity can usually be abolished by pushing the anesthesia further, but this needs very

careful watching as in some instances a dangerous condition may develop with the degree of anesthesia required to abolish all rigidity. This condition occurs far less often than with ether anesthesia.

The face and lips are, as a rule, paler than usual but may retain normal color, provided there is no obstruction to respiration. Any obstruction will cause more or less duskiness, according to the degree of interference with respiration. In anemic or weak patients the color remains far better in the Trendelenburg position, as would be expected with an anesthetic which depresses the heart.

Mucus and saliva are not secreted in sufficient quantity to cause trouble as with ether.

The bodily temperature is on the average reduced by about 1° F.

It is sometimes possible in the case of very young children to chloroform them during sleep. Using an Esmarch's or Skinner's mask, place one or two drops of chloroform on the gauze, holding the mask some inches above the face, and gradually bring it closer giving a very dilute vapor for some time. The child may show only a slight restlessness or make a few swallowing movements and pass from natural slumber to the anesthetic sleep without awaking. Most of these attempts, however, will be failures, the inhalation of the chloroform vapor causing the child to awake, not necessarily to cry, although this frequently happens, but to move the head and eyeballs from side to side for a minute or so before the anesthetic sleep overcomes him. In the same way many children take chloroform, even though awake, without any attempt to resist or cry out, if told to expect the sweetish odor, apparently more pleasant to the average child than to the adult.

After a child has held its breath during crying and resistance, it usually takes in several deep inspirations and if the mask contains much chloroform a large amount of vapor may be taken in with each inspiration. Even with two or three such long breaths a quantity sufficient to produce deep anesthesia may be inhaled and the result of this will not be apparent until about one minute after, so that great care must be taken to remove the mask in time or serious risk of overdose is incurred.

There appears to be a widespread belief that chloroform is much safer in children than in adults; this is not borne out by experience. The author believes that the danger from anesthesia is somewhat greater in young children and infants than in the adult subject. This also pertains to the other extreme of life, old age.

CHAPTER VII

ETHYL CHLORIDE, ETHYL BROMIDE AND SOMNOFORM

Ethyl Chloride

Ethyl chloride is a colorless, very volatile liquid with an aromatic odor and sweetish taste. Its specific gravity is .9214 at 32° F. The boiling point, 56.5° F., is below that of ordinary room temperature so that it is only kept in a liquid state by being held in sealed containers. It is supplied in glass capsules containing 3 c.c. or 5 c.c.—the former dose suitable for children, the latter the adult dose—and in larger containers of 50 to 100 c.c. fitted with a spraying nozzle. Like ether it is highly inflammable.

It may be administered by either the open or closed method, the latter, of course, being the most economical.

When giving by the open method, it is usually sprayed on the ordinary ether mask or, it may be sprayed into the filler tube of the Webster ether inhaler. Many closed inhalers are in use where the rebreathing method of administration is desired, the one shown below being quite satisfactory. Used in this manner a capsule, 3 or 5 c.c., is inserted in the chamber for it. The inhaler having been applied to the face, the capsule is broken, the liquid spraying into the bag where it quickly changes into a gas. If it is desired to prolong the anesthesia, further capsules may be used; but to maintain the color the facepiece must be lifted from time to time and a breath or two of fresh air admitted. The induction period by the latter method is usually 40 to 60 seconds

and the period of anesthesia from 40 seconds to 3 minutes. By the open method induction will usually take about 4 minutes.

Its chief use is for short operations or for inducing anesthesia before ether. A more pleasant and shorter induction period is obtained by this means than where ether is used from the start.

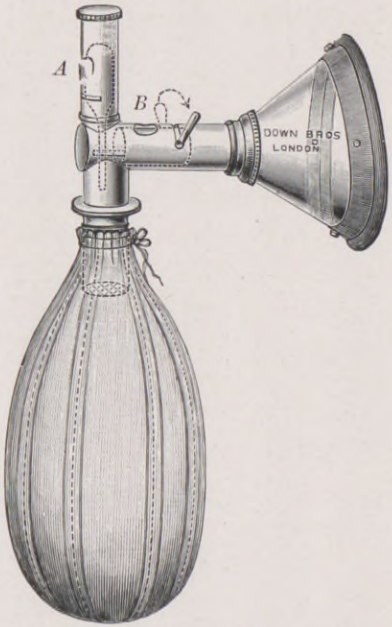

Fig. 23.—Ethyl chloride inhaler.

Stages of Anesthesia.—As with nitrous oxide when given without oxygen, the rapidity with which anesthesia is produced makes it difficult, often impossible, to differentiate the stages. There is first a quivering of the upper eyelids. The breathing soon becomes deeper and more rapid, remaining regular. A little later vibratory

movements of the larynx are felt by the fingers under the chin which in a few minutes deepen until the characteristic laryngeal stertor is established. About the same time that the breathing deepens the patient's color improves, the face becoming a healthy red. In some cases a light perspiration breaks out over the face and neck. The eyeballs at first move from side to side, later becoming fixed and turned either upwards or downwards. The pupils are widely dilated and do not react to light. The corneal reflex is absent. The muscles are relaxed, except the masseters, which in about one case out of three remain rigid.

Fourth Stage.—Overdose.—The pupils are widely dilated and fixed, eyelids separated, breathing shallow or absent, face pale, pulse weak and rapid.

The usual remedial measures are employed in overdose. The volatility of this drug, however, is such that artificial respiration causes rapid elimination and the color and normal respiration returns, as a rule, after three or four inspirations.

It is advisable, owing to the possible spasm of the masseters, to insert a gag before commencing the induction should the proposed operation be in the mouth. This enables the mouth to be promptly opened without loss of time even with the masseters contracted.

After effects are less severe than with ether or chloroform. Vomiting is rare after short administrations. It is well to keep the patient in a recumbent position for about half an hour after the anesthesia. The preparation should be the same as for other general anesthetics, though this is not so imperative as with ether and chloroform.

Ethyl Bromide

Ethyl Bromide, C_2H_5Br., monobromethane, is a colorless, mobile, heavy, refractive liquid with a chloroform-like odor and a sweetish taste. Its specific gravity is 1.453, its boiling point 98.6° F., slightly higher than that of ether, so that, unlike ethyl chloride, it does not require to be kept under pressure, but can be dropped or poured on, or into, an inhaler in a manner similar to ether. Much less of the drug is required to induce anesthesia than in the case of ether, three or four drams usually sufficing. If exposed to light it soon takes on a brownish tinge. Unlike ethyl chloride and ether, it is not readily inflammable.

It may be administered either in an open or closed type of inhaler. In the former case the induction usually takes about four minutes, by the latter method sixty to ninety seconds. The available anesthesia is about the duration of that of ethyl chloride and the signs of anesthesia practically similar.

Although it has been used for extensive operations, it is here inferior to ether both in safety and in the matter of cost. As far as statistics are at present available, it is about half as safe as ethyl chloride and less agreeable to inhale.

Although tried rather extensively some twenty years ago it has practically fallen into disuse and is mentioned here chiefly on account of its being a constituent of somnoform.

Somnoform

The mixture sold under the name of somnoform was first introduced in France but its use has now spread extensively, chiefly among the dental fraternities of the United States and Canada. Originally the composition

was given as ethyl chloride 65 per cent, ethyl bromide 5 per cent and methyl chloride 30 per cent. That now vended it is claimed contains ethyl chloride 83 per cent, ethyl bromide 1 per cent, methyl chloride 16 per cent. Further, it was shown some time ago that a quantity of this mixture sold in the United States contained no ethyl bromide.

Aside from the fact that we avoid the use of methyl compounds in anesthesia on account of their recognized danger, when we consider that methyl chloride boils at 22° below zero and that therefore it must escape rapidly into the air on being released from pressure, also that the quantity is less than one-fifth of the ethyl chloride in the mixture, it would appear that it can have little or no effect on the anesthesia. Similarly it requires about four times as much ethyl bromide to produce the same effect as a certain quantity of ethyl chloride. The quantity of ethyl bromide contained in somnoform is one one-hundredth of the whole, therefore only one four-hundredth of the anesthetic content; surely so negligible a quantity can have no effect except on the imagination. It therefore remains that the ethyl chloride content of somnoform produces the anesthesia.

After careful research with ethyl chloride, ethyl bromide and somnoform, the author came to the conclusion that where an anesthesia of this type was indicated ethyl chloride is the most satisfactory and the safest.

The methods of anesthesia are those of ethyl chloride.

Ethyl bromide and somnoform are mentioned chiefly that the nurse may have some knowledge of these volatile compounds when they are discussed or administered in her presence.

CHAPTER VIII

LOCAL AND SPINAL ANALGESIA

These methods of anesthesia aim at producing loss of sensation in a part to be operated upon, the patient still retaining sensation in other parts of the body. The functions of speech, sight, hearing, mentality, which in the course of a general anesthetic are all in abeyance, are left unaffected. On this account there exists, in most people, some anxiety as to the possibility of painful stimuli. Any great anxiety on this score should prevent its use in such patients, as the mental strain is likely to produce far more harmful results than could a general anesthetic. These results are not always seen at the time, the patient coming under the care of the neurologist at a later date.

Local Anesthesia

Anesthesia of a part may be produced in various ways; the most usual at present being by infiltration of the skin, subcutaneous tissue, muscles, etc., with weak solutions of novocaine or stovaine; while for the intestines a one per cent solution of quinine-urea hydrochloride is used.

The nurse will be required to prepare syringe and needles for local or spinal anesthesia. The syringe used for local anesthesia is usually of about 30 c.c. capacity, as weak solutions and large quantities are generally used here, 1 per cent, .5 per cent or .25 per cent being most commonly used, the latter most of all. The nurse should keep in mind the total amount used, as this information will be required for the operation records.

Often the local anesthesia is used in conjunction with a general anesthetic with the idea in abdominal operations of obtaining greater muscular relaxation, or, in

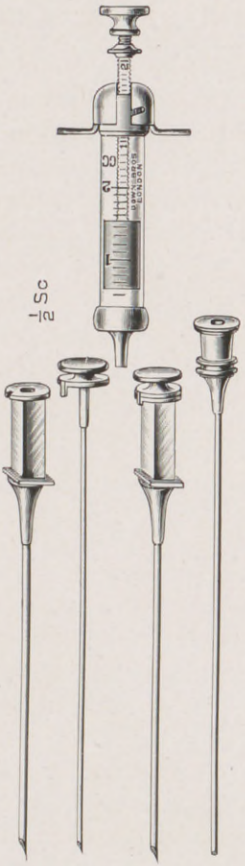

Fig. 24.—Syringe and needles for spinal analgesia.

other parts of the body, of being able to proceed with a lighter general anesthesia.

For spinal anesthesia the syringe used need only be

of small capacity, 2 c.c. being sufficient, as the quantity of solution used is small. The solution is put up in sealed capsules of 1 c.c. capacity already sterilized. From .7 c.c. to 1 c.c. of the solution is generally used.

In sterilizing the syringe and needles, great care must be used, if boiled in hard water, to wash away all traces of deposit from the water by passing distilled water several times through both syringe and needle. If this is neglected, the alkaline salts contained in the water will neutralize stovaine, which is often the drug used, rendering it inert and the injection consequently of no avail.

The same precautions regarding asepsis will be taken as for a major operation, it being readily seen that should any infection be conveyed into the spinal canal the result will be an attack of cerebrospinal meningitis and almost certainly death within a few days. For this reason it is considered unwise to use this method of anesthesia in patients who are the subject of any infective process, though some use it where the infection is limited to a definite part of the body remote from the site of injection.

The drugs now used for local and spinal anesthesia are usually novocaine or stovaine. These drugs possess about one-third the toxicity of cocaine which was formerly used. Recently butyn has been used but shows no sign at present of superseding novocaine or stovaine. Cocaine is still utilized to a great extent for nose and throat surgery, the less toxic drugs above mentioned being considered inadequate for the purpose. In tonsillectomies it is injected by syringe, but in nasal operations strips of gauze moistened with a 10 per cent solution are packed into the nose, the mucosa becoming sufficiently anesthetized by this means. The quantity

and rate of absorption into the system is very uncertain when this method is used, and should absorption proceed at a much greater rate than excretion, a poisonous dose is soon retained within the system, resulting in some cases in a fatality. It is important that the nurse bear this in mind and exercise due care to wring out the saturated strips of gauze as dry as possible, the anesthesia being produced quite effectively by gauze in this condition, while the risk of overabsorption is much lessened.

Before infiltration of any drug is proceeded with, the skin is prepared in the ordinary way for operation; the one injecting the drug must also prepare his hands as for an operation.

Spinal Analgesia

The injection for spinal analgesia is usually made between the third and fourth lumbar vertebræ. A line drawn across the back at the level of the iliac crests passes over the fourth spinous process. The point of entry of the needle is about half an inch above this line a little below the center of the third interspace then directed inward and slightly upward, almost at right angles to the body. The area about this point and the anesthetist's hands will require to be as carefully prepared as for a major surgical operation, the serious result of any infection carried into the spinal canal having already been mentioned. Sensation may be dulled at the point of entry of the needle, if desired, by a spray of ethyl chloride directed for a few seconds on the part.

This method of analgesia is not considered advisable in operations above the umbilicus, any anesthesia extending higher than the ensiform cartilage, being dan-

gerous on account of the possible paralysis of the muscles of respiration and consequent embarrassment of that function. It will be seen that its principal use is for operations about the lower limbs or pelvis, amputation after crushing injuries of the legs, hemorrhoids, etc. It has been used in parturition.

The immediate after-effects are very slight, sometimes a little headache.

There are more serious sequelæ though, which sometimes appear later; paralysis of the anal sphincter and that of the bladder, which may persist for two or three weeks or even longer, are among the most serious. In from 3 to 7 per cent of the cases there is failure to produce complete analgesia. The dose may be repeated in these cases, but it is more usual to proceed with the operation under a general anesthetic in such instances.

CHAPTER IX

ANESTHETIC MIXTURES AND SEQUENCES

We have so far dealt with anesthetics separately. It is often advisable, however, to use more than one anesthetic in a given case, either by the mixture of two or more anesthetics, as the well-known A.C.E. or C.E. mixture, or by the induction with one anesthetic, the continuation of the anesthesia being carried on by another considered more suitable for this purpose. A.C.E. consists of one part alcohol, two parts chloroform and three parts ether. C.E. is this mixture with the alcohol omitted. Originally the alcohol was put in chiefly with the idea of keeping the solution from deterioration, but it has been found unnecessary for that purpose. The question has arisen whether we have here simply a mechanical mixture of two drugs or whether some chemical change has taken place. In favor of the latter is the fact that on mixing these drugs a certain amount of heat is generated, quite sufficient to be distinctly observable. Various other proportions of ether and chloroform have been used, e.g., 5 to 1, 16 to 1 and 32 to 1, the two latter, of course, being administered in the same manner as ether, while A.C.E. or C.E. mixture is administered chiefly on an open mask similar to the administration of chloroform. Anesthol is another mixture used so far chiefly in the United States. It consists of ether 47.11 per cent, chloroform 35.89 per cent and ethyl chloride 17 per cent.

Those mixtures containing a large proportion of chloroform such as the A.C.E. and C.E. have a fruity odor and less irritating properties than ether. They are often used for the early part of, or whole of, the induc-

tion of anesthesia, preliminary to ether; thus avoiding the unpleasant early effects of ether.

Again, a better relaxation of the abdominal muscles is obtained with this mixture than with ether which causes some to prefer it to the latter, while it is less depressant than chloroform. Combining thus some of the advantages of both, it has been widely used though not so much now as formerly. This is probably partly owing to the increased use of nitrous oxide or ethyl chloride for induction.

Owing to their fruity odor, if not presented too strongly at the beginning, A.C.E. and C.E. are pleasant to inhale. The symptoms are much like those of chloroform, the respiration is more inclined to a light stertor than with chloroform but is often quiet. In administering, it must be borne in mind that the ether content of the mixture is more rapidly evaporated than chloroform so that if considerable is placed on the mask at one time, the proportion of ether will be greater at first and later almost pure chloroform may be left on the mask. The administration therefore should be as regular as possible in order that the proportion of the ingredients may remain constant throughout. Those inhalers having a separate bottle for the chloroform and ether, e.g., Stock's and Gwathmey's, can be regulated to give a mixture of any desired proportion, which is maintained throughout with more evenness than is possible when dropping the mixture on an open mask.

The sequences usually used in anesthesia are A.C.E., or C.E. followed by ether; some use chloroform instead of the former but this sequence is more common in Europe than on the American Continent. Nitrous oxide followed by ether, or ethyl chloride followed by ether, are both sequences much used. Others are in vogue, but to a much less extent and therefore need not be considered here.

CHAPTER X

PREOPERATIVE AND POSTOPERATIVE CARE OF THE PATIENT

Sometimes the patient has been an inhabitant of the hospital for days or weeks before operation and has become familiar with the routine and with the nurse or nurses in charge of that particular section of the hospital. The large proportion, however, are admitted only the day before that on which their operation is to take place and, as in the majority of cases it is their first operation, it is also their first introduction to the routine and observances of a hospital. In all these, however, an opportunity is given to become at least a little familiar with their surroundings. The practice of only admitting the patient on the morning of operation, often just in time to be hastily disrobed and hurried to the operating room cannot be too strongly condemned except in the matter of the most trivial operations, in accident, or other emergency cases.

With those patients arriving at the hospital just before the hour set for operation the nurse has little to do beforehand, except to hurriedly undress them and get them to the operating room. Any preliminary treatment that may have been ordered by the surgeon has had perforce to be done at home, and whether this has been properly carried out or not is often a matter of uncertainty. With those admitted on the day previous or earlier, however, the preparation comes under the nurse's hands. It was formerly the practice to give a purgative the night before operation with an enema on the morning of operation, sometimes preceded by a

saline cathartic. This drastic treatment has gradually been modified. If a purgative be administered it should be not less than 36 hours before operation, better 48 hours before, followed by an enema the night before operation if that is considered necessary. However, the purgative is now usually omitted altogether, an enema the evening previous to operation being found quite sufficient. One must bear in mind that in some people who have never had occasion to use an enema before it induces a feeling of weakness and faintness; in fact when purgation, followed by an enema on the morning of operation, was in vogue an occasional patient reached the operating room in a state of collapse and had to be returned to the ward and the operation postponed to a later date. Unless the requirements of the operation demand a completely empty intestine it is advisable that some of the contents be retained; as the completely empty bowel, containing nothing to stimulate peristalsis, lies in a condition of stasis which is conducive to the multiplication of bacteria and therefore excessive gas formation. How often when the surgeon opens an abdomen in a so-called well prepared patient do we see a mass of intestines distended with gas try to force their way through the incision, causing infinite trouble in attempting to retain them within the cavity and therefore delay to the operation. In these cases there is necessarily a good deal of handling of the intestines in addition to the delay, both of which are most undesirable concomitants in any surgical procedure, for they conduce to a postoperative paralysis of the intestine and consequent further gas formation. The distended abdomen thus induced causes considerable distress and sometimes severe pain after the operation, interfering with sleep and so prolonging the period of convalescence.

The early morning hours are the most desirable for operation if it can be so arranged. Unfortunately in a large hospital with a number of operations performed daily, it is impossible to have all take place in the early morning. Some have perforce to be relegated to the later hours. The patient is brighter and fresher with his reserve of energy at its highest after the night's rest. The stomach is empty and no time is allowed for the feeling of hunger to assert itself as it may later, causing in some, distress and a feeling of weakness.

When an operation is to take place during the morning hours, a light meal is given about 6 P.M. the previous evening, nothing being allowed afterwards except perhaps water if requested. There can be no objection to the latter beverage as it is rather an advantage to have the patient's tissues well supplied with fluid beforehand. It tends to lessen the occurrence of severe postoperative thirst with its attendant discomfort.

Should the operation be set for a later hour, say after midday, it is advisable in many cases to give some nourishment in the early morning, 6 or 7 A.M., if the patient has a desire for food. The extremely nervous in whom this desire is absent are better left without food, as if taken it will in all probability remain undigested in the stomach only to be vomited after the operation or, lacking a well conducted administration, at the time of induction of anesthesia.

In patients exhausted from some prolonged disease or suffering and also in old people and very young children, food should not be withheld as long as in those in the prime of life. With very old or feeble patients a little clear soup or stimulant may be given during the night preceding the operation. In very young children and infants it is inadvisable to withhold

food longer than the usual interval between meals for a child of that age. The same applies to giving food after the operation should there be no contraindication from the nature of the operation itself.

In some people smoking is a deeply ingrained habit and deprivation of the soothing weed results in a certain amount of discomfort and possible irritability. Still it is advisable that the practice be discontinued if possible for one or two days before an operation. The pernicious habit of allowing patients to smoke up to the time of operation, especially in those who smoke to excess, cannot be too strongly condemned. The pharyngeal and laryngeal irritation thus produced and kept up until shortly before operation, becomes a positive menace to the one indulging and a source of extreme anxiety to the anesthetist. The anesthetic, particularly if ether is used, causes such irritation of the chronically inflamed throat that a spasmodic closure of the glottis may occur and respiration be severely hampered. The anesthetic in some cases may even have to be temporarily withdrawn, until a sufficient airway is established, thus prolonging the induction with loss of time and energy, the latter most severe on the patient himself, especially as many excessive smokers possess a heart muscle already considerably weakened by overindulgence in their favorite weed. The habitual smoker does not realize that the use of tobacco is harmful at this time, in fact he probably appreciates its soothing influence more now than ordinarily, and it may therefore be necessary to explain that its irritating effect makes it difficult to take an otherwise easy anesthetic. This information must be imparted judiciously so as not to raise any feeling of alarm in the patient's mind regarding the outcome of his operation, but rather to impress him with the view

that every detail in connection with his operation has been well thought out and that all is being done for his especial benefit.

It will also be the duty of the nurse to see that the bladder has been emptied normally, or in case of failure in this respect for some reason, to report the same to the attending physician or house surgeon in order that the necessary attention may be given. Dental plates and trinkets should be removed before the patient leaves the ward. Sacred emblems worn about the neck may be retained unless the operation involves this part of the body.

The temperature of the room should be about 70° F.; where the atmosphere contains a fair degree of moisture, 65° to 66° will suffice, but the patient must be kept sufficiently covered for comfort and especially must this be looked after during his transit to the operating room, the more so if the corridors are cool and draughty. It is customary to put long stockings on the patients, which cover feet and legs completely, before sending them to the operating room, in addition to the requisite blankets. One sees the necessity of this when we realize that during an operation under anesthesia the bodily temperature invariably falls between one and two degrees.

Some operating tables are heated either by electricity or hot water but this method of conserving bodily heat increases the complications of the operating table, is generally unnecessary in a properly heated operating room, and indeed seems to be falling into disuse. If necessary, hot water bottles may be placed at the feet, or alongside the body, in parts where they will not interfere with the field of operation.

Anesthesia may be induced either in a room set apart

for that purpose and adjoining the operating room or in the operating room itself, the latter method being perhaps the most common at the present time. If it is given in the anesthetic room, a nurse should be available to restrain the patient if necessary. It is better that the nurse hold the patient's hands than the reverse, as some muscular patients may exert sufficient pressure to cause discomfort if not positive pain when the higher controlling centers cease to function. Restraint will seldom be needed, however, if an efficient anesthetist is officiating; the confidence of the patient being gained, his skill in conducting the induction insures in all but the most intractable cases, a smooth, comfortable anesthesia. It should be unnecessary in these days of skilled nursing to utter a warning on the matter of injudicious talk, but one occasionally hears such tactless speech in the patient's presence, before unconsciousness supervenes, that it is necessary to call attention to the matter. This thoughtlessness is not by any means confined to the nurses, but during induction in the operating room the surgeon and his assistants may talk about some previous case which had an unfortunate ending, or even about the prospects of the case in hand. The sense of hearing is very acute in the early part of induction and the patient naturally listens with great intentness for any expression of opinion in relation to the impending operation, and if he is very nervous, he may even construe some perfectly innocent remark into an expression of pessimism. Some of the more innocent remarks made by the surgeons, assistants or nurses, or occasionally by the family physician when present, are that "it will be disagreeable at first" or that "it will feel choky at first," but that they must not mind—one might as well try to comfort a criminal about to be

hanged with the latter statement. It really seems ridiculous to have to mention this in these days, but I have heard these remarks repeatedly and many much more calculated to rouse alarm; this, too, after the patient had been brought into a calm state and was ready to take the anesthetic as directed. It cannot be too strongly impressed on all that the anesthetist is the only one who should address the patient after he has taken charge of the induction, be it in the anesthetic or operating room. He it is who is most fitted by training for this and who must be solely responsible for the result.

The necessary preparation of the patient for operation should not be commenced until the anesthetist gives the signal. It is seldom necessary to wait until the patient is completely anesthetized. The preparation may be begun synchronously with the application of the inhaler, particularly in bad cases where time is an important element to success. Often it is advisable to wait until towards the end of the second stage of anesthesia. It must not be supposed, however, that because a patient is partially anesthetized he can be handled roughly. If the preparation is to be carried out simultaneously with induction every movement, such as placing the patient's arms in position, application of alcohol, ether or iodine to the skin, etc., must be performed gently. This is apparently not always realized, and the limbs are often hastily jerked into position causing resistance on the part of the patient and a consequent delay in the proceedings, or, should the lithotomy position be the one of election, when lifting the legs in order to fasten the feet in the leg holders, if a hand is first placed behind the knee joint the knee will usually bend readily; the other hand may be placed above the ankle to assist. Many nurses, however, first grasp the sole of the foot

and press upwards expecting the knee to bend. The result is a stiffening at the knee and a jerking of the limb which by this action has been thrown into a condition of clonus. The result is that one has usually to wait until complete relaxation occurs. It should be the aim of the nurse to proceed with the preparation in a gentle, quiet manner in all cases, whatever the stage of anesthesia.

In some cases owing to intense nervousness, alcoholism, etc., it is unwise to attempt any preparation until complete anesthesia supervenes. Whether the patient in question is such an one is for the person administering the anesthetic to decide, and it is for this reason that on the anesthetist devolves the responsibility of giving the signal for commencement of the work.

On some operating tables straps are provided for fastening the wrists and legs, the patient being firmly secured to the table before the administration is begun. The more usual method, however, is to pass a folded sheet beneath the back, passing the ends over the wrists and forearm on either side and tucking the loose end under the arm and back. This prevents the arm from slipping off the table and hanging with the inner side pressed against the table edge, a position which may cause temporary paralysis of the musculospiral nerve from pressure. Fastened in this manner the arms are not easily withdrawn, but require some effort to move them.

On completion of the operation, it will often be necessary to change the nightgown worn by the patient either on account of soiling with blood, iodine, etc., or on account of dampness from the patient's perspiration; it is usual therefore to have a spare gown kept warm during the operation ready for the change, as well as

warm blankets to cover both stretcher and patient in order that the body shall not come in contact with any cold surface and shall also be protected from draughts or chilling while being conveyed through cold passages. These precautions are even more necessary during transit back to the ward than during the trip to the operating room from the ward, the patient's vitality having now been more or less lowered, according to the severity of the operation and the degree of resistance. A nurse will, of course, accompany the patient to and from the operating room and will see that there is no loitering or unnecessary delay en route. Waiting for attendants and elevators may cause loss of time. This can be overcome by method and discipline.

The transfer from stretcher to bed must also be accomplished without undue exposure, care being taken that the room and bedding are sufficiently warm. The patient's head should be laid on one side in order that any secretion may gravitate to the lower cheek where it can readily be wiped away. The nurse should remain with the patient until consciousness is so far established that the patient can take care of any secretions from the mouth or nose or in case of vomiting that there may be no risk of inhalation of any foreign matter. By the time the patient reaches the ward, however, indeed when he leaves the operating room, the reflexes ought to be sufficiently active to prevent any such danger. If nitrous oxide or ethyl chloride be the anesthetic used, the patient will, of course, be wide awake before leaving the operating room. Sometimes an approaching attack of vomiting is marked by pallor and a weak pulse, which symptoms pass away as soon as the vomiting is over.

Rarely a patient may reach the ward with reflexes

still in abeyance, and may continue in a state of stupor much longer than is usual. In any such case of protracted unconsciousness, the nurse in charge should inform the anesthetist or surgeon, or failing these a house surgeon, in order that the reason for the condition may be ascertained and if necessary appropriate measures taken for the patient's safety. The condition is usually due to an unnecessarily large dose of anesthetic at some period of the operation either administered by an inexperienced anesthetist, or at the request of the surgeon for greater relaxation at some stage of the proceedings; or the anesthetic may have been continued longer than necessary, e.g., until the last stitch was in, a method only necessary in the case of nitrous oxide anesthesia where the patient wakes almost immediately on discontinuing the gas. Again it may be due to some faulty position in bed interfering with free respiration and consequent rapid elimination of the anesthetic. Other causes quite apart from the anesthetic will be discussed in a subsequent chapter.

A number of experiments and observations, carried out during the past few years, have shown the desirability of maintaining a certain degree of warmth and humidity both in the ward and operating room. Too high or too low a temperature, or a very dry or very moist atmosphere, have been shown to increase the post-operative death rate materially. The most desirable temperature has been shown to be between 66° and 70° F. with a relative humidity of about 80 per cent, equal to 5.5 grains of water to the cubic foot of air. This temperature may appear rather low to some, but the high relative humidity prevents evaporation from the body so that the patient feels as warm as in air of the ordinary winter dryness at 75°. The absence of

evaporation is soothing to the lungs, the mucous membranes and the nerves. The lack of moisture during the cold winter of northern climates affects the skin of even healthy people, causing a disagreeable dryness which encourages the use of various so-called preparations of cold cream, etc., to the great pecuniary advantage of the manufacturer and vendor of these articles. A great deal of this might be dispensed with by the simple process of insuring that the air of our houses and public buildings is maintained at the proper degree of temperature and moisture, particularly the latter.

Of course, at times of extreme summer heat, it is impossible to maintain the desired coolness, but in temperate climes during the greater part of the year this can be done. In the dryness of winter pans of water placed on radiators assist in providing the necessary moisture by evaporation, or better still, in buildings such as hospitals with a forced ventilating system the requisite moisture may be added to the air before it is driven to the various parts of the building.

Operating rooms are often kept sufficiently humid by having the sterilizing room adjacent, the steam from which affords the requisite amount of moisture.

It is not to be assumed, however, that the temperature must be maintained at a continuous dead level. It is better to vary it a few degrees even in the daytime. The night temperature also should be a little below the optimum above mentioned, while the day temperature may be from that to a few degrees higher. Again when the patient is bathed, the temperature will be raised to a sufficient degree for comfort while the body is exposed. It will readily be seen from the above that much danger may be incurred by the patient from the ill-advised efforts of the "fresh air fiend" who opens a window and

suddenly reduces the temperature to about 50° and also from the one who fears draughts and cold and therefore keeps a temperature sometimes of 80° or over.

Postoperative Nourishment

When to permit postoperative nourishment depends largely on the locality involved, the severity and duration of the operation, the anesthetic used, and the resulting condition of the patient. In operations on the stomach or intestines, for example, the alimentary canal must be kept at rest until sufficiently strong union of the sutured parts has taken place and all danger of breaking of stitches and consequent leakage into the peritoneal cavity has passed. Here the surgeon will order the diet at first as his judgment dictates. In some operations in the mouth, tonsillectomies, cleft palate, etc., fluids may have to be given for some days. Ordinarily, however, one may administer clear soup or beef tea four hours after the operation or if the latter was of short duration tea or coffee with dry toast. A cup of tea with little or no milk and sugar, even if rejected soon after taking, by its mildly astringent action on the mucosa of the stomach soothes that organ and so decreases the discomfort of the patient. Individuals vary so greatly in the degree of nausea suffered after an operation that no hard and fast rule can be laid down for all. I have seen a patient one and a half hours after an operation of over one hour's duration take a full meal composed of beefsteak, potatoes, etc., and be only the better for it. On the other hand, there are those whose appetite is completely in abeyance for days after. If a patient desires food, in which case digestion is likely to be satisfactory, it should be given early, unless, as above stated, some condition of the operation

demands abstinence. If this is not done and the stomach left empty, the desire for food may pass away and be replaced by a feeling of emptiness and nausea induced by sheer hunger. This latter condition has been observed frequently where certain hard and fast rules are laid down and the surgeon, expecting his patient to be fed when food was indicated, has neglected to order anything.

Postoperative nausea and vomiting may sometimes be difficult to control and it is only necessary to mark the number of drugs, etc., recommended for its treatment to surmise how inefficient they are in severe cases. Fortunately where a skilled surgeon and anesthetist have handled the case, severe postoperative conditions are comparatively rare and by far the majority of cases suffer little from nausea, although there is, necessarily, in nearly all cases, some degree of pain and discomfort. Those naturally of the bilious type suffer most from nausea, the type who are easily upset in this respect under the ordinary conditions of life. In these, strong hot coffee or tea, the application of ice to the epigastrium or a blister in that region may be of benefit. An enema of sodium bromide, 60 grains in 4 ounces of water, or chloretone 15 grains in capsules by the mouth, may be used. Champagne or a dry ginger ale is often of benefit; orange juice is eagerly taken by some and proves of great benefit. To get rid of the disagreeable after taste of ether, slices of lemon may be sucked or a little vinegar poured onto a handkerchief and the fumes inhaled.

Nausea and vomiting, when present, are not necessarily a result of the anesthetic. In many a preliminary dose of morphine may be the cause, as this drug is often responsible for a sensation of nausea when taken inde-

pendently of an anesthetic. It is therefore advisable to ascertain, if possible, before giving a preoperative dose of morphine whether the patient has used it on any previous occasion and with what results. If the above condition has been produced, it were better, if feasible, to substitute some other drug; e.g., sodium bromide 3 i or 3 ii in enema the night previous to operation and repeated two hours before operation has a better result in many cases. Again, the operation itself may be the cause of postoperative vomiting. Where the gall-bladder has been drained or removed, the stomach, intestines or pelvic organs handled, especially if to a great degree, the patient may be subjected from this cause alone to a distressing amount of sickness. It is obvious from the foregoing that it behooves all who have any hand in the case, from preoperative to postoperative care, the surgeon, anesthetist, nurses, orderlies, in fact all who come in contact in any manner with the patient, to each look upon his part of the work seriously as bearing in some degree on the ultimate result of the surgical procedure.

It may be advisable, for certain reasons, to adopt other than the prone position when the patient is returned to bed. The Fowler position is often used. In this position the head and shoulders of the patient are propped up with pillows or some kind of bed rest so that the body forms an angle of 45 to 80 degrees with the horizontal plane. Lacking a proper bed rest for the purpose, a simple and efficient method is to adjust an ordinary chair under the mattress of the bed, in such a way that its back and legs are in contact with the under surface of the mattress, while the front of the chair seat rests upon the upper surface of the spring mattress. The chair which thus acts as a large wedge cannot slip

Fig. 25.—Fowler position. If for some reason it is desirable that the patient's body be in the prone position, a somewhat similar result may be attained by raising the head of the bed by the insertion of wooden blocks under the legs of that end, the reverse of the position shown in Fig. 26.

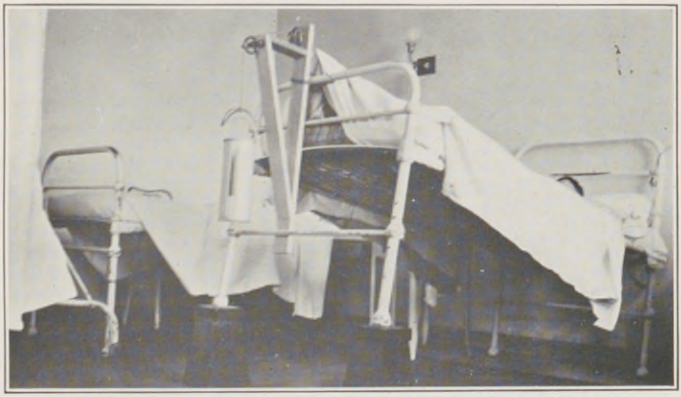

Fig. 26.—Modified Trendelenburg position of bed.

back because the front legs rest against the head of the bed. It is then necessary to adopt some plan to prevent the patient's sliding down towards the dorsal position. A simple device is to place a bolster across the bed below the buttocks and to connect its free ends by means of bandages to the head of the bed.

This position is often used in cases of pelvic infection to prevent pus from getting into the upper abdomen by gravity and infecting a further area as it would in the prone position. It also forms a comfortable position after thyroidectomy and probably reduces the tendency to respiratory complications by allowing more freedom of movement to the diaphragm, and consequently to the base of the lungs; the tendency after abdominal operations being to keep this part at rest in order to avoid pain at the site of incision, only the upper portion of the lungs remaining active. After a prolonged operation it must be seen that a patient has sufficiently recovered his reflexes to admit of being raised to this position; otherwise it will be necessary for him to remain in the prone position for a time; the need for this, however, will be rare.

For some cases the reverse of the Fowler position is necessary. To obtain this the foot of the bed is raised and the legs placed on blocks, a modified Trendelenburg posture being thus obtained. This position is useful in conditions of shock in order, by gravity, to increase the supply of blood to the brain. It may be used also where no such indication exists, but where the weight of the body is required to assist in producing counterextension on a fractured limb, when extension is employed to retain the bones in position.

CHAPTER XI

POSITIONS ASSUMED AND SPECIAL PREPARATION FOR VARIOUS OPERATIONS

The location and type of operation determines to a great extent the method of administration and selection of the anesthetic used. Indeed, the same operation may be performed in different ways by different surgeons and so necessitates some variation in the anesthetic procedure. This is particularly the case in operations about the mouth and nose. In the operation for removal of tonsils and adenoids the method of dissecting the tonsil from the pillars then completing the operation with the snare is perhaps the most common at present, though many use the Sluder method, or some modification of that operation. Then the position of both surgeon and patient may alter according to choice. The following postures are those chiefly in use:

1. The dorsal with head neither flexed nor extended.

2. The dorsal with head extended over the end of the operating table.

3. The dorsal with the head turned to the left, or right side, the surgeon sitting or standing on the side to which the head is turned.

4. The prone position lying on the chest, face to one side, for operations on the spine, Hibb's operation, etc.

5. The lateroprone posture used in operations on the kidney.

6. The semirecumbent, or propped up, posture, is favored by many for operations on the antrum, eth-

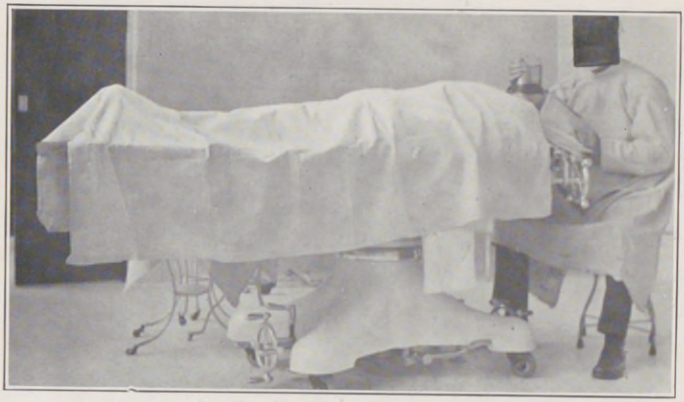

Fig. 27.—Dorsal position.

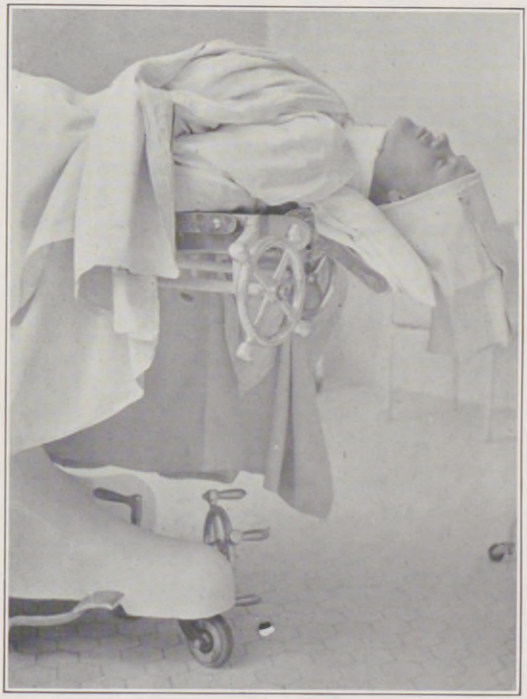

Fig. 28.—Dorsal position, head extended over end of table.

moids, frontal sinus, submucous resection of nasal septum, nasal polypi, thyroid gland, etc.

7. The sitting position, either straight up or slightly bent forwards, the latter the better as it allows any blood to flow readily from the mouth.

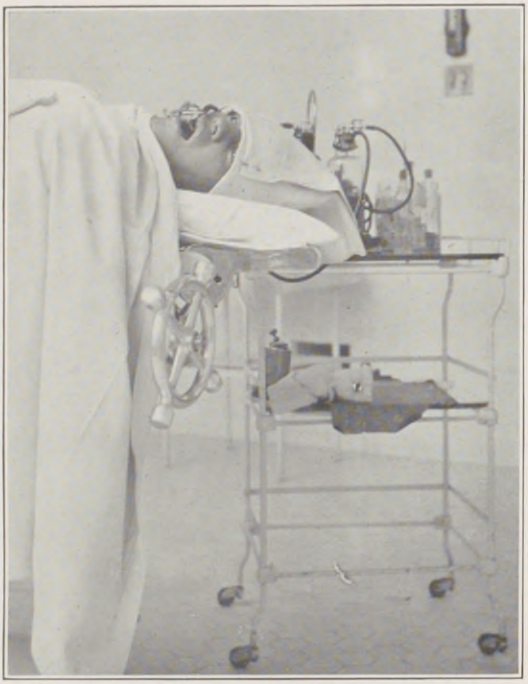

Fig. 29.—Dorsal position, head turned to left side, Doyen's gag with ether tubes in position for tonsillectomy.

8. The Trendelenburg posture.

9. The lithotomy position, feet held up by slings; used for rectal, vaginal operations, etc.

It will be seen that in those positions adopted for mouth or nose operations, including all the above but

numbers 4, 5, and 8, except perhaps the semirecumbent; blood, mucus or any infective material will readily flow

Fig. 30.—Prone position lying on the chest, face turned to right side. Gwathmey's ether mask *in situ*.

Fig. 31.—Lateroprone posture, section of the table raised (sand bag may be used instead) for operation on kidney, etc

from the mouth and nose; an important desideratum as the accidental inhalation any of these fluids, particularly pus or the secretion of a diseased tonsil, may result in an

attack of pneumonia or be the cause of a pulmonary abscess. The semirecumbent posture, of course, would rather favor the aspiration of blood, etc.; so is used chiefly in nasal operations where little bleeding which can reach the mouth is anticipated, or if much hemorrhage, or other effusion of fluid is likely to be met with, the posterior nares is plugged, either by a plug of suitable size consisting of a roll of gauze with a silk thread attached by which to remove it, or, better still, by a gauze pad held in the Watson-Williams postnasal for-

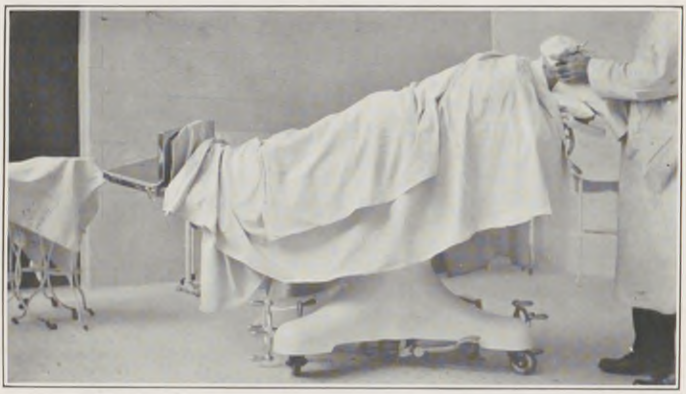

Fig. 32.—The semirecumbent, or propped-up posture.

ceps which keeps the plug *in situ*, the tongue being held well forward by the tongue holder hooked on to the forceps. The mouth is kept open by a gag and the anesthetic administered either through a separate tube or one attached to the gag.

The Trendelenburg posture, or a modified Trendelenburg when used for mouth operations, is open to the objection that it causes some congestion of the parts to be operated on and so increases hemorrhage. The recumbent positions will therefore be seen to be usually the

best both from the surgeon's and anesthetist's point of view, the removal of blood, etc., usually devolving on the latter. Tonsils, adenoids, a deflected septum, or polypi, but particularly a large mass of adenoids may obstruct

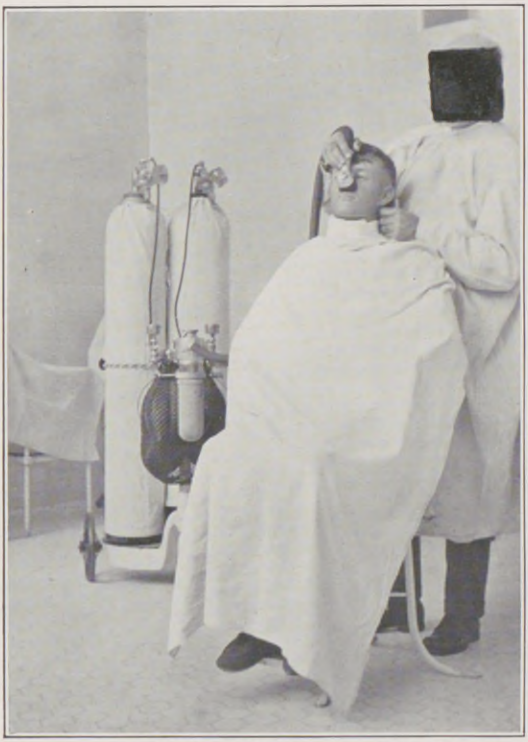

Fig. 33.—Sitting posture, head slightly bend forward to allow secretions to flow readily from the mouth.

the respiration to a degree that will make perfect anesthesia very difficult, cyanosis easily supervening as the patient approaches the third stage. It may even be necessary in extreme cases to commence the operation before all reflexes are completely in abeyance. Need for

this, however, will seldom arise. The nurse accompanying the patient from the operating room to the ward,

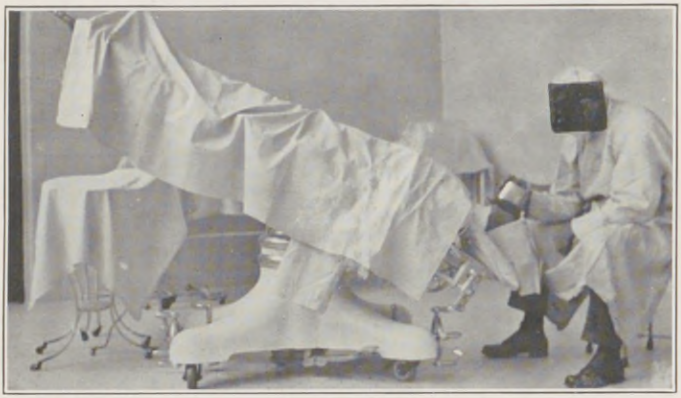

Fig. 34.—Trendelenburg position, Webster ether inhaler *in situ*.

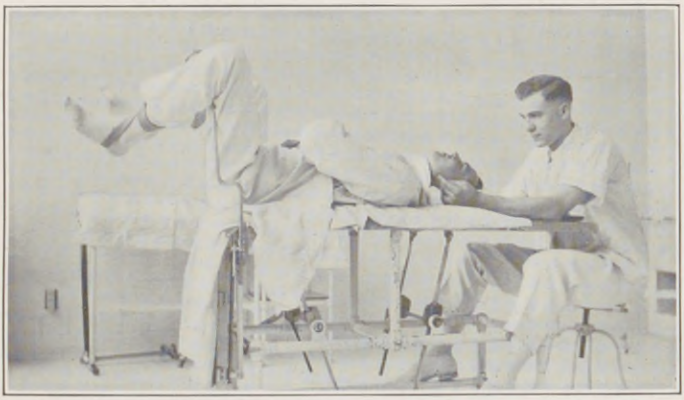

Fig. 35.—The lithotomy position showing also the correct manner of holding the jaw forward by fingers behind the angle of the jaw.

also the one in charge of the ward will find it imperative in this class of cases to occasionally wipe out the dependent cheek—the patient's head invariably being

kept to one side—as some slight oozing of blood will occur for a variable time after the completion of the operation.

For this class of operation nitrous oxide-oxygen, or ether are the anesthetics of choice; though ethyl chloride may be used where the operation is of short duration as in the removal of adenoids. Nitrous oxide-oxygen is usually used when the sitting position is adopted though it may be used in the various dorsal positions. When used it is not always possible for the anesthetist to take

Fig. 36.—Watson-Williams postnasal plug forceps and tongue holder.

care of the effusion of blood, he being fully occupied in maintaining a sufficiently deep anesthesia by keeping the nasal piece closely approximated and in seeing that the correct mixture of nitrous oxide and oxygen is supplied. Should the nasal inhaler permit the inlet of air, it will be difficult, if not impossible, to maintain a smooth and sufficiently deep anesthesia. The hemorrhage may be brisk during the operation, but is quickly stopped at its termination by turning on a full supply of oxygen, which reduces the clotting time of the blood. Ether is usually used in the dorsal positions, anesthesia being first induced in the ordinary manner by one of the vari-

ous ether masks, then continued by one of the many vaporizing inhalers, which usually combine suction also; the anesthetist thus being able to keep the field of operation clear by aspirating all fluids from that region.

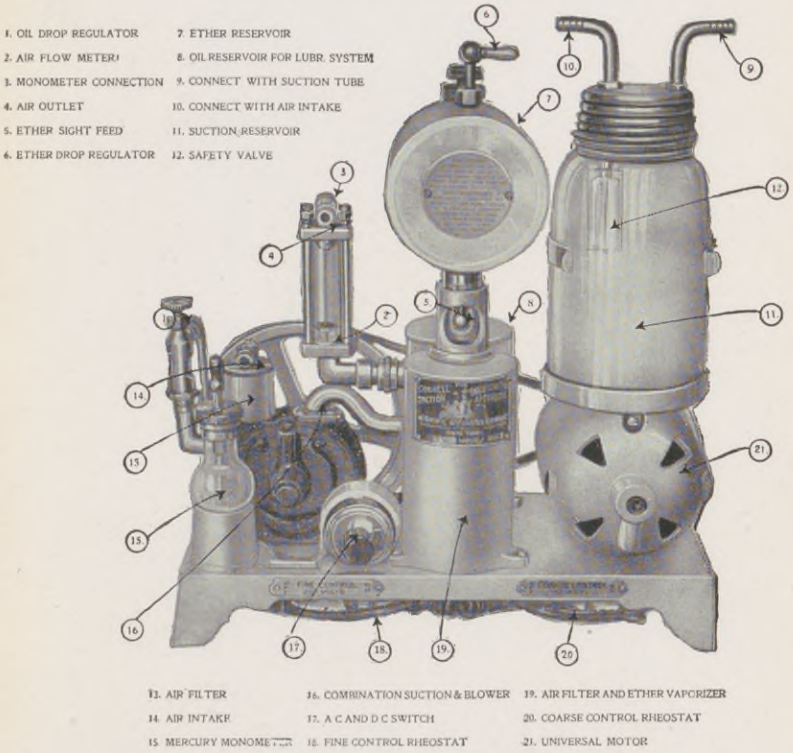

Fig. 37.—The Connell suction insufflation apparatus.

Ether may also be used in the sitting position, but is perhaps not quite so convenient given in this manner.

It is very important that all rubber tubing and the metal tubes for suction and delivery of anesthetic used on these vaporizing machines be kept absolutely clear,

or suction and delivery will fail when most required. As few large hospitals are so fortunately situated as to have a separate machine for each person using it, it becomes the duty of a nurse to see that these tubes are kept clean. Again in esophagoscopy and bronchoscopy, owing to the fact that the bronchoscope will occupy the midline of the mouth, with need of space for movement

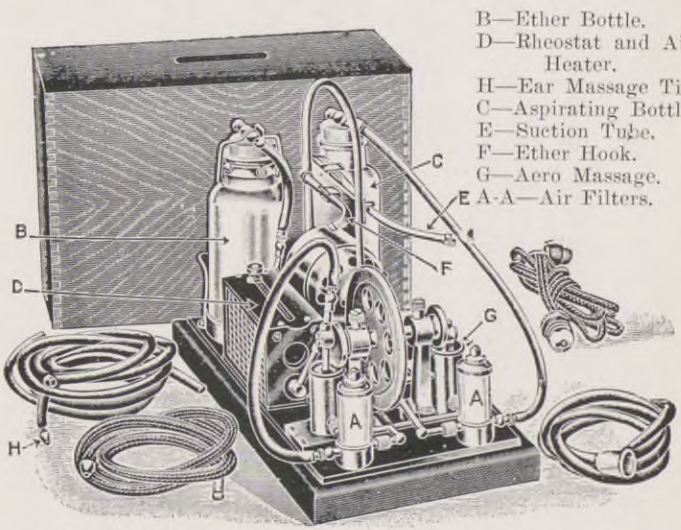

Fig. 38.—The Steiner ether vaporizer and suction apparatus.

to each side as the exigencies of the exploration demand, the gag used must be one such as O'Dwyer's which is readily retained to one side of the mouth without a tendency to move towards the middle line. This gag with anesthetic tubes attached, or with a separate anesthetic tube, may be used.

If the esophagus is the subject of examination, the administration of the anesthetic is comparatively easy; but should the trachea be the part examined, the tube

inserted may be of such large diameter as practically to fill the trachea, all respiration being conducted through the bronchoscope. It will obviously in this case be impossible to get any anesthetic to the lungs by means of a mouth tube. On examining the bronchoscope, however, it will be seen that a small tube communicating with the lumen of the bronchoscope comes off from its side at an angle of about 45 degrees. The rubber tube from the inhaler may be attached to this;

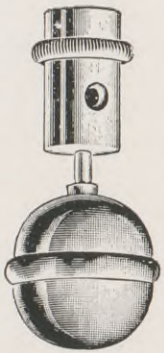

Fig. 39.—Safety valve float for Steiner's ether vaporizer. When the blood, mucus, etc., reaches a certain height in the suction bottle, the float is lifted, letting air into the bottle and preventing further suction, which with an overfilled bottle, will clog the valves and tubes of the airline.

the anesthetic then passes in through the tube of the bronchoscope on inspiration and so reaches the lungs. Unless absolutely necessary, however, it is better not to use the bronchoscope for this purpose as, at each expiration, a strong vapor of ether is puffed out into the surgeon's face much to his distaste.

Again if the bronchoscope is passed beyond the bifurcation into either bronchus, it is obvious that the air containing the anesthetic only reaches the opposite lung while both lungs are inhaling and exhaling. Under

these circumstances, with half the absorbing surface cut off, it becomes more difficult to maintain a satisfactory anesthesia, a strong ether vapor being required for delivery to the available lung. It is necessary to bear this in mind in such cases and to increase the ether percentage in time, or one is apt to soon have only a partially anesthetized patient on his hands.

Operations on external parts of the chest or abdomen require no special apparatus any more than do those on the limbs. The position is altered, however, when the pleural cavity is to be opened, in which case, in order to prevent collapse of the lung, the anesthetic must be given under a slightly positive pressure, 15 to 30 mm. of mercury above the pressure of the atmosphere. This is achieved by passing a tube—a silk woven catheter, size 22 to 24 French, is correct for an adult, smaller for children—into the trachea until the end is within an inch of the bifurcation. The tube from a vaporizing inhaler is then connected with the catheter and a stream of ether vapor at the above-mentioned pressure is driven into the lungs, keeping up the necessary inflation. For this purpose it is necessary to add to the ordinary vaporizing inhaler a safety valve, in order to avoid any danger of too great pressure with consequent rupture of some of the pulmonary air cells, and also a mercurial manometer which shows the pressure at which the anesthetic vapor is being delivered to the lungs. Therefore special machines have been built for the purpose, e.g., that of Janeway, Kelly, Elsberg, etc., all of which are excellent for the designed purpose. The above is called the intratracheal method of anesthesia and differs from the intrapharyngeal in that, in the latter case, two tubes are passed into the nostrils and back to the pharynx, the anesthetic vapor being delivered in this manner at

the back of the mouth. This is a useful method in certain mouth operations.

By use of the intratracheal method there is no danger of aspiration of fluids, as the return flow of air from the lungs passes outside the intratracheal tube, which it will be observed is much smaller in diameter than the trachea with this end in view. In thus passing out, the exhaled air carries with it any fluids or blood to the mouth where they can be readily wiped away.

Catheters for intratracheal use are now made especially for the purpose with a mark showing the distance of insertion from the teeth. This is 26 cm. in the case of adults; for children twice the distance from the teeth to the upper part of the larynx will be found satisfactory. If the tube is inserted too far and touches the bifurcation of the trachea, a fit of coughing will ensue which ceases on a slight withdrawal of the tube. The pharyngeal tube for an adult is 13 cm. in length. Care must also be taken not to insert these too far or they may enter the esophagus and cause dangerous dilatation of the stomach by the introduced vapor.

The intratracheal tubes after sterilization are kept in cold water in order to better preserve their rigidity until they are wanted. A more satisfactory method now often adopted is to have a stout wire which can be bent to the desired curve inserted into the intratracheal tube. This keeps it sufficiently rigid and may be withdrawn as soon as the tube is in position. It will be the duty of the nurse to attend to these also and should the introduction of the tube be done with the aid of a laryngoscope to perhaps see that the small electric globe and battery are in working order. Even though she may not always be called upon to attend to this part of the work she should be familiar with the preparation and

working of this instrument. Various opportunities for practice in this will be afforded also in the eye and ear department, in the preparation of instruments for esophagoscopy and bronchoscopy. Some anesthetists do not, however, use the laryngoscope but insert the intratracheal tube by touch instead of by sight. When inserted by aid of the laryngoscope that instrument is passed well back in the pharynx, the tip of the instrument then pressed upwards, raising the epiglottis, when the larynx with its vocal cords comes into view. The tube is passed between the vocal cords to the depth above mentioned. When inserted by touch the epiglottis is raised by the index finger of the left hand and the tube passed in. There is danger of passing the tube into the esophagus, which mistake is easily determined by the fact that there is no rush of air through the tube with inspiration and expiration as is the case when it has entered the trachea. It is perhaps unnecessary to state that a deep anesthesia must first be secured before the operation of inserting the tube is carried out. The intratracheal method is used by some for the operations of tonsillectomy, cleft palate, etc. Though, of course, there is no necessity here of positive lung pressure, the fact that the return flow of air as before mentioned makes it impossible to inhale any secretion, is considered sufficient warrant for the method. The disadvantage is that insertion of the tube takes a little time and so prolongs the operation somewhat.

Abdominal operations, particularly the more extensive and lengthy, require much more of the anesthetist than a simple surgical anesthesia. Here the surgeon usually demands complete relaxation of the abdominal muscles, a condition not necessarily present because complete loss of sensation has been obtained. With chloroform this relaxation is almost invariably present;

but this drug, owing to its less safe attributes, is not much used in large centers. Ether relaxes to a much less degree than chloroform and nitrous oxide to a still less degree. It becomes necessary then to occasionally push ether to a stage beyond that of the usual surgical need, in such cases as operation on the gall-bladder where that organ and its surrounding tissues are explored, operations on the pelvic organs, gastroenterostomy and other intestinal operations. After the exploration and the offending organ has been brought into view the anesthesia may be allowed to return to the ordinary third stage for the remainder of the operation, except occasionally while the peritoneum is being sutured. This gives no special trouble, however, unless the intestines are abnormally distended with gas, a condition sometimes due, as previously explained, to injudicious preparation.

Should nitrous oxide be used for these cases, the addition of a little ether will usually bring about the desired relaxation. Owing to the difficulties attending some of these cases, the observant nurse will be impressed with the necessity of neglecting nothing in the preliminary preparation.

For gall-bladder operations, it is desirable that the back be raised in that region, so as to bring the gall-bladder more easily into view when the abdomen is opened. This is accomplished by placing a long sandbag two or three inches in diameter across the table under the part to be raised or, in many of the more modern tables a portion of the table itself can be raised, at will, as shown in Fig. 31, which does away with the sandbag and simplifies proceedings.

The nurse will do well to acquaint herself with the positions assumed for various operations and with the use and size of sandbags required for the various posi-

tions, which are illustrated for this purpose. Besides the above, a sandbag is usually placed beneath the loins in operations on the kidney, the patient being in the lateroprone position, retained there by a large sandbag in front and behind; these latter require to be as large as a small pillow to be effective. This position is assumed also in cases of drainage for empyema except that no sandbag is required beneath the patient. In some modern tables, however, all these positions, as in the gall-bladder position, can be attained by adjustments on the table itself without the use of other extraneous methods.

Operations on the spine, usually transplantations of bone, "Hibbs' operation, etc.," necessitate the prone position, patient lying on the chest with the face to one or the other side, whichever is most convenient. This position does not present as much difficulty to respiration as would appear at first sight. Perhaps the most troublesome item is that one is unable to have the face exactly towards one side; it is usually turned slightly downwards towards the table surface which makes it somewhat troublesome to retain a mask on the face, especially the facepiece of a nitrous oxide inhaler. If ether is given, a tube may be inserted in the mouth or the intrapharyngeal tubes through the nose and the ether, vaporized with either air or oxygen, delivered through the tubes.

Operations on the brain may be done either in the prone or sitting position, the anesthetic usually being ether or nitrous oxide-oxygen though some, mostly in European countries, prefer chloroform with oxygen. Here the anesthetist must, by his method of administration, render the brain as anemic as possible, and perhaps the most effective way to this end is the use of chloroform with oxygen. This drug, as has been stated before,

invariably reduces the blood pressure and therefore causes a less vigorous circulation in the vessels of the brain along with other parts. Given with oxygen, the breathing is rendered less vigorous and on account of an oversupply of this gas in the air cells, it is not necessary for the circulation to be so vigorous in order to oxygenate the tissues. Ether, however, may be administered in the same manner with oxygen and is not only much safer, but the audible respiration in contradistinction to the generally inaudible one of chloroform is very reassuring when we consider that the head and face are usually covered with towels and quite inaccessible to the anesthetist, whose position is best taken seated about opposite the knees of the patient when in the prone position. He depends for information as to the patient's condition on the respiration and circulation as noted at the wrist or ankle. Nitrous oxide-oxygen, of course, is the anesthetic of choice, by many, especially on this continent.

If the sitting position is preferred, the patient's arms and legs are strapped to the chair, the back of the head reclining on the head rest if the operation is on the frontal portion of the brain; if on a more posterior portion, the patient faces the back of the chair, with his forehead on the head rest, the limbs being fastened as before. In this position nitrous oxide-oxygen is the best anesthetic, though ether and oxygen may be used in the manner previously indicated, one of the vaporizing inhalers being then most convenient, or the intratracheal or intrapharyngeal method may be used. The important thing by any method, besides a perfect anesthesia, is to keep the patient well oxygenated, as before stated, in order that bleeding may be reduced to the minimum and the surgeon have a clear field. The nurse, as well as all others engaged on the case, should realize that prep-

aration must be made quickly, anything likely to be required should be immediately available, both for surgeon and anesthetist. These cases will not stand prolonged operation, and if called upon to endure any such, usually succumb to its effects within 24 hours after the operation, even though the latter is apparently successful at the time.

In obstetric cases the nurse will always have a large field of work, as in the majority of such cases she is called upon to administer the anesthetic. In only a comparatively small percentage of these cases is a specialist called in for that purpose. These cases, almost invariably, take the anesthetic well. Probably the chief reason for this is that the patient has no fear or anxiety on the score of the anesthetic, her thoughts being fully occupied with her condition and the length of time she must endure further pain. When the anesthetic is presented, therefore, it is inhaled with avidity, the only request as long as consciousness remains, being for more. She receives it with a sense of comfort instead of alarm. The nurse must not, however, allow herself to be lulled into a sense of false security by the apparent ease of administration, but must realize the powerful nature of the drug she is handling and keep constantly alert for the approach of danger. Apart from the danger, however, is the fact that labor may be lengthened by an injudicious administration.

In the early stage of labor the pains are not often severe, and no anesthetic is required. Later, when severe and frequent pain is felt, the anesthetic may be begun. The administration is intermittent, until near the end of labor, to coincide with the pain, unless some instrumental interference becomes necessary. The anesthetist should rather anticipate the pain than only begin the administration when the pain is felt. A commencing

contraction of the uterus can be felt by the hand on the abdominal wall, over the uterus, before the patient feels the oncoming pain. This is the time to apply the mask and commence the administration, removing it as soon as the uterine contraction shows signs of diminution; otherwise, should the anesthetic be continued to the end of the pain its termination will find the patient sometimes beyond the desired stage of analgesia with the result that the onset of the next pain is considerably delayed and hence labor is prolonged. This applies, of course, more particularly when chloroform or ether are the anesthetics used. When nitrous oxide is used, the elimination is so rapid that the patient speedily awakes and contractions are not so long delayed; but even here the same method and care in administration is needed to get the best results. As a rule only one or two inhalations of nitrous oxide are given with each pain and this quantity may be given pure, without oxygen. Near the end of labor, or if for any other reason complete anesthesia is needed, oxygen in sufficient quantity must be given with the nitrous oxide to maintain a good color, otherwise the baby may be born more or less cyanosed. If such be the case, immediately on delivery, a full pressure of pure oxygen should be turned on, before cutting the cord, in order to fully oxygenate the child. Should any further anesthetic be required by the mother, she can rapidly be brought back to the necessary condition of analgesia or anesthesia.

The vast majority of patients will still have either chloroform or ether administered on account of their portability, so that the nurse should take advantage of any opportunity to see their administration in the lying-in room in addition to the theoretical knowledge acquired by reading.

CHAPTER XII

THE DIFFICULTIES AND COMPLICATIONS OF ANESTHESIA

Vomiting

Vomiting during the course of anesthesia should be of rare occurrence and then only if some preexisting condition, such as the pernicious vomiting of pregnancy, or of some intestinal lesion; for example obstruction or perforation, where sometimes a reverse peristalsis occurs and bile-stained fluid or even fecal matter may be ejected from the mouth. Occasionally it becomes necessary, generally in the case of accidents, to anesthetize a patient with a full stomach, when the contents will almost certainly be ejected during the recovery period if not before. In any of these cases a good induction and proper level of anesthesia will usually save the anesthetist from having to cope with this disagreeable condition until the end of the operation, when recovery from the anesthetic renders this complication less dangerous. If, however, an unnecessarily slow induction or irregular administration be permitted, vomiting is likely to occur in all these conditions and sometimes also in those who have had proper preparation.

In such cases there is danger of food or other vomited material being inhaled, with consequent obstruction to respiration, or infection followed by pneumonia or lung abscess. If vomiting occurs, therefore, no time should be lost in wiping out the mouth, the head being turned to one side and kept low in order to limit the possibility

of inhalation of foreign material, the anesthesia being deepened as quickly as possible to the required degree.

In cases such as those above cited, it is sometimes considered advisable to wash out the stomach before administration of anesthesia; this, however, is open to the objection that it tires the patient and does not invariably achieve the desired result.

During the recovery period, when symptoms of vomiting appear, the head should be turned to the side and the lower cheek wiped out as required; sometimes a finger held in the lower cheek is desirable, permitting, as it does, a free flow of mucus, etc., from the mouth. If the teeth tend to become clenched, interfering with respiration, it may be necessary to open them by use of a mouth wedge or better a wooden tongue depressor, which being thin is usually more easily inserted between the teeth, especially if a tooth is missing, even though it be one of the molars.

When the tongue depressor is passed between the teeth at whatever point, do not attempt to pry the teeth apart —indeed these depressors would easily break were such an attempt made—but pass it gently back to the pharynx which when touched will cause the patient to gag and thus open the teeth. A mouth gag is now quickly inserted and the jaws held apart. If the teeth are not rigidly clenched, pressing forward the lower jaw, the pressure being from behind the angle of the jaw as though trying to force the lower teeth forward of those in the upper jaw (Fig. 35), tends to lift the base of the tongue from the pharynx and to raise the epiglottis, so giving a good airway. This should not be done, however, at the moment of vomiting, as raising the epiglottis at that time obviously adds to the risk of inhalation of vomited material.

Persistent Muscular Rigidity

Persistent muscular rigidity is very infrequent in chloroform or C. E. anesthesia, but may be very troublesome in nitrous oxide or ether anesthesia. It is only of importance in operations in the abdomen, the recti abdomini being the muscles most affected. Rigidity of these muscles increases the surgeon's difficulties materially. It most commonly occurs in athletic patients, alcoholics, excessive smokers and those of nervous temperament. If nitrous oxide is the anesthetic administered, an admixture with ether generally causes relaxation better than either ether or nitrous oxide singly. There are patients, however, the victims of some painful, long standing affection, where the muscles of a particular area have acquired the habit of being constantly "on guard" in whom it may be practically impossible to obtain complete relaxation of the diseased area with inhalation anesthesia though spinal anesthesia will abolish rigidity in these cases. Muscular rigidity may also be brought on by premature incision in the abdomen or by insufficient oxygenation; the remedy for either being obvious. Sometimes, as in gall-bladder cases, the surgeon requires a sandbag under the back or the table broken in the center, both head and feet being lowered. This tends to put the abdominal muscles on the stretch and to produce the effect of rigidity. The opposite to this position, that is with feet and head slightly raised, will often assist in producing relaxation when the operation is such that there is no objection to this posture.

Obstruction to Respiration

Obstruction to respiration may arise from swelling of the tongue or from muscular spasm about the fauces, palate, pharynx, and larynx. This condition is marked

by stertor resembling ordinary snoring and may, if moderate in volume, not indicate any marked degree of obstruction. If very loud, and cyanosis begins to appear, the lower jaw must be pushed forward or it may be necessary to hold the tongue forward with the tongue forceps.

Spasm of the adductors of the vocal cords, allowing the cords to fall together, is marked by laryngeal stridor, a high-pitched crowing noise. It is most commonly heard in children and usually indicates too strong an anesthetic vapor or too deep an anesthesia. It may also rise reflexly from some strong stimulus as dilatation of the sphincter ani or cutting off the prepuce during circumcision.

The pressure of a large goiter, or any inflammatory swelling of the neck, may cause respiratory obstruction. Cases of acute cellulitis of the neck are particularly prone to a dangerous degree of obstruction and here the circulatory system has been weakened by the accompanying toxemia so that any extra strain resulting from insufficient oxygen supply is very poorly borne and demands speedy relief. It may sometimes be necessary in such cases, if cyanosis becomes severe, to insert a tracheotomy tube. It will be well, therefore, in all such cases, for the nurse to see that a tracheotomy tube, or better several of different sizes, ready sterilized in case of need, be at hand. If required, the need will be so urgent that no time can be allowed for preparation; a speedy wipe over the part with iodine, ether or alcohol, the necessary incision and insertion of the tube by the surgeon being all that the condition will permit. If any delay occurs, the introduction of the tube will come too late to be of use.

A fine rhythmic tremor, often spoken of as "ether tremor"—being seen most frequently under that drug—may occur, affecting principally the lower extremities.

It occurs mostly in nervous, muscular men and is abolished by increasing the quantity of ether. It is practically never seen in chloroform anesthesia. It must not be confounded with the movements of anoxemia, often seen during nitrous oxide anesthesia, which are much coarser, affecting nearly the whole body, and demand an increased administration of oxygen for their relief. The treatment for these two conditions is so opposite that it is important to differentiate between them, a matter fortunately of no difficulty after they have once been demonstrated in a patient.

Acidosis or Hypoalkalinity

A reduced alkalinity of the blood occurs in all anesthesias of any duration but the normal balance, in all but a few exceptions, is soon recovered without interference. The word "acidosis" is usually used to distinguish this condition but is rather a misnomer as the blood, even in the most severe cases, never actually becomes acid in reaction. It always remains alkaline, but the alkalinity is reduced in degree according to the severity of the case.

The symptoms usually commence eighteen to thirty hours after the operation and consist of vomiting, mental irritation, even amounting at times to delirium; sometimes there are intervals when the patient is dull and apathetic; dyspnea, cyanosis, inability to eat or drink, collapse as evidenced by a rapid, feeble and intermittent pulse, an ashen color of the face, sunken eyes, convulsions, Cheyne-Stokes breathing and later on, coma. The bowels as a rule are open, in severe cases diarrhea is present. When constipation is present it is looked upon as a less hopeful sign. The skin at first is usually hot and dry, later when the vasomotor centers fail, profuse sweating occurs.

Acetone is invariably present in the urine, which becomes less in quantity; its odor can also be detected on the breath. The temperature is usually not raised until near the end, varying then from 101° F. to 105° F., with a tendency to a sudden rise shortly before death, 107.6° F. having been noted. There is some tenderness and pain in the upper area of the abdomen.

The vomited matter, at first the usual bilious stomach contents, later resembles the dregs of beef tea; but is sometimes described as coffee ground, showing the presence of altered blood. The patient usually rejects everything taken into the stomach, even a drink of water.

This complication is slightly more common after chloroform than after ether. It has occurred after even short anesthesias by ethyl chloride and nitrous oxide and after spinal anesthesia where stovaine has been used.

Children of high strung, nervous temperament fall victims most readily to the disease. The confinement, changed diet, environment, homesickness, dread of operation, anesthesia, etc., may lead to changes in metabolism. These patients are usually intolerant of fats in their dietary and in some cases starchy foods also.

In the severe cases, where death results, the liver has been found to have undergone fatty degeneration with breaking down of the cells.

The disease occurs about equally in either sex, but is most common in the young, in those with impaired kidney function, or who have been the subject of long continued infectious processes with fever and its increased metabolism.

Treatment

In mild cases a saline purgative and plenty of water or aerated soda water and the withholding of food until the patient's appetite demands it is usually sufficient. In

more severe cases intravenous or subcutaneous infusion of sodium bicarbonate or sodium citrate or enemata of these and glucose may be given. A diuretic or laxative should be given to carry off the product. Patients, especially children, should not be kept too long without food before an operation, in the latter not longer than the usual interval between meals for a child of that age. Glucose may be given every four hours for one or two days before operation if the child is in the hospital that long, if not from the time it comes to the hospital. Children take glucose readily as a sweet and may have it in doses of ʒ i o. h. iii for children under three, or ʒ ii o. h. iv for children over that age, the last dose being given two or three hours before operation. After operation if glucose is not tolerated by the stomach, ʒ iv o.h. iv by rectum may be given or ʒ vi to x of a 2.5 per cent solution given subcutaneously, or 10 c.c. of a 10 per cent solution slowly injected hypodermically. If dyspnea occurs, inhalation of oxygen is desirable. Certain preparations of pancreatin administered before operation have had a beneficial effect decreasing the number of cases, therefore the recent discovery of insulin would appear to be of the greatest importance to this condition and its use to offer the most certain remedy.

CHAPTER XIII

MEDICATION

It is frequently considered advisable to administer some drug, or combination of drugs, to the person about to undergo an operation. Some of these are considered as adjuvants to the anesthetic, lessening the amount required or in some manner modifying its effects. In all such cases the individual patient ought to be considered, the type, constitution, probable response to different drugs, etc. This is frequently not done and the preanesthetic medication resolves itself into a routine administration of a certain drug or drugs without regard to the exact requirements of each individual.

The actual administration is left, in practically all cases, to the nurse who needs therefore to have some knowledge of the objective aimed at in order to administer the drug intelligently, and also of the care required to give the exact dose ordered. A slight leak in a hypodermic syringe may appear a small matter, but if the total dose is contained in 10 or 15 minims of fluid and three or four drops leak from the syringe, it means that the patient has only received two-thirds or three-fourths of the dose ordered. The same applies when the drug is given by enema; should the patient not retain the whole it should be at once reported or an equal quantity to that lost injected.

Morphine is probably the most universally administered drug preliminary to an anesthetic. It soothes irritation, relieves pain if present, and frequently renders the patient drowsy, occasionally extremely so. Thus he is more receptive to any anesthetic; an important desid-

eratum if ether be used on account of the latter's irritating properties, which are not so noticeable with the patient in this condition. Should nitrous oxide-oxygen be used, morphine assists in deepening the anesthesia and also in obtaining muscular relaxation. The two anesthetics mentioned rather increase the respiratory efforts and have no direct poisonous effect on the heart muscle. Chloroform as already pointed out has a poisonous effect on heart muscle as also has ethyl chloride to a much less degree, one-nineteenth. As morphine depresses both the action of the heart and respiration it should not be used preliminary to chloroform or any mixture containing this drug. The dose used varies from ⅛ to ¼ gr. usually ⅙ gr. for the adult.

Atropine is often administered in combination with morphine, the object here being chiefly to dry up the secretion of the salivary glands and so avoid the great quantity poured out, especially when ether is used; it is useful also before nitrous oxide, though this anesthetic does not stimulate salivary secretion to the same degree as ether. It is more important, though, in administering nitrous oxide, that there should be no salivation whatever; the face mask requiring to be closely applied for full effect and if removed, to wipe away saliva, the patient comes partially out of the anesthesia very rapidly and the smoothness of the administration is apt to be disturbed. If the dose of atropine is sufficiently large, the vagus is also rendered less sensitive to inhibitive stimulation; the doses given, however, are usually too small to obtain this effect. The dose is better regulated according to the weight of the patient rather than by only recognizing age. Where a certain dose is routine for adults a small 80 pound woman may receive the same dose as a husky 250 pound man, which at once shows the absurd-

ity of such unintelligent routine. Children bear atropine well and may be given a relatively large dose, but morphine is best not administered to the young, say under 12 years, unless there is some urgent necessity. The adult dose of atropine is usually $\frac{1}{150}$ to $\frac{1}{100}$ grain, the latter being often necessary to obtain results; in case of the smaller dose there is frequently much mucous secretion. Sometimes hyoscine, hyoscyamine or scopolamine, isomers of atropine, are ordered instead of the latter drug but possess no real advantage over it.

Heroin is sometimes used in place of morphine as it is believed by some to have less deleterious effects. Experience has failed to show such result. So far it appears more unreliable than the latter drug. It has been shown to depress the respiration to a greater degree, a most undesirable attribute in a drug used in combination with anesthesia. Several cases of severe respiratory depression after its use have come under my own observation and one should be chary of replacing a drug like morphine, whose physiologic action has been observed for many decades, by a new drug, unless the advantages are very obvious.

A serious disadvantage indigenous to both morphine and heroin is the fact that they cause nausea in many people and so help to produce postoperative vomiting; indeed, where neither of these drugs have been administered beforehand and the patient has gone after the operation for five or six hours without nausea, a dose of one of these drugs given to relieve pain has promptly started nausea and vomiting. It has also frequently been observed to start a feeling of nausea after the preoperative hypodermic, before the patient leaves for the operating room.

Sodium or potassium bromide may be used in com-

bination with morphine or in lieu of this drug. The sodium salt is best used, proving less irritating than the potassium salt. In order to relieve the stomach of possible irritation, it is best given as an enema, ʒ i in ʒ iv of water is about the average dose; more or less may be administered according to the size of the patient. It is best given in plain water rather than in saline, the salt contained in the latter helping to promote postanesthetic thirst, besides furnishing an extra load for the kidneys, by which it has to be excreted. If given about six P. M., on the night before operation, one invariably finds the patient has had a comfortable night free from worry; in fact it induces a much calmer frame of mind in the patient than does morphine. The dose may be repeated two hours before operation.

Magnesium sulphate has been recommended by some, given with the preliminary morphine. It is said to enhance considerably the action of the latter drug. We have not found it of as much benefit as its enthusiastic advocates state. It is given hypodermically in 25 per cent solution or in hypodermoclysis as a 4 per cent solution, as much as 400 c.c. of the latter solution being administered between ½ and 2 hours before operation. Of course these solutions must be absolutely sterile, which adds considerably to the task of preparation. Therefore, unless some very definite benefit results, one is not justified in increasing the labors of the already busy ward nurse.

CHAPTER XIV

SURGICAL SHOCK, ITS CAUSE, SYMPTOMS AND TREATMENT

The condition of "surgical shock" may be brought about in various ways. It may be caused by severe hemorrhage, occurring either during the course of an operation, or as the result of an accident or some pathologic condition such as rupture of a vessel in the course of a tubal pregnancy, where the effusion of blood is into the abdominal cavity and therefore unseen, the diagnosis having to be arrived at from other symptoms present. Strangulated hernia, crushing injuries of the limbs, particularly if involving much nerve tissue, also injury of internal organs, even though little or no hemorrhage occurs, may bring about the condition.

Henderson's theory of the modus operandi is that the injured person at first, as is at least often the case, breathes deeply and frequently on account of the pain. More than the necessary amount of oxygen for his bodily requirements being thus introduced into the system and less carbon dioxide being present than is required to stimulate the respiratory center, results after a variable time in decreased respiratory efforts or in marked cases the respiration may cease altogether for short periods. A similar effect may occasionally be produced by the inhalation of ether which invariably causes more rapid and often deeper respirations, but rarely to the degree required to produce the above condition. Stimulation of the vagus nerve also may so inhibit the heart's action that lowering of the blood pressure occurs, a condition present in all cases of "shock." Rough manipulation in

the course of surgical operations, a slow, haggling incision through the skin instead of a clean rapid cut, handling of the viscera or exposure of large areas of intestine, dragging on the mesentery, etc., all tend to produce the condition in a greater or less degree according to the delicacy of touch and dexterity, or otherwise, of the operator.

Some of the conditions enumerated above which tend to bring about the symptoms of shock are caused while the victim is under the influence of an anesthetic. Crile and Lower, have asserted that any injury applied to tissues is carried by the sensory nerves to the brain, causing certain pathologic changes in the nerve cells. Similar changes, however, were shown thirty-three years ago, to occur when an anesthetic was administered independent of an operation and more recently the same changes have been shown to occur as a result of fear, excitement, fatigue, etc. It was also asserted that the administration of an anesthetic did not prevent this transmission of impulses through the sensory nerves in spite of the fact that Sherrington and others showed from experiments that the contrary was the case. For the above reason it has been the custom for some surgeons to infiltrate the skin and muscles of the abdomen in laparotomies, or those of the neck in thyroidectomies, in addition to the use of a general anesthetic, to prevent such conduction. It has been recently shown by Forbes and Miller in a series of most delicate galvanometric experiments that an anesthetic such as ether does prevent the transmission of impulses along sensory nerves so that, unless the injection of a local anesthetic, when a general anesthetic is being given, enables one to reduce the quantity of general anesthetic, which is frequently not the case, the chief result of the local anesthetic has been to burden the excretory

organs with another poison at a time when all the energy of the patient is required to combat the effect of the operation and anesthetic.

The condition of shock is of intense interest to surgeon, anesthetist and nurse. If already present from some injury, hemorrhage or intestinal condition, it, of course, comes under the care of first the surgeon and nurse. Should there be a prospect of improvement from the condition the patient is kept under observation without immediate surgical interference in order that the system, by rest and appropriate treatment, may have an opportunity to recuperate. Frequently, however, this contion has been brought about by some accident or unfortunate occurrence, as an acute obstruction of the bowel from some cause, or rupture of a vessel in some abdominal viscus, etc. In many cases, therefore, waiting would only mean disaster and an operation to relieve the condition causing the shock offers the only prospect of cure. Here then is where an expert anesthetist, capable of deciding on the most suitable anesthetic and the best method of administration, and a nurse conversant with the probable needs of the case and who anticipates these so that no delay occurs when certain remedial agents are required, are able to be of the greatest use and probably turn the scale in favor of recovery by conserving the remaining energy of the patient to the utmost.

Various circumstances also may occur, in the course of an operation, to bring about this condition in one not showing signs beforehand. When this occurs, it is the anesthetist who is in a position to first notice any change and on whom will rest the responsibility for appropriate treatment. The surgeon must not be interrupted in his work, indeed it is important that everything be done to hasten the operation to a successful issue in order that

the anesthetic may be withdrawn and any traumatism or other circumstances increasing the shock may cease, the patient be kept at rest in bed, and whatever remedies are determined upon administered promptly and efficiently.

Treatment may be commenced in the operating room when the symptoms are manifested while the patient is still on the operating table. Strychnia, ether, camphor in oil, pituitary extract, adrenalin are the principal remedies used.

Strychnia, formerly much vaunted, has been shown to be of no avail in this condition. It either does not affect the blood pressure or causes further depression. It may slightly stimulate respiration for a time. Ether has only a transitory effect and that not beneficial when given during anesthesia. It seems a most illogical thing to inject more ether into the tissues with the hope of stimulating and benefiting the patient during ether anesthesia. Camphor causes a slight dilatation of the superficial vessels of the skin, thus tending to lower blood pressure and therefore is of less than no benefit. I should not have mentioned these three remedies except that they are still often prescribed as restoratives in the condition of shock or collapse. There remains pituitary extract which is injected intramuscularly and which, acting on the vasomotor system, causes contraction of the muscular walls of the blood vessels and so raises the blood pressure; this is assisted by the effect on the cardiac muscle, the heart beat becoming slower and stronger. If no blood has been lost, the normal quantity being still contained in the vessels, the reduction of blood pressure may still occur in the condition of shock; for, owing to the dilatation of the vessels, the bulk of the blood may be contained in the splanchnic area and the brain and other vital organs be thus rendered anemic.

If, however, considerable hemorrhage has occurred; or if, previous to operation, the patient has been the subject of persistent vomiting from any cause, the quantity of fluid contained in the system will be inadequate and this deficit must be supplied by the introduction of normal saline solution. This may be given intravenously if the need is very urgent, otherwise it is usually administered subcutaneously; two needles of fairly large caliber being introduced through the skin and connected by rubber tubing with a glass funnel into which is poured the solution at a temperature a few degrees higher than the body, 105° to 110° F.; the solution loses some of its heat during its flow through the tubing. By this method absorption is slower and the vessels are more apt to retain the fluid. Always give pituitary extract at the commencement of the administration of saline, if not given before, in order to assure sufficient tone to the vessel walls, otherwise the saline solution simply leaks through the vessel walls into the tissues, waterlogging them and producing a condition worse than before administration.

Previous to the introduction of pituitary extract, it was my custom to mix adrenalin with the saline solution in order that this drug might be slowly absorbed and produce the same effect. This method was perhaps more beneficial than was realized at the time, as it has been shown recently that during anesthesia the secretion from the adrenals is diminished, or in some cases totally suppressed, for a time. The object of mixing adrenalin with the saline, however, was to keep up the blood pressure by its slow, steady administration. A dose of adrenalin raises the blood pressure rapidly, with almost as rapid a fall, the whole cycle occupying only a few minutes. It was to reduce this evanescent action to a more prolonged, steady effect, that the above method was adopted. Pitu-

itary extract has a prolonged effect lasting for some hours, and, in medicinal doses, does not elevate the blood pressure to so great an extent as adrenalin; indeed, in cases of depressed blood pressure from any cause, it usually does not raise it above the normal, sometimes not so high, especially in profound depression.

Should the condition of shock present itself after removal of the patient to bed the same treatment should be carried out there. Warmth must also be supplied in the shape of hot water bags or by other means, and the patient kept quiet in order to encourage rest. Further saline may now be introduced slowly, by the rectum, if considered advisable.

It must be understood that if hemorrhage has been the cause of the condition we are treating, it is necessary that the bleeding point be secured before such treatment as suggested can be inaugurated, otherwise to raise the blood pressure would only be to encourage the hemorrhage afresh; for example, a ruptured vessel in the course of an ectopic gestation fills the abdomen with blood. The blood pressure is lowered by the hemorrhage while the intra-abdominal pressure is increased by the addition to its contents of the quantity of blood effused. Finally the intraabdominal pressure is as great as the blood pressure in the vascular system; when this happens, bleeding ceases. If, however, the pressure in the vessels were increased by drugs or other means to a greater degree, hemorrhage would at once recommence. It is, therefore, necessary in these cases that the bleeding point be first secured, everything being meanwhile prepared in order that the instant this is accomplished remedial treatment as above outlined may be commenced.

CHAPTER XV

CONSIDERATION OF THE PATIENT'S VIEWPOINT

In the busy life of a hospital it is possible to forget the attitude of mind with which the patient looks upon it all. The majority of people fortunately do not find it necessary to become inmates of a hospital more than once, many of course not at all, though some unfortunates find it imperative to make repeated visits owing to some surgical condition which cannot be remedied with one operation.

It therefore happens that in the greater number of instances it is the patient's first introduction to a hospital and everything is new and strange. What is a daily routine to the doctors and nurses is one of the most important events of life to the patient. We must continually bear this in mind, and doing so should develop a spirit of the utmost consideration, looking upon each patient not as "Case No. 2" but as an individual transplanted from his or her ordinary surroundings into a strange atmosphere and needing, for the time being, sympathy and consideration for any apparent weakness displayed.

Most people dread the approach of an operation; and though people of well balanced mind do not often show much disturbance, some anxiety, either as to the taking of the anesthetic, or the outcome of the operation, is almost invariably present; others express the opinion that they are certain of dying under the anesthetic and these not always of the very nervous type. Such an idea persisted in for a few days becomes of the nature of an autosuggestion and may interfere seriously with the smoothness of the anesthesia, or cause such a degree of

depression that the anesthesia becomes a far more difficult and dangerous matter than in the ordinary case. These people must be treated by counter-suggestion and here the nurse has a great opportunity to be of benefit, as she comes, more than anyone else, in contact with the patient in the ward and by her general demeanor and optimistic view of things can give such encouragement as will tend to comfort and reassure those in her charge. She should succeed in creating that true atmosphere of kindliness and personal interest in each patient's welfare, for which her position provides an opportunity. Most patients, especially women, crave sympathy at this time. They like to think they have engaged the cleverest surgeon and the most skillful anesthetist, that their case is perfectly understood and to be assured that it is a moral certainty that they will be completely cured, or at least greatly benefited by the operation where cure is impossible.

It is the usual rule that a patient admitted to hospital for any but a trivial operation, should arrive at latest on the afternoon of the day previous to that on which operation is to take place. In major cases it would be much better could they be in a day earlier than this, thus allowing more time to become familiar with their surroundings and to receive any necessary preoperative treatment. Often those admitted for tonsil or other mouth or nose operations arrive only from a few minutes to half an hour before the time fixed for operation. These are mostly children and the result is that they are undressed as rapidly as possible and hurried into the operating room with no preparation except that of going without breakfast, where the parents have carried out the surgeon's orders in that respect, a matter about which there is often some room for doubt; sometimes no

doubt at all when the child disgorges an undigested meal, fortunately, as a rule, at the end of the operation. Often these children are accompanied by several relatives, all vying with each other in expressions of sympathy and by extra attention filling the little one with the idea that something dreadful is about to happen. The child arrives in the operating room filled with alarm and consequently cries and struggles during the early part of the induction. Compare this with the child admitted the previous day. He has become accustomed to the nurse and his new surroundings, is interested in his toys and in the other children in the ward and is brought to the operating room often cheerful, at the worst not very apprehensive, and seldom displays the least objection to the anesthetic. Thus he is saved all the loss of energy which results from fear and the consequent struggling. With proper management of cases, the crying and struggling child should be a rare exception.

Every patient who has to receive a general anesthetic should be visited by the anesthetist at least once before the operation. At this visit he can acquaint himself with the patient's physical condition, making what examination is necessary. If the case is one that has been in the hospital some time and, on account of some blood condition, some condition of the heart, thyroid, or other organ, has been under observation and treatment, in preparation for the operation, a considerable history will have accumulated including reports of the pathologist, internist, heart specialist, etc. This record will be required by the anesthetist in order that he may the more completely appraise the case and decide upon the best method of anesthesia; for he it is who is finally responsible for the result of the anesthetic. It will

often be necessary in this latter type of bad risk to see the patient on several occasions, extending over some days or possibly weeks. Later, when the time comes to induce anesthesia, the anesthetist does not appear as a stranger to the patient, but as one who takes a sympathetic and intelligent interest in his well-being.

When an operation has been determined upon and the hour fixed, there should be no delay or postponement except for the gravest reasons. All preparations should be made so that no sign of hurry or confusion may appear. Each department coming in contact with the patient should be prompt and punctual, the ward nurse, the anesthetist, operating room nurse, surgeon and assistants. Any delay, once the movement of the patient to the operating room has begun, may be the cause of a certain amount of distress to a nervous patient who "has screwed her courage to the sticking point" and now wishes the ordeal over as quickly as possible. Should any hitch whatever occur, which may occasionally be the case even in the best conducted hospital, no argument should be worded in the patient's hearing; any controversy must be settled later. With perfect coordination and everywhere a spirit of working in the patient's interest an absolute smoothness of action is not difficult of attainment.

Whether the anesthesia be induced in a separate room, or on the operating table, it should be understood that the anesthetist has complete charge of the patient for the time being and will give any words of direction or encouragment considered necessary. It is surprising how often one hears unwise remarks in the presence of the patient after the anesthetic mask has been applied. One cannot be too careful in this regard, for in the early stage of induction all sounds are exaggerated to the

patient, who is frequently listening intently for any chance remark which may seem to bear on the operation. Similarly, if detained in the anesthetic room on account of some delay in the previous operation, every sound from the operating room is listened to with a morbid avidity as the door between the two rooms is opened to permit the passage of nurses or others. The importance of the effect of fear, anxiety, or a poorly administered anesthetic on the resisting power of the patient should be fully considered by all who have to do with the case. It may retard the convalescence for several days, keeping a hospital bed engaged which could otherwise be available for another patient, an important consideration not only from the point of view of needless public expense in the case of the nonpay patient, but also from an economic point of view; in that the work which could have been performed by the patient during the days lost has resulted in loss of income to one who can ill afford it. Even where the extra cost is of no special consideration, the loss of time to "the man of affairs" is a serious consideration.

Again when an operation is postponed, say to the next day, the first feeling of the patient may be one of relief, but it is soon realized that the ordeal has still to be faced and the whole anxiety of the previous twenty-four hours again experienced. Therefore after the patient has been made aware of the hour of operation, for none but the gravest reasons should it be postponed to a future date.

CHAPTER XVI

APPARATUS USED IN ANESTHESIA AND ITS CARE

A nurse employed in the operating room should have some knowledge of the apparatus used for anesthesia and suction of blood or other fluids from the mouth and nose. It is not usually considered sufficient nowadays to induce anesthesia and then let the surgeon work until the patient is partially awake, the anesthetic being again administered until the patient is under, the surgeon again going to work, this procedure being repeated as often as necessary until completion of the operation. At one time this method was necessary, but it has become obsolete owing to the various forms of apparatus now in use by which a continuous stream of anesthetic vapor can be poured into the mouth or nose, the surgeon meanwhile proceeding with his task without delay or interference. It is obvious, that by use of inhalers which permit of this latter method, the duration of the operation is lessened and the risk of inhalation of blood or pus diminished; it being obviously difficult to remove secretions while a mask is applied over the mouth and nose in the repeated administrations made necessary by the older method.

A vaporizing inhaler such as Stock's or Gwathmey's is often used. By these ether or chloroform singly or in any proportion may be administered; the vapor being carried through a rubber tube from the machine to the metal mouth tube, or what is better, in those cases requiring a gag to maintain an open mouth, through a tube attached to the gag as in Fig. 40.

A combined ether vaporizer and suction machine is now frequently used, the air pump driven by a small electric motor, Figs. 37 and 38. This relieves the anesthetist of the labor of pumping with a foot or hand bellows as in the earlier inhalers mentioned, then, too, there is an advantage in economy of space, having the ether vaporizer and suction machine on the same base. To obtain good results, these machines must be kept in perfect working order; any leakage of air, or weakness of the air pump soon being felt in the inadequate stream

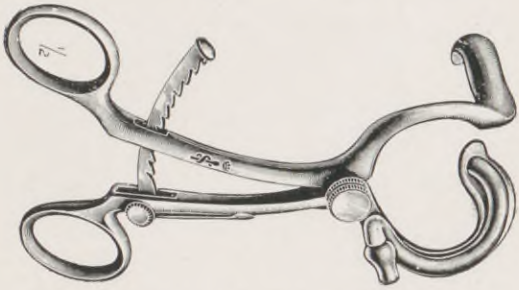

Fig. 40.—Doyen's gag with ether tubes.

of ether vapor supplied and the poor vacuum maintained in the suction bottle. It is usually preferable for the anesthetist who uses the apparatus to take care of it so far as oiling, filling the ether bottle, etc., is concerned, but it often devolves upon a nurse to empty and clean the aspirating bottle and tube and it is most important that she be sufficiently familiar with the apparatus to replace any connection disjoined correctly, otherwise the machine fails to function properly. Should the ether bottle be connected incorrectly, instead of ether vapor, a stream of liquid ether may be forced into the mouth possibly with disastrous results. This

applies also to those inhalers where bellows are used to force in the air, such as Stock's or Gwathmey's.

When cleaning tubes, either rubber or metal, through which blood, mucus, etc., has been aspirated, it is absolutely necessary that all clot be removed from their bore. The same applies to the mouth tube or tubes attached to gags for ether delivery. These sometimes pick up a little blood which clots inside. If not cleaned out thoroughly this becomes hardened by boiling, when the instrument is next sterilized, with the result that no ether gets through and the smoothness of the anesthesia is interrupted. All metal tubes should first be cleansed by having a stream of water run through the lumen then a little alcohol or ether passed through to dry the interior. It may appear that unnecessary stress has been laid on this matter, but these mistakes are made with fair constancy, in a teaching hospital, where nurses enter the operating room for a short course of training and are constantly being changed.

The anesthetist's table is usually small, indeed it is not necessary or convenient to have it otherwise, but the space must be properly utilized. Where a record of each anesthetic is kept, as it should invariably be, the greater part of the table top is occupied by this, in order that the anesthetist may make the requisite notes as the operation progresses. These notes should not be left to the conclusion of the operation and then hastily and most likely inadequately completed. In addition, the various anesthetic containers and a few wipes will be all that can be accommodated on the table top. The shelf beneath should have the necessary instruments that may be required, together with any spare anesthetic masks, arranged in an orderly manner. No extraneous things, such as gowns, etc., have a place

here; these can be kept in the supply room or in the anesthetic room. The anesthetist should be able to put

Fig. 41.—Connell breathing tube.

his hand on any instrument required even in the dark. This cannot be done where things are jumbled together

in an untidy mess. Each table should contain, besides the necessary mask and anesthetics, a mouth gag, tongue forceps, mouth wedge and an artificial airway, as Connell's or Lumbard's, Fig. 41. Pituitary extract and ergot, with the necessary syringe, ready sterilized for administration, may be either here or on another table in the operating room. Sterilized normal saline solution will also be available, with the necessary needles, etc., to administer it, either subcutaneously or intravenously as may be advisable.

Pituitary extract and ergot are supplied in small sealed capsules already sterilized for administration; the adult dose usually contained in a capsule. While on this matter, it may be as well to remark that these two drugs are given intramuscularly and not hypodermically. If administered in the latter way, there is danger of necrosis of the tissues at the point of injection. The small blood vessels are contracted to such a degree, by the action of the drug about the site of injection, that the circulation to that portion of skin may be cut off long enough for the above condition to result, much to the patient's discomfort and possible indignation, and to the chagrin of those having care of the case.

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