stages, generally before consciousness is lost. It may come on quite suddenly after a brief period of faltering respiration, or it may follow great and prolonged excitement, violent struggling, or strong and continued muscular rigidity or convulsions, or vomiting.

The picture is like that of shock. Suddenly the breathing falters, and almost on the instant the pulse fails, the face blanches, the eyes glaze, bleeding from cut vessels stops (supposing an operation to be in progress), and the whole aspect is that of imminent death. Ordinarily, under prompt and proper treatment, the subject revives in a very few minutes, but occasionally he does not, and another "death from chloroform" is entered on the discredit account of surgical annals.

The determining cause of chloroform collapse is an overdose of the drug. Overdosage may come about in several ways. If the subject is an old toper, or is predisposed to heart failure by reason of shock, fatty heart, congestion of the lungs, or uræmic or septicæmic poisoning, the *normal* dose of chloroform is for him an *overdose*. Again, even in the case of a sound subject, a normal dose, in the sense of a normal chloroform strength of vapor, may lead to overdosage by reason of suddenly occurring quick and deep respirations. Such unusually rapid and full breathing always follows the giving way of a fit of rigidity or of struggling, with its attendant stoppage of breathing, and the circumstance accounts for the frequency of collapse, already noted, occurring early in the chloroformization and following a scene of excitement and struggling. Lastly, overdosage may come from an overcharge of chloroform upon the inhaler, as may easily happen where the inhaler is simply a towel or handkerchief upon which an unmeasured quantity of chloroform is dashed from time to time.

The *action* of chloroform is complex, as is the case with the ethereal narcotics generally. When blood is charged directly with chloroform, the red corpuscles shrink, and, if there be free access of air, dissolve completely in the serum, presumably as a result of oxidation of their substance. But in ordinary chloroform narcosis the percentage of chloroform in the blood is too slight to lead to any change in the blood discs. Certain of the early chloroform effects, such as coughing, holding the breath and struggling, are merely reflexes of local irritation of the air passages. But, for the rest, the essential phenomena of chloroform narcosis all result from a direct action of the poison upon the *nerve centres of the brain and spinal cord* and upon the *heart*, or its contained ganglia—an action which in the main is one of *progressive paralysis of function*. The influence, however, does not fall with equal weight upon all the parts affected. The brain is perturbed before the cord, and of the tracts of the cord, the sensory suffers earlier and more severely than the motor. The centres of the medulla succumb last, and again the motor tract resists longer than the sensory, the respiratory and vaso-motor centres holding out the very longest.

Upon the *heart*, a directly weakening influence is a characteristic action of chloroform. If chloroform vapor is blown upon the exposed heart of a frog, the organ stops beating instantly, while its musculature relaxes and refuses to respond to any kind or degree of stimulation. In ordinary chloroform narcosis, a fall of blood pressure, even possibly to zero, is a classical feature of the intoxication, and a progressive weakening and dilatation of the heart, beginning at the auricles, can be demonstrated. When the poisoning is intense, the heart beats more slowly as well as more feebly, and stops at last in diastole.

Just what is the *pathology of chloroform collapse* has been a subject of dispute for many years. Some have held it to be heart failure, pure and simple, due to direct action of the poison upon the heart or its contained ganglia, while others, though admitting that the heart suffers a direct weakening, yet maintain that there never is a primary cardiac paralysis, but that death begins always in the centres of the medulla—respiratory or vaso-motor. This latter belief received a strong impetus from its reaffirmation by the second Hyderabad Commission.* According to Hare †—himself a later experimenter with chloroform under commission from the Nizam of Hyderabad—the chain of cause and effect in chloroform collapse is *primary paralysis of the vaso-motor centre*, whereby vascular control wholly disappears, the blood collects in the veins, and the subject dies as he would die from actual hemorrhage, by failure of respiration and of heart through lack of blood to nourish the respiratory centre on the one hand, and to excite and maintain the contractions of the heart on the other.

Whatever be the true explanation of chloroform collapse, the following *clinical* points seem now to be established: In extreme chloroform narcosis the *respiratory* function always fails before the *cardiac*; but if a faltering of the breathing, when it occurs, be not detected instantly and treated promptly and properly, the associated heart failure will follow surely and swiftly and will at once imperil life. The time elapsing between failure of respiration and the succeeding failure of heart action will vary with the chloroform strength of the inhalation. If the narcosis is produced by a prolonged inhalation of low chloroform percentage, the heart may beat for two or three minutes after the breathing has stopped; but if a strong percentage is used, the one failure of function will follow upon the heels of the other so quickly that the two will seem to be simultaneous.

Chloroform has but little action on the *nerves*, or, except in the case of the heart, upon the *muscles*, unless the narcosis has been prolonged or repeated. In such latter cases, however, chloroform may cause a temporary fatty degeneration, affecting not only the muscles, but also the liver and kidneys. Ordinarily this condition disappears after a few days, but while it endures, it is obviously a possible source of danger, and indeed accounts for occasional *late* deaths after chloroform narcosis.

Body temperature falls during chloroform narcosis, mainly as a consequence of muscular inaction.

Elimination of absorbed chloroform is principally by the lungs and kidneys, and the greater bulk of the poison escapes unchanged.

The *therapeutic applications* of chloroform are *locally* as an addition to liniments for rubefaction, or, in dilute mixture, as an anodyne for the relief of itching or of surface pains; by the *stomach*, principally as an antispasmodic, notably in intestinal colics, where the power of chloroform is unrivalled; and by *inhalation*, as an antispasmodic, an anodyne, or, carried to full narcosis, as an anæsthetic in surgical procedures.

For the *local* uses of chloroform the United States Pharmacopœia offers *Linimentum Chloroformi*, Chloroform Liniment, a preparation compounded of chloroform, three parts, and soap liniment, seven parts, by measure. In continuous application as an anodyne, this liniment should be applied under some air-proof texture to prevent the dissipation of the chloroform by evaporation. Chloroform is also much used as a local anodyne in the form of an extemporaneous ointment, made by incorporating one part of chloroform with eight or nine parts of some simple fatty basis.

For *giving by the stomach*, chloroform itself may be prescribed in extemporaneous mixture with glycerin, mucilage, or syrup. The dose ranges, for an adult, from a few drops to a teaspoonful. The latter dose, however, is a large one: it will be apt to produce decided narcotic symptoms, and often, also, vomiting. If ordered by drops, it must be remembered that the drop of chloroform is unusually small, the number required to fill the measure of 4 c.c. (fl. ʒ i.) ranging from one hundred and eighty to two hundred and seventy, according to the circumstances of the dropping. Most commonly chloroform is given internally in the form of one or other of the following official preparations of the United States Pharmacopœia: *Spiritus Chloroformi*, Spirit of Chloroform. This is a solution of chloroform in alcohol of the strength

* See the Lancet for the year 1890.
† The Therapeutic Gazette, February, 1897.

of six per cent. of chloroform by measure. Dose, anywhere up to a teaspoonful, diluted in some form of mixture. *Emulsum Chloroformi*, Emulsion of Chloroform, is compounded of chloroform, expressed oil of almond, tragacanth and water, the chloroform being present in the proportion of four parts, by measure. This emulsion keeps well, dilutes smoothly with water, and so forms a convenient preparation for the giving of chloroform. Since it contains no alcohol, the dose may be proportionately greater than that of the spirit just described, and may be set at from one to two tablespoonfuls. *Aqua Chloroformi*, Chloroform Water. This is simply a saturated solution of chloroform in distilled water, and is necessarily a feeble preparation, since chloroform dissolves in water but sparingly (1 part in 200). The water may be given, by itself, in doses of one or two tablespoonfuls, but it is more commonly used as a watery menstruum in composite prescriptions, wherein the chloroform of its composition acts as a preservative.

For *administration by inhalation*, only purified chloroform of known good quality is to be used. It is most commonly employed without admixture of other substances, the vapor being breathed, diluted with air. Whether the inhalation be a few whiffs only for the relief of pain or spasm, or whether it be for the establishment of full narcosis for anæsthesia, the fundamental principle must be observed to administer the vapor *sufficiently diluted*. Air overcharged with chloroform vapor is certain and swift death to all animal life, and the proportion of admixture for human inhalation should not exceed, for *continued* use, three and a half per cent. of chloroform to air. When, therefore, chloroform is administered by the homely apparatus of a handkerchief or towel, the points should be observed not to put more than half a teaspoonful or so of the agent upon the towel at any one time, and to hold the cloth free from immediate contact with the face, so that the inhaled vapor may be mixed abundantly with air. It is in this way that brief inhalations are practised for anodyne and antispasmodic purposes. And partly, perhaps, because of their brevity, and partly because of the existence of pain on the occasion of the inhaling, accidents during such brief inhalations are rare. Accidents, however, may occur if the chloroform is *self*-administered by a subject in the recumbent posture. For in such case, if unconsciousness supervenes, the chloroform-charged handkerchief is liable to fall directly upon the upturned nose and mouth, and there to remain, delivering possibly dangerous charges of vapor to the now narcotized subject. Accordingly, self-administration never should be practised unless the subject's head is raised sufficiently so that in the event of unconsciousness the hand and handkerchief will certainly fall down and away from the face, and the inhalation thus automatically be stopped. But under any circumstances chloroform is a dangerous drug for self-use.

The giving of chloroform to the degree of *narcosis*, for *anæsthesia in surgical procedures*, is a special topic, treated in this work in the following article, to which the reader is referred.

A last mode of using chloroform medically is by *deep injection*, by means of the hypodermatic syringe, for the relief of neuralgia. About 2 c.c. (fl. ʒ ss.) is injected at a dose, but the procedure is a harsh one, severe local reaction having several times followed the practice.

In the matter of the *toxicology* of chloroform, the first point to note is that chloroform taken by swallowing, even undiluted, is much less dangerous than would be supposed. The smallest fatal dose of which the writer has read was a drachm taken by a child four years old (Taylor). Boehm ("Ziemssen's Cyclopædia") mentions half a fluidrachm as a fatal dose, but does not give the age of the subject. On the other hand, cases have been reported of recovery after doses of from half an ounce to four ounces (presumably fluidounces). The symptoms, in poisoning by swallowing, are the production of a narcosis generally similar to that induced by inhalation of chloroform, accompanied in many cases by gastric troubles due to the direct irritation of the potion. The treatment must be conducted upon general principles, since there is no chemical antidote to the drug. Belonging to the subject of toxicology is the question whether it is possible to narcotize a sleeping person by chloroform inhalation without the subject's first awakening from the natural slumber so as to become cognizant of the attempt. And from recorded cases and the results of experiments, there seems to be no doubt but what the question is to be answered in the affirmative, *if the subject is in sound sleep* when the administration is made. But otherwise the attempt will certainly be recognized.

Edward Curtis.

CHLOROFORM, ETHER, AND OTHER ANÆSTHETIC AGENTS, ADMINISTRATION OF.—Before taking up the administration of the individual anæsthetics it will be well briefly to consider certain questions of a general character relative thereto, as the choice of the anæsthetic, the preparation of the patient, etc.

In view of the marked differences which exist between the actions of the several anæsthetics, it is evident that in certain cases the conditions presented by the state of the patient, the nature of the operation, etc., may render the use of one agent more suitable than another, and it has come to be a well-recognized fact that a judicious choice of the anæsthetic, especially in cases presenting unusual features, is, to all concerned, an important factor in the satisfactory conduct of the case. In the choice of the anæsthetic the first consideration is undoubtedly the safety of the patient, and it follows that in ordinary cases that agent should be employed which will least endanger the life of the patient. Omitting the important rôle of local anæsthesia and the use of those unusual agents whose true position as to safety has not as yet been determined, we are brought to a consideration of the relative safety values of nitrous oxide, ether, and chloroform.

The statistics of anæsthesia, like other statistics, may be selected and manipulated in such a manner as to prove the particular views of a given writer whether he favors one or the other anæsthetic. Good examples of the fallacy of individual statistics or those derived from small groups of cases, are furnished by the report of Laurie, showing 50,000 consecutive chloroform administrations without a death, and that of Anstie, showing 21 deaths in 3,058 chloroform administrations. It is obvious that to determine rightly the proportion of fatalities to administrations, individual statistics and smaller groups from various reliable sources should be put together till a large mass has been formed, the deductions from which must be of the greatest possible value:

	Administrations.	Deaths.	Rate.
Statistics collected by Julliard:			
Chloroform	524,507	161	1 in 3,258
Ether	314,738	21	1 in 14,987
Statistics collected by Ormsby:			
Chloroform	152,260	53	1 in 2,873
Ether	92,815	4	1 in 23,204
Statistics collected by Gurit in Germany from 1891 to 1897:			
Chloroform	.....	....	1 in 2,039
Ether	.....	....	1 in 5,000
Statistics from St. Bartholomew's Hospital from 1875 to 1890:			
Chloroform	19,526	13	1 in 1,502
Ether	8,491	3	1 in 2,830
"Gas and ether"	12,941	1	1 in 12,941

There are very few reported deaths from nitrous oxide, and considering the many millions of administrations that have taken place, the *rate* of its mortality would probably be one in several hundred thousands.

It is the writer's opinion that the statistics of anæsthesia are particularly unreliable and misleading owing to unreported fatalities, of which there are probably a far greater number than of those reported. Julliard has given particulars of 20 deaths by chloroform that took place within his knowledge, only 3 of which had been published. Waller refers to 3 cases not reported, and mentions one hospital from which 2 chloroform deaths were reported out of 9 that occurred during one year.

Another source of error in these statistics is the fact that the fatalities reported are, for the most part, those which are due to the *immediate* effect of the anæsthetic, while the cases that die subsequently from conditions which may be attributed partly or wholly to the anæsthetic are more apt to be unrecorded. Ether probably furnishes a greater number of these cases than chloroform, and in consequence the statistics of this anæsthetic are probably more favorable than the whole truth of the matter warrants. It is therefore probable that nitrous oxide is the safest general anæsthetic if its use is restricted to momentary administration as for tooth extraction. The prolonged administration of this anæsthetic is quite a different matter, however, and at the present time there are not sufficient data of its use in this way to warrant conclusions as to its safety. The writer has administered gas with air or with oxygen for operations lasting from a few minutes to more than two hours in several hundred cases, and while he has had no death, alarming states have several times appeared with such rapidity and so little warning that it seems probable that the general adoption of this form of anæsthesia would lead to a mortality more nearly approximating, if not exceeding, that of chloroform and ether. This opinion is strengthened by the occurrence of four such deaths in New York City which have come to the writer's notice within one year.

Ether is undoubtedly *second* in safety, whether used alone or following nitrous oxide.

Chloroform is the most dangerous of the agents under consideration.

In mixtures such as A. C. E. the most active ingredient is chloroform, the effect of which is modified by dilution and by the action of the other elements of the mixture. In point of safety these mixtures should probably be placed between ether and chloroform, the greater the proportion of chloroform the more dangerous the mixture.

It is thus evident that from the standpoint of statistics the choice of the anæsthetics should be as follows:

First, nitrous oxide for such operations as necessitate *no more* than one complete administration of the gas.

Second, ether, whether given alone or preceded by nitrous oxide.

Third, a mixture such as A. C. E.

Fourth, chloroform.

There are, however, other factors than statistics to be considered before a proper choice can be made, and these are found in connection with *the condition of the patient* and *the nature of the operation*. Conditions of the patient affecting the choice of the anæsthetic are as follows: Age is responsible for the presence of certain conditions which may modify the effects produced by the different anæsthetics and consequently their safety. It is a popular belief that chloroform is the ideal anæsthetic for children, and that they possess an immunity from its dangerous action not enjoyed by adults. The statistics of anæsthesia prove this to be without foundation, and would rather indicate a greater relative mortality in these subjects, as would seem reasonable in view of their delicate constitutions. In the *Lancet's* investigation of the chloroform question, out of 406 chloroform deaths in which the ages were stated, 58 were fifteen years old or younger. This relative mortality of nearly fifteen per cent. in children is large when we take into account the fact that this age furnishes but a small percentage of the cases requiring anæsthetics.

Ether, if presented in concentrated vapor, is very irritating to the delicate mucous membrane of the air passages of infants and young children, and the respiration may become greatly obstructed by the excessive flow of mucus and saliva thus set up. A properly diluted vapor of ether is well borne by these patients, however, and by careful administration anæsthesia may be accomplished without undue irritation, although mucus and saliva are usually more abundant than in adults. Infants and very young children are easily asphyxiated by nitrous oxide, and the period of anæsthesia resulting from a single administration is so short in these patients that its use is rarely advisable. Older children take gas more satisfactorily, although the period of anæsthesia is much shorter than in adults, and reflex phenomena are more pronounced. Age again becomes a factor in the choice of the anæsthetic in those of advanced years. Here, the impaired respiratory power, the tendency to bronchial affections (or their presence) and to alterations in the blood-vessels, render the use of ether more dangerous perhaps than at any other time of life. The danger of chloroform in reference to these conditions is not particularly affected, and chloroform is thus brought into favorable contrast with ether in the aged.

The mere age, however, should not altogether govern the choice of the anæsthetic without reference to the conditions presented by each patient. Many very old persons take ether perfectly well, and there are some who would be greatly endangered by chloroform.

Nitrous oxide with oxygen may occasionally be of service in the aged under circumstances which would render the use of ether or chloroform particularly dangerous. Exceedingly fleshy individuals are not, as a rule, good subjects for nitrous oxide or ether owing to the fact that they are very liable to difficulties with the respiration under these anæsthetics. Chloroform or chloroform mixtures are better taken by this class of patients. The condition of the heart is occasionally a factor in the choice of the anæsthetic. The presence of valvular lesions with perfect compensation does not materially affect the choice of the anæsthetic, as these patients take anæsthetics in the usual manner. When compensation is not perfect and the patient suffers from dyspnœa, cyanosis, cough, œdema, effusions, etc., the use of an anæsthetic is more or less hazardous, and a proper choice will greatly enhance the patient's safety. The presence of dyspnœa, cyanosis, and cough contraindicates the use of ether and nitrous oxide. Chloroform is perhaps more suitable for these cases, particularly if oxygen is administered with it. In all cases with heart disease it is advisable to avoid the struggle which frequently occurs during the period of excitement, and this should be done *when possible* by the administration of gas followed by ether.

Many prefer the A. C. E. mixture in these cases, and it is probable that if any one anæsthetic were to be chosen for all of this class of cases, such a mixture would be best.

Anæsthetics are especially dangerous in cases presenting degenerative changes in the heart muscle. Chloroform particularly, and ether, or A. C. E., should be preferred according to the indications present.

Disease of the blood-vessels may affect the choice of the anæsthetic. Marked atheroma contraindicates ether, chiefly on account of the danger of cerebral hemorrhage from the elevation of blood pressure which accompanies its use.

Chloroform or A. C. E. would be preferable here, as in cases with aneurism. Nitrous oxide should not be administered to these patients in the usual way. Its use would only be justified when combined with sufficient oxygen to obviate the asphyxia which would otherwise result and which would be dangerous under these circumstances.

The presence of acute disease of the lungs is a contraindication to the use of ether, and whenever such conditions have recently been present this agent should be administered with great care, if at all. Chronic pulmonary complaints are apt to become more active after the administration of ether, particularly in old persons. In cases of slight or quiescent pulmonary tuberculosis ether is apt to be harmful and should be avoided if possible.

Patients who are liable to pulmonary hemorrhage should not have ether. In this class of cases nitrous oxide with oxygen, chloroform, or A. C. E., is preferable to ether.

Active disease of the kidneys, acute or chronic, constitutes an indication for great care in the choice of the anæsthetic. It is very generally accepted that ether is more damaging to *diseased* kidneys than chloroform, and this

is borne out by clinical experience. Nitrous oxide with oxygen probably disturbs the kidneys less than any other general anæsthetic, and should be the first choice in cases presenting nephritis, while chloroform should be second.

Patients who are particularly exhausted, collapsed, or anæmic are greatly endangered by chloroform. Ether is preferable for these cases.

The presence of dyspnœa, as caused by the pressure or direct intrusion of tumors on the air passages, stenosis of the same from false membrane or from the presence of foreign bodies, compression of the lungs by effusions, interference with respiration from abdominal distention or paralysis of the respiratory muscles, is a contraindication to ether or nitrous oxide. Chloroform alone or as in A. C. E. is preferable, especially when administered with oxygen.

Comatose or semi-comatose patients require little if any anæsthetic and are easily brought into a dangerous condition if much is employed. The choice should be governed by the conditions present.

Insanity does not appear from clinical evidence to indicate the use of one particular anæsthetic rather than another, and the choice in these cases should be determined by other factors than the mental state.

Circumstances connected with the operation to be performed often have a determining influence upon the selection of the anæsthetic. The sitting posture as usually required for tooth extraction, and occasionally for operations upon the tonsils and adenoid growths in the pharynx, is a distinct contraindication to the use of chloroform, and the many fatalities which have attended its administration under these circumstances are sufficient warrant for the statement that *chloroform should never be administered to a patient in the sitting position.*

In operations on the brain chloroform is frequently preferred to ether on account of causing less congestion. In operations about the mouth and nose, when it is necessary that the effect of the anæsthetic be maintained beyond a brief period, the narcosis is best continued by chloroform from a Junker apparatus, although ether may be administered before the operation begins.

For abdominal operations chloroform is preferred by many operators on account of the greater quietude of the abdominal muscles and the less vigorous form of respiration than frequently accompany the administration of ether, though it is possible with the latter anæsthetic to produce satisfactory results in the majority of these cases by proper administration.

In operations upon the large joints, particularly the reduction of dislocations, upon the rectum, the deep glands of the neck, the kidney, and for intestinal obstruction ether is preferable to chloroform on account of the unusual tendency to shock which attends these operations. Many fatalities have been recorded from chloroform in these operations. The same is held to be true of operations in which the optic nerve is severed.

In obstetrics much may be gained by a proper selection of the anæsthetic. There are two conditions in these cases which call for the use of anæsthetics, one being for the relief of the pain attending labor, the other for obstetric operations. Since Simpson, in 1847, first advocated the administration of chloroform for the relief of pain in labor, this agent has been almost universally used for this purpose and almost to the exclusion of other anæsthetics. It has been thus administered in a vast number of cases, and very few fatalities have occurred. Indeed, the administration of chloroform is held to be, and probably *is*, particularly safe during the latter part of pregnancy owing to the increased power and tone of the vascular system and the heightened resistance of the body generally. There are, of course, exceptions to this rule—patients to whom chloroform must be dangerous under any circumstances—and these should not be endangered through mere routine.

The simplicity of the administration of a few drops of chloroform to relieve a labor pain and the delightful result produced practically without danger or discomfort, give to this anæsthetic a place that will not soon be held by another agent.

The use of ether as an analgesic during labor has never been extensive; and while ether is at a disadvantage as compared with chloroform in point of comfort and simplicity of administration, it possesses certain advantages which are often desirable and which will be considered later. The writer has used ether for this purpose in many cases with the utmost satisfaction.

In obstetric operations surgical anæsthesia is usually required, and in the selection of the anæsthetic certain points in connection with the patient's special condition should be considered.

The effect of the different anæsthetics upon the uterine contractions, and the rapidity of the recovery of the uterus from the effects of the anæsthetic, are important. Used simply as analgesics in labor there is very little effect upon the uterine contractions, as a rule. Such effect, however, is in direct proportion to the amount employed, and is manifested by lessened force and frequency of the "pains." The writer is not aware whether ether or chloroform is more liable to such action, but would point out the difference in the effects of these two agents when administered to the more profound degree necessary for obstetric operations. Hensen, Dunhoff, and others have demonstrated that ether and chloroform diminish the force of the pains, prolong the interval, and lessen or suspend the action of the abdominal muscles. The force of the pains is quickly restored after ether, very slowly after chloroform. Hensen, therefore, considers that ether should always be used as the anæsthetic in labor.

Preparation for the Administration.—From the standpoint of the anæsthesia a number of details of preparation for the administration are of much importance. The general condition of the patient should be carefully noted several days before the administration. The heart, lungs, and kidneys should be thoroughly investigated. If the patient's condition can be improved or fortified in any way against danger from the anæsthetic it should be done. The influence of digitalis, strychnine, etc., for several days before the operation is often beneficial in counteracting possible depression from the anæsthetic or shock from the operation. In cases in which considerable hemorrhage is liable to occur during the operation, the vessels should be well filled by the ingestion of considerable quantities of fluid for several days prior to the operation. The patient's stomach should be as nearly empty as possible at the time of the operation without withholding nourishment to the extent of producing weakness. It has been the experience of many observers that from three to six hours should elapse between the taking of solid food and the administering of the anæsthetic, preferably the longer time. The length of this period is, however, of less importance than the character of the food last taken, regarding which I should say that the worst possible consisted of meat, vegetables, and milk, and the best, of clear soup, beef juice, or some other non-coagulable fluid of distinct nutritive value. Aged and weakly patients should be treated more leniently in respect to the withholding of nourishment than the young and strong. Whenever it is found desirable that the patient should have nourishment less than three hours before the operation, it should be administered by way of the rectum. The same is true of alcoholic stimulation, which is sometimes desirable shortly before the operation. A condition is occasionally met in cases of intestinal obstruction in which the stomach contains material which has passed into it from the bowel and which is being vomited with little or no effort (regurgitative vomiting). The danger of infection of the lungs through aspiration of some of this material during narcosis is considerable, and if possible the stomach should be thoroughly washed out before the administration.

While the time of the narcosis is usually determined by other circumstances, it is well to bear in mind that the patient's condition is usually best at about eight in the morning and two in the afternoon. As regards the

relation between fasting and the patient's general condition, the early morning presents the favorable circumstance of a prolonged fast which is natural and which

FIG. 1264.—Gross' Mouth Gag.

does not produce the weakness and faintness often felt in passing the usual meal-time. Although an empty stomach is not as essential before a brief administration of nitrous oxide as before ether or chloroform, it is still very desirable and should always be so arranged if possible. It is customary to have the bowels well evacuated before operations, and a number of points have been observed in this connection which bear upon the anæsthesia and the condition of the patient. A drastic and vigorous cathartic the night before a morning operation is very apt to leave the patient not only in a weakened condition but "ill" by reason of headache, nausea, vomiting, and general malaise. The administration of laxatives for several days before the operation, together with regulation of the

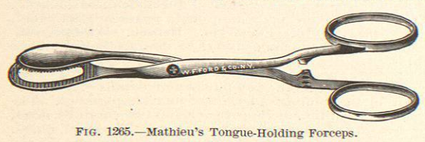

FIG. 1265.—Mathieu's Tongue-Holding Forceps.

diet, would seem to accomplish the purpose more satisfactorily. The rectum and bladder should be empty. This should not be overlooked in brief administrations of nitrous oxide, especially in children, for there is a distinct tendency toward evacuation of these organs under this anæsthetic. Before the administration of an anæsthetic, arrangements should be made for the proper protection and care of the patient during the narcosis.

Ample covering should be provided during the operation, and this is a point frequently overlooked or inadequately carried out. The table should be padded to a comfortable degree if possible, and undue pressure upon any part of the patient should be prevented. Particular care should be taken that the arms and legs do not hang

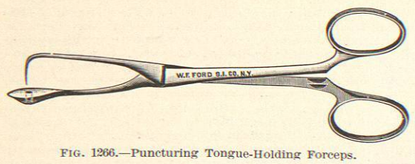

FIG. 1266.—Puncturing Tongue-Holding Forceps.

over the edge of the table, for many cases of paralysis result in this way. The position of the patient should be as natural and unrestrained as possible in view of the requirements of the operation. Apparatus used to maintain certain positions, as the crutch for the lithotomy position, and shoulder rests used in the Trendelenburg posture, should be well padded and not too tightly applied. When the arms are to be extended over the head during the narcosis they should not be *over-extended*, for paralyses have been caused in this way.

The administrator should have at hand and ready for use *a mouth opener* such as a wedge of hard wood, a wooden conical screw, or some such instrument as that shown in Fig. 1264, a forceps for grasping the tongue as shown in Fig. 1265. A tongue-holding forceps which pierces the tongue is useful for such cases as require the tongue held forward for prolonged periods, causing less after disturbance than the grasping forceps. An excellent tongue-piercing forceps is shown in Fig. 1266. A mouth

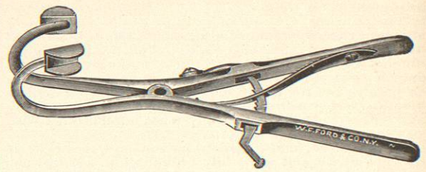

FIG. 1267.—Denhart's Mouth Gag.

gag for holding the jaws apart is often required (see Fig. 1267). Mouth props as shown in Figs. 1268 and 1269 are necessary for dental cases.

The following should also be at hand: A number of small swabs should be *fixed* upon handles or sponge forceps ready for use. A number of towels, a small basin, a hypodermic syringe *in working order*, and various stimulants in solution or tablet form, including strychnine, nitroglycerin, digitaline, atropine, etc., a trachea tube, and instruments necessary for tracheotomy, and in major cases it should be seen that apparatus for infusion is ready. A stomach tube is occasionally useful.

FIG. 1268.—Hewitt's Mouth Prop.

THE ADMINISTRATION.—*Principles of Administration.*—At the time of the administration the patient should assume a natural and comfortable position. The clothing should be loose everywhere. The presence of removable artificial teeth or other loose bodies in the mouth should be ascertained and such should be removed. The nares should be free from foreign material. Natural quiet should be maintained at the beginning of the administration and until anæsthesia is complete. Unnatural quiet and whispering should be avoided. The patient should be encouraged in a confident manner, for encouragement lessens fear and fear produces a kind of shock which increases the danger of anæsthetics, especially chloroform. The effect of the anæsthetic up to the time of unconsciousness should be briefly explained to the patient. He should be instructed how to breathe, naturally but with slightly more vigor than usual, not excessively.

FIG. 1269.—Daintree's Adjustable Mouth Prop.

The best position for the head during the administration is a matter of great importance. If a pillow is used, it should be small and should extend beneath the shoulders far enough to cause the head to assume a moderately extended position over its upper edge. The face should be turned well to one side, though not to the extent of interfering with the respiration. In this position the tongue has less tendency to obstruct the respiration, and drainage from the mouth is favored. The administrator should never lose sight of the seriousness of anæsthesia. He should be familiar with its statistics and should remember that too great a belief in the safety of any one of the anæsthetics constitutes one of its dangers. Too much must

not be trusted to an *apparatus*, and it should be remembered that perhaps "the best apparatus is a good man."

Inhalers should be handled carefully and kept clean for each case. Only anæsthetics "especially prepared for inhalation" by chemists of known reputation should be employed. Chloroform is known to decompose even in the bottle if exposed to direct sunlight for a short time or to ordinary daylight for a prolonged period. Chlorine and hydrochloric acid are thus liberated, and the chloroform is rendered irritating and unfit for use. Chloroform vapor is decomposed by an open flame into carbonyl chloride (phosgene gas), an intensely acrid and

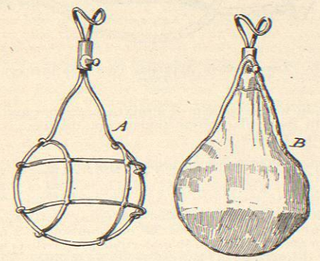

FIG. 1270.—The Esmarch Mask. *A*, The wire frame; *B*, the same with flannel cover.

pungent gas which causes great irritation of the eyes and respiratory tract. So great is the irritation of this substance that a number of deaths have been attributed to its effect upon the lungs through breathing it in operating-rooms where chloroform was used in the presence of open lights and where ventilation was poor. These deaths have occurred among the physicians and assistants rather than among the patients. Exposure of ether to light and air renders it unfit for use, through the formation of acetic acid and other products which give it a sharp and irritating odor. Ether is highly inflammable and its vapor in air is a violent explosive. On account of the great weight of the vapors of ether and chloroform, an open flame near the floor is more dangerous than one overhead. When chloroform is used in a room in which there is an open flame, free ventilation should be insured by drawing the windows down from the top. In practice the greatest danger from the inflammability of ether has proved to be in connection with the use of the cautery. Squibb has reported the ignition of ether vapor at a point fifteen feet from the source of the vapor.

During the administration of an anæsthetic the depth of the narcosis is indicated by the condition of certain functions and reflexes, upon the correct interpretation of which often rest the smoothness and safety of the administration. The chief of these in the order of their value are: the respiration, the corneal, conjunctival, and lid reflexes, the pupil. The condition of these in the different periods of narcosis has been considered under "Phenomena of Anæsthesia," Vol. I., p. 299.

It will be found in practice that no one sign can be relied upon in all cases, and it is better to take into account all of the signs at a given time rather than to depend upon any one. In children the conjunctival reflex is lost very early. In neurotic individuals the pupil is apt to remain reflexly dilated throughout the administration. The breathing, its rate, depth, sound, and alterations, is probably the best of any one sign.

The administration of the anæsthetic should be lessened toward the close of the operation, and should be stopped when all painful procedures have ceased or as soon as vomiting or slight movement will no longer disturb the operator. The patient should be watched closely by the administrator or by some other experienced person till signs of consciousness are present.

Chloroform.—Experiments by Snow, Bert, Dubois, Waller, and others, upon the percentage of chloroform vapor in air necessary to produce the surgical degree of anæsthesia with reasonable safety and in a reasonable time, show from one to five per cent. to be the required amount. The latter strength of vapor is to-day considered dangerously high, and between one and two per cent. is thought to be sufficient. Practically it must be said that our methods of administering chloroform are largely empirical and far from exact. We do not deal in known percentages, and if it were possible to do so an indefinite factor would still remain in the uncertain and irregular intake of the vapor owing to variations in the rate, depth, and regularity of the respirations. Snow, Clover, and others have devised more or less complicated inhalers for the purpose of administering chloroform mixed with air in known percentages within the five-per-cent. limit, and in the hands of the inventors these inhalers proved most satisfactory. In the hands of others, however, numerous accidents and deaths occurred in their use and they are no longer employed. *The men, and not the inhalers, produced the results.* At the present time the administration of chloroform is usually conducted in one of the following ways: From a towel; from a handkerchief; from a mask; from a Junker inhaler.

A towel has been used in several ways. In one it is folded into a square several layers thick and the chloroform, several drachms at a time, is poured upon one surface, which is held close to the face, flat, or in the form of a cone. This was the original method of Simpson and Lister, and was supposed to furnish a vapor within the limit of safe percentage. Snow and Sansom demonstrated that a dangerously high percentage might be inhaled by this plan. Another method of employing a towel is to gather one of its corners into a concave shape and use this as a mask upon which the chloroform is poured. By pulling the corner of a towel through a ring or safety pin (Lister's method) a very fair mask may be formed.

A handkerchief has often been used either in the same way as the towel or crumpled up and held in the hand or placed in a cup or tumbler, chloroform being poured upon it and held close to the face. This is a plan frequently followed in administering chloroform as an analgesic in labor, a few drops for each pain being all that is required.

Perhaps the most generally adopted plan of administering chloroform is by means of a mask, consisting of a

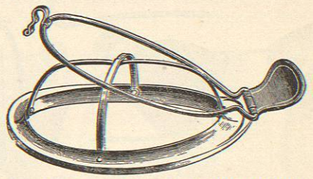

FIG. 1271.—The Schimmelbusch Mask (folding).

dome-shaped wire frame covered by a piece of flannel. The Esmarch, Skinner, and Schimmelbusch masks are the most employed (see Figs. 1270 and 1271).

In the administration of chloroform by means of a towel or cone, two distinct plans have been followed. In one it has been pushed "powerfully and speedily" (Simpson) by the use of comparatively large quantities at a time, and consequently a strong vapor. This has been called the Scotch method. In the other plan small quantities at frequent intervals are used, and from the fact that a drop bottle is usually employed and the addition of the chloroform carried out a drop or more at a time at regular and short intervals, this plan is known as "the