

much commended by Prof. William Goodell. When ether is inhaled, the atmosphere is, as far as possible, excluded, in order that the anæsthetic effect may be quickly induced. *The important point in the administration of chloroform is to secure such an admixture of atmospheric air as that the amount of chloroform-vapor shall not exceed three and a half per cent.* If this rule be regarded, the form of inhaler is of little importance. The original method of Simpson consisted in applying the vapor by dropping slowly chloroform on a piece of thin cloth laid over the mouth and nose, or by a linen handkerchief moistened with half a drachm. The mouth and nose should be protected from the irritant action of the chloroform by inunction with oil.

A cone made of a towel, having a large opening at the apex, and containing a suitable, very porous sponge, is now probably more employed than any other form of inhaler for giving chloroform. The typical method for administering it is that of Snow: in a bag of suitable size the vapor of chloroform is mixed with air in the proper proportion, and then given directly; but, obviously, such an arrangement is not often available.

In administering the vapor of chloroform by any of the modes in use, it should not be forgotten that it has a density and weight four times those of air, and that, consequently, when a cloth or handkerchief is held closely over the mouth, the air is displaced, and the patient may be breathing little more than chloroform-vapor. During the administration of ether, attention should be directed to the state of the respiration, for arrest of the respiratory movements is the only source of danger. When chloroform is being inhaled, the state of the circulation, as well as of the respiratory apparatus, must be regarded.

MEANS OF REMOVING DANGEROUS SYMPTOMS.—Suspension of the heart's action is to be met at once by the withdrawal of the vapor, and the inversion of the patient, according to the method of Nélaton; failure of respiration, by forcibly drawing out the tongue, by the practice of artificial respiration, and by faradization of the respiratory muscles. Artificial warmth should be applied, and cooling of the body by cold-water douche, etc., should be prohibited. Acupuncture of the heart, galvano-puncture, injection of ammonia into the veins, are measures which have been used in extreme cases, but unfortunately rarely with success. Amyl nitrite, by inhalation or subcutaneously, has proved very useful in some cases. Schirmer arouses patients by irritating the nasal mucous membrane by means of a roll of paper of suitable size, and this may be made more exciting by dipping the end in aqua ammonia. Alcoholic stimulants—whisky or brandy—have often been used hypodermatically with asserted advantage. At the present time the subcutaneous injection of ether is the popular expedient. It is, however, very questionable whether the administration of alcohol or one of its derivatives can be useful in a condition of things brought

about by an anæsthetic of alcoholic origin. The author believes, indeed, that serious mischief is done by this practice in cases capable of resuscitation.

In practicing resuscitation for arrest of breathing due to ether, artificial respiration by the method of Silvester, faradization of the chest-muscles, and inversion of the body by the method of Nélaton, are the most promising expedients.

THERAPY.—Anæsthetic agents are used to quiet pain and spasm from disease, to render the dressing of injuries and surgical operations painless, and to produce muscular relaxation. Ether-inhalations give entire relief to the pain of *neuralgia (tic-douloureux)*, *cancer*, and *inflammation*; to pain dependent on spasms—*tetanus*, *chorea*, *hepatic* and *nephritic colic*, etc. It is not necessary in these cases, as a rule, to induce full anæsthesia, for, as has already been pointed out, the sensibility to pain ceases before the condition of insensibility is reached—before, indeed, the perceptive centers of conscious impressions are otherwise impaired than as to the appreciation of pain. Paroxysms of *maniacal delirium*, and of *puerperal mania*, when violent and uncontrollable, are sometimes quickly quieted and refreshing sleep obtained, from which the patient eventually arouses in a calmer frame of mind. Ether is the proper agent for this purpose. It should not be forgotten that *anæsthetics are dangerous in delirium tremens*.

In *puerperal convulsions due to reflex irritation*, or to *uræmia*, the use of chloroform is invaluable. It is equally effective in the *reflex convulsions of early life*, in the *uræmic convulsions of scarlet fever*, and in the so-called *hystero-epilepsy*. When puerperal or other forms of convulsive seizures are due to cerebral hæmorrhage, no good can be accomplished by anæsthetic inhalations. In any case, although convulsions may be arrested by anæsthetic inhalations, other appropriate measures must be resorted to for the permanent removal of the causes. A *paroxysm of epilepsy* impending may be aborted by the inhalation of ether, but the nitrite of amyl is a more effective remedy for this purpose.

In certain *neuroses of the respiratory organs*, great relief is obtained by anæsthetic inhalations. *Laryngismus stridulus* may be quickly cured by the vapor of chloroform. A few drops of chloroform on a handkerchief will suffice, and special care should be taken to dilute the vapor largely with air. A similar procedure will relieve severe paroxysms of *whooping-cough*, but a more energetic use of chloroform is required when *convulsions* occur during a fit of coughing. No single agent gives more relief in *asthma*, but, like all other remedies for this disease, the power of relief declines, and increasing doses of the anæsthetic become necessary, so that the habit of chloroform or ether narcosis is formed.

Anæsthetic inhalations should not be recommended in cases which

will probably require their use for a long time, because the inclination for this kind of intoxication grows rapidly, and is as difficult to control as the opium-habit. The author has seen one case in which the patient consumed a pound of chloroform daily, but, as might be expected, this extraordinary consumption of the anæsthetic did not long continue, for the patient succumbed in a few months.

In *obstetric practice* the applications of anæsthetics are numerous and important. The indications and contraindications for chloroform in *natural labor* may be formularized as follows: When the labor is of short duration, and not excessively painful, anæsthetics should not be used; on the other hand, when the labor is protracted and the suffering great, they favor the progress of the case and prevent exhaustion and uterine inertia. In *primipara* caution is necessary. The inhalation of the anæsthetic should not begin until near the close of the first stage, unless those painful but ineffectual contractions occur which have been aptly characterized as "nagging pains," when the vapor, very much diluted, may be cautiously inhaled for their relief. The inhalation should be practiced only during the existence of the pain. The influence of the anæsthetic on the pulse, respiration, and uterine contractions, should be carefully observed, and, if the pulse fail, the respirations become shallow, or the pains lose in efficiency, the inhalation should be discontinued. If the anæsthetic cause great excitement, and the patient become loudly clamorous for more, while the uterine contractions are lessening in force, it is doing harm and should be withdrawn. It is never necessary, nor proper, to administer the anæsthetic to complete unconsciousness. Toward the close of the second stage, when the head begins to distend the external parts, the quantity of chloroform may be somewhat increased, but the inhalation should be discontinued when the occiput has passed under the pubic arch. If these rules are followed, the action of the anæsthetic is beneficent. Properly administered, the use of chloroform may be considered perfectly safe in the parturient female. It is generally conceded that no well-authenticated case of death from the use of chloroform in labor has occurred, when the administration was in the hands of a properly-qualified medical man.

The following evil results, the author believes, have followed the incautious use of anæsthetics in labor: the progress of the case arrested, so that forceps became necessary; slow and imperfect uterine contractions, and consequent *post-partum* hæmorrhage; a toxic condition of the mother's blood, with after-excitement, wakefulness, and puerperal mania; asphyxia of the child, tedious convalescence, and subinvolution of the womb.

When *instrumental delivery* is required, the utility of anæsthetics is unquestionably great. It facilitates the necessary manipulations, and prevents shock. The inhalation should be carried far enough in these cases to produce sufficient quietude in the patient, and it may be to

complete muscular resolution. When *turning* is to be performed, the state of chloroform narcosis must be deep enough to suspend uterine contractions.

If *puerperal convulsions* occur at any stage, the utility of chloroform is unquestionable. The limits of its utility in these cases have already been indicated.

When careful examination of the pelvic viscera is to be made to establish the diagnosis in difficult and obscure cases, as, for example, *phantom tumor, ovarian and fibroid growths, pelvic abscess, etc.*, the importance of full anæsthesia can hardly be over-estimated.

The use of anæsthetics in *operative surgery* is now an indispensable practice. It may be compendiously stated that ether, or chloroform, is required in all *surgical operations of magnitude*, for the *reduction of dislocations*, for the *taxis in strangulated hernia*, for *dressing painful wounds* and *adjusting fractures*, for *breaking up adhesions*, and *contractions of muscles and tendons in cases of deformity*, for *establishing the diagnosis in feigned diseases, etc.*

The after nausea and vomiting, which are sometimes most depressing, and occasionally dangerous, produced by anæsthetics, may be prevented by the hypodermatic injection of morphine and atropine before beginning the administration of the anæsthetic. After the patient emerges from the anæsthetic sleep, the above-mentioned unpleasant after-effects may be relieved by a minute quantity of morphine ($\frac{1}{12}$ of a grain) and atropine ($\frac{1}{12}$ of a grain) injected subcutaneously.

COMPARATIVE UTILITY OF ETHER AND CHLOROFORM.—Chloroform is more pleasant to inhale, and is less irritant to the air-passages than ether. The vapor of chloroform is not, and the vapor of ether is, inflammable, whence it follows that the former may be alone admissible at night under some circumstances. The stage of excitement is longer from ether than from chloroform, but, as ether may be given much more rapidly, this difference in action may be made to disappear in practice. Chloroform is more prompt in its effects, and the narcosis induced by it more sustained, than is the case with ether; but these advantages possessed by chloroform are quite balanced by the greater freedom with which ether may be administered. The danger from the inhalation of chloroform is vastly greater than from ether.

It follows from the above considerations that ether should be used in preference to chloroform in all cases, except during labor. Chloroform is to be preferred in labor, because more pleasant to inhale, more prompt in action, and without inflammability. The consideration of safety must necessarily take precedence, but experience has shown that chloroform is perfectly safe in labor when properly administered.

The frequency with which fatal cases of chloroform narcosis have been reported—amounting in the aggregate now to about five hundred—imposes an immense responsibility on the administrator. In the

present state of opinion on the subject, the use of chloroform, when ether is available, for the production of anæsthesia, can hardly be justified, especially if a fatal result follow its administration.

Ethyl Bromide.—The physical properties of this ether are mentioned on another page in connection with ether. As an anæsthetic, it was first known to Mr. Nunnely, of Leeds, and he first employed it in surgical practice in 1865. Dr. Turnbull gave an account of its properties, based on experimental and clinical evidence, in 1877, but the most extended trials of its anæsthetic powers were made by Dr. Levis, of Philadelphia, in 1879-'80. In the latter year two unsuccessful cases occurred, one in the hands of Dr. Levis, its chief promoter, and the other in the practice of Dr. Marion Sims, of New York. These fatal cases, and some crude physiological experiments, undertaken to prove that ethyl bromide is a heart-paralyzer, started a reaction against this anæsthetic, then beginning a promising career, and in a short time it fell into almost complete disuse. It has, however, valuable properties which should preserve it from neglect. To induce complete insensibility, from four to six grammes (3 j—3 jss) must be administered rapidly. The odor is not unpleasant, and but little irritation of the air-passages is produced. If administered in full quantity, there is a very brief (scarcely noticeable) stage of excitement, and the period of rigidity is very short and not pronounced. The face is flushed, the ears red, the eyes injected, and the pupils are more or less dilated. The action of the heart is accelerated, and the pulse increases in force. The respiration is also somewhat quickened, and in some subjects becomes snorting or stertorous, but irregularity or arrest of the respiratory movements has not occurred. More or less embarrassment of breathing has been occasionally caused by an accumulation of bronchial mucus. It does not often induce nausea and vomiting; but women are more apt to be disturbed in this way than men. The duration of the stage of insensibility is brief and the awakening prompt, with little of the confusion of mind and excitement characteristic of ether and chloroform. As a rule, the patient wakes out of the anæsthetic condition with little distress of any kind.

In the fatal cases recorded, there are strong doubts in regard to the share of ethyl bromide in the result. In Dr. Levis's case the patient was far advanced in pulmonary disease, and was unfit for the administration of any anæsthetic. In Dr. Sims's case the death of the patient occurred a number of hours after the operation, which was a tedious one, requiring very protracted use of the anæsthetic. It is said that a strong odor of bromine pervaded the entire body of this subject. It is, however, in a high degree improbable that decomposition of the ethyl bromide takes place when it is inhaled.

In administering this anæsthetic the method pursued with ether is

best. If given promptly, in sufficient quantity, and but slightly diluted with air, the stage of insensibility can be induced in about five minutes (Levis). It is not suited to operations requiring much time. It is, however, peculiarly well adapted for slight or brief operations of a very painful character, and for ophthalmic practice it is unequalled, according to Chisolm.

M. Périer states that he has used ethyl bromide very often as a local anæsthetic, instead of ether, and, he affirms, with great success. The method to which he refers is local anæsthesia as inaugurated by Richardson with the spray-douche. Among other distinct advantages over ether, ethyl bromide is not inflammable, and can consequently be used under circumstances prohibiting the former.

The inhalation of ethyl bromide has been utilized in the treatment of diseases for the relief of which the bromides have been given by the stomach. MM. Bourneville and Ollier have carefully investigated this action of ethyl bromide in *hysteria* and *epilepsy*. They find that hysterical seizures are promptly arrested, and that in epilepsy the daily administration of this remedy during a period of two or three months notably diminishes the frequency of the attacks. This practice might be advantageously extended to the treatment of severe *chorea*, *whooping-cough*, *spasmodic asthma*, *hepatic and renal colic*, etc. For these purposes, only sufficient ethyl bromide is inhaled to relieve the pain or spasm, or to induce sopor.

Bichloride of Methylene.—This agent, similar to chloroform, was first proposed as an anæsthetic by Dr. B. W. Richardson. It is more agreeable to inhale, and less apt to produce after-sickness, than chloroform, but it is not less, and probably more, dangerous to life. Five or six deaths have occurred in the cases in which methylene bichloride was administered. Spencer Wells has constantly used it since it was introduced, without a single untoward result. But he employs a special administrator, and gives the vapor with a regulated supply of air. His apparatus consists of a mask closely fitting over the mouth and nose, connected by a flexible tube with a bottle containing the anæsthetic, and with a rubber hand-ball, which sends into the mask, with every contraction of the bulb by the hand, this quantity of air with the anæsthetic vapor. As no accidents have happened, and yet patients are kept narcotized for hours at a time, there can be no doubt of the security afforded by this method of conducting the inhalation. It were well if this plan were applied to the inhalation of chloroform as well as bichloride of methylene.

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LOCAL ANÆSTHESIA.—The diminution of the cutaneous sensibility, by the application of ice and freezing mixtures, has long been practiced. It was not, however, until Richardson's method by the hand-ball spray apparatus had been proposed, that there had been much use made of local anæsthesia.

This method consists in directing a current of atomized ether against the part to be anæsthetized. The ether employed for this

purpose should have a specific gravity not to exceed 0.723. Rhigolene, the lightest liquid known, a product of the fractional distillation of petroleum, is more effective than ether, but great difficulty attends its use, owing to its extreme volatility. When a current of atomized ether or rhigolene is directed against the skin, the rapid evaporation produces an intense degree of cold, in consequence of which the nerves lose their power of transmitting impressions to the sensorium.

A serious drawback to the process of producing local anæsthesia is the unpleasant burning which follows in the part when it recovers from the freezing, and also the great pain which attends the application of ether-spray to certain parts.

THERAPY.—For small operations, such as *extraction of teeth and opening abscesses*, the method of local anæsthesia is extremely useful. It has been and can be used with entire success in much larger operations, but it is generally employed for merely minor ones.

The application of ether-spray to the spine is an extremely serviceable remedy in *spinal irritation* and in *chorea*. In the latter disease it alone suffices to effect a cure. In *neuralgia* of superficial nerves, *lumbago*, *muscular rheumatism*, etc., the ether-spray affords relief very quickly, which may be permanent.

Nitrous Oxide.—Protoxide of nitrogen. Laughing-gas.

COMPOSITION AND PROPERTIES.—A colorless, inodorous gas, having a slightly sweetish taste, and a specific gravity of 1.527. It consists of one equivalent each of nitrogen and oxygen. It increases the rate of combustion of inflammable substances. Water at ordinary temperature absorbs about three fourths of its bulk of the gas. By pressure and cold the gas may be condensed into a liquid, and can then be stored up in suitable vessels for transportation and use. The quantity of the gas taken up by cold water may be much increased by pressure, and the water will then yield it up on heating. Hence this constitutes a convenient mode of storing the gas for preservation. The ordinary mode of storing the gas is in gas-bags holding about eight gallons, in gasometers, or in the liquid form in strong metallic casks.

PHYSIOLOGICAL ACTIONS.—The first surgical operation performed with a modern anæsthetic was the extraction of a tooth, the subject being unconscious from the inhalation of nitrous oxide. It had long been known that this gas produced decided exhilaration when inhaled to a certain point. It has a very short anæsthetic stage, unless the inhalation of the gas be continued.

The first effect of the inhalation of nitrous oxide is a subjective dizziness, whirring noises in the ears, and tingling and loss of sensation throughout the body. Extraordinary illusions beguile the senses, and the intoxicated subject suddenly breaks forth into singing, declamation, sobbing, melancholy, or manifests a pugnacious tendency and