which contraindicate the use of the latter, I return to chloroform, always, however, with increased precaution in noticing its action on the heart. Another usually alarming symptom of a too profound effect from chloroform is when the pupil is found suddenly and widely dilated, and I always desist from chloroform narcosis when this is observed.

Finally, it is not proper in my opinion to endeavor to bring the patient rapidly under the influence of chloroform. The free admixture of air with the vapor, accustoming the nerve-centers and the heart to the presence of this agent in the blood, is essential to safety. The average time of obtaining a complete narcosis with chloroform in my work is from fifteen to twenty minutes. When ether is employed I always use it with the Ormsby inhaler or some form of apparatus which does not permit the passage of the atmosphere over the ether vapor and thence directly into the respiratory tract. The Allis instrument or any other form of inhaler is extremely objectionable, in my opinion, for the reason that the passage of the atmosphere over the ether vapor lowers the temperature of the inspired air very considerably, and carries this cold vapor into the respiratory tract, often producing severe irritation, and sometimes fatal inflammatory reaction. Moreover, the use of the closed apparatus which mixes air with the ether vapor, with which warm air is carried back into the lung, produces a modified form of asphyxia and makes narcosis possible with a smaller quantity of ether carried into the blood than is possible with the open inhaler, which permits an unlimited supply of oxygen into the lungs. This modified asphyxia is perfectly free from danger, can be controlled with great ease by the anesthetizer, and when it becomes necessary to increase the oxygen in the blood, the simple tilting of the inhaler to one side permits a sufficient quantity of fresh air to pass into the respiratory organs without permitting it to pass over the ether vapor. In a series of demonstrations made in operations at Mt. Sinai Hospital, I proved that with the Ormsby inhaler the patient could be anesthetized with ether, held in narcosis during the operation, and would come out more rapidly and with less vomiting and irritating after-effects on the kidneys and other organs than by the employment of any of the open methods of inhalation. It is a well-known fact that the elimination of ether vapor from the blood through the kidneys is the cause of very considerable irritation of these organs, and the larger the volume of ether in the blood the greater the volume for elimination by the kidneys. It is clear that the small quantity of ether necessary in the use of the closed inhaler in part removes this danger to the kidneys. Again, the warming of the ether by the expired air prevents much of the irritation and consequent inflammation of the trachea, larynx, bronchial tubes and lungs which follow the use of the open inhaler, in which the cold vapor is carried into the respiratory tract.

In the hands of a tyro, ether is safer than chloroform, and this without regard to the condition of the patient; but in the hands of an experienced operator, one who has studied his case carefully, and satisfies himself that the conditions justify the use of chloroform, this agent is practically without danger. I prefer to use chloroform in all cases where there are pathologic changes in the kidneys, and in which heart lesions are absent. When the lungs are seriously involved, as in tuberculosis, gummatous tumors or any form of pulmonary inflammation, or in pleuritis in which there does not exist an effusion sufficient to interfere with the

heart's action by compression, chloroform is in general preferable. When, however, in any way the heart has been crippled, ether is the safer. In general, in all operations within the abdominal cavity chloroform is preferable, for the reason that vomiting is less apt to occur during as well as after the operation. As intimated above, however, when there is any heart lesion, even in abdominal surgery it is better to employ ether than threaten this crippled organ with chloroform.

I am especially afraid of chloroform in patients who have had repeated attacks of rheumatism, and in whom the action of the heart is weakened either by serious valvular lesions, or in whom atheroma of the coronary arteries or fatty metamorphosis of the heart muscle exists. In that class of patients known as "chronic alcoholics," chloroform is preferable, by reason of the difficulties met with in producing profound narcosis with ether.

In children, ether is in general the safer anesthetic. In the early part of my career I was taught to believe that chloroform was the better agent in this class of cases, but under 12 years of age it is not without considerable danger. In my service at Mt. Sinai Hospital, a child of 10 years, on whom four days earlier an amputation had been done under chloroform without the suggestion of danger, while the wound was being dressed and while chloroform was again being administered by the same physician and with the same precautions, died from heart failure when not more than a dram of the agent had been employed, and before complete narcosis. Two other fatal cases of chloroform anesthesia in children, in the hands of an experienced operator, occurred in another institution, to my knowledge, and if I know personally of three such instances, many others must have occurred. Chloroform is especially dangerous in children who have been weakened by any inherited or acquired dyscrasia, or from improper nourishment, and great care should be taken to prevent a too rapid administration of this agent, when, as is frequently the case, the little patient begins to struggle and make rapid and deep inspiratory efforts. In children over 12 years of age, well nourished, with no serious lesions of the kidneys or respiratory apparatus, chloroform is, in my opinion, as safe as ether.

19 West Thirty-fifth Street.

THE AMOUNT OF THE ANESTHETIC.*

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The anesthetic is undoubtedly a prominent etiologic factor in the disturbances which accompany and follow surgical operations. To it may be attributed, directly or indirectly, much of the rapid pulse and respiration, exhaustion, shock, nausea, vomiting, asphyxia, syncope, bronchitis, pneumonia, pulmonary edema, and nephritis seen in connection with surgical procedures under general anesthesia, and clinical evidence abundantly proves that these disturbances bear a more or less close relation to the amount of the anesthetic used. It must, therefore, be of interest and value to look into the question of the amount of the anesthetic and to determine, if possible, the facts which may enable us to reduce this element to the minimum.

Let us consider for a moment the way in which the general anesthetics may cause the disturbances referred

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to. I am convinced, from long observation, that the rapid pulse and respiration, exhaustion and shock not uncommonly seen after operations free from hemorrhage, are more frequently due to the anesthetic than to the operation, and are in direct proportion to the amount used. This is particularly true of ether, and the condition is here due to overstimulation. This is accompanied by rapid and vigorous pulse and respiration, and these, if long continued, almost invariably result in exhaustion and shock. Quiet pulse and respiration are usually compatible with good anesthesia, and are attained by avoiding the overstimulation of large quantities of ether. Exceptional cases require so much, however, that this is not possible, and it becomes a question whether another anesthetic should not be chosen. While a great many factors enter into the question of nausea and vomiting after general anesthesia, I am satisfied that there is a direct proportion between the amount of the anesthetic and the amount of the disturbance.

Asphyxia during anesthesia is almost invariably due to mechanical obstruction to respiration, resulting from too rapid and free use of the anesthetic. Under such circumstances the upper air-passages become more and more congested, stertor becomes more and more pronounced and the respiratory efforts more and more vigorous. From these causes the obstruction is progressive and may finally become complete if the anesthetic be pushed. Asphyxia may also result from an overdose or from the entrance of foreign bodies into the air-passages. Syncope from the anesthetic is invariably due to an overdose.

While the cause of bronchitis and pneumonia following operations with anesthesia is probably complex, the anesthetic is a prominent factor in the cases not due to sepsis, exposure, the injury, or the operation itself, and its action in this respect would seem to be both direct and indirect; direct in the local irritation and congestion attending the administration, and indirect in the lowering of body temperature and particularly in causing conditions of the respiration which favor the aspiration of foreign matter into the lungs. The latter is no doubt the greatest source of trouble in this connection, and the offending material may be mucus, saliva, vomited matter, blood or other products of the operation. The rôle of mucus and saliva formed so freely during some cases of etherization, is of great importance. This secretion flows into the pharynx and is often drawn into the larynx and trachea, where it is carried back and forth until it is churned into froth. It acts as a mechanical obstruction to respiration; the patient suffers from lack of oxygen and the consequent violent respiratory efforts serve to draw the foreign substance deeply into the lungs. While in the mouth and pharynx this material is exposed to the micro-organisms that inhabit the region, often including the pneumococcus, and if other conditions are favorable, so-called "ether pneumonia" may result.

Acute pulmonary edema is, in my judgment and experience, a rare complication of anesthesia. The condition from the intense and rapid lung congestion of "ether tion termed "bronchorrhea," in this connection, may be occasionally due to a slight pulmonary edema resulting drowning," but in the vast majority of instances is nothing more than the mucus and saliva from the mouth and pharynx above referred to. The relation of the amount of the anesthetic to these pulmonary complications is obvious.

The influence of anesthetics on the kidneys is a sub-

ject that has received much attention, a notable example of which is the recent elaborate experimental research of Dr. W. H. Thompson and Dr. R. C. Kemp. While some contend that one anesthetic and some that another is most damaging to these organs, all agree that it is the large amount that is dangerous, and this point is sufficient for the present argument. Assuming that the quantity is an important factor in the disturbances following general anesthesia, and that the minimum amount possible is a desirable consideration, what are the facts to guide us to this end? Granting that a degree of narcosis is required which will assure perfect quiet and relaxation on the part of the patient, the necessary amount of the given anesthetic will be found to depend on: 1. The requirements of the particular patient. 2. The requirements of the particular operation. 3. The method of administration. 4. The administrator.

The requirements of the particular patient will vary greatly with the type and condition presented. In general terms a predominance of the conditions in one or the other of the following groups will determine whether the patient will require more or less of the anesthetic as compared with that taken by what may be called an average patient: 1. Patients who, as a rule, require more than the average are the large, strong, energetic, wiry, excitable, neurotic and intemperate. 2. Those who, as a rule, require less than the average are the small, weak, lethargic, languid, calm, phlegmatic and temperate. Patients who are worked up to a high point of nervous tension and who have only restrained themselves by great effort, frequently require large amounts of the anesthetic. Those who are exhausted and emaciated by prolonged illness not only require small amounts to produce complete anesthesia, but will remain quiet under a much lighter degree of narcosis than will most patients in usual health. Many children at the age of puberty require an unusual amount of the anesthetic.

The requirements of the particular operation will vary according to its nature, severity, location and duration. It is a matter of common observation that certain operations require a particularly deep narcosis, such as those of the rectum, perineum, bladder, urethra, eye and ear, and abdominal procedures involving severe or deep manipulations. On the other hand, a comparatively light narcosis is sufficient for most superficial operations, those on the extremities, bones, joints, cervix, etc.

The method of administration plays, perhaps, the most important part in the amount of the anesthetic used, if not in the amount the patient receives, and the one does not necessarily mean the other. I have in many instances been called on to etherize patients who had previously had ether administered to them by the open method, with partial or complete failure after the use of enormous quantities of ether, and I have experienced little or no difficulty in anesthetizing these patients with small quantities of ether by the close method. In administering chloroform, while several ounces an hour may be required if it is poured on and administered from a folded towel, one ounce will frequently be sufficient if an Esmarch mask and drop-bottle are used, and with a Junker apparatus several drams will suffice. Not only does the method of administration determine the amount of the anesthetic, but the manner in which a given method is carried out will affect the result. Take the administration of ether from a cone, as an example. There are two ways in which ether may be

added from time to time, small quantities (3i or ii) frequently, or large quantities (3i or more) at longer intervals. The former plan will consume much less ether and is as preferable to the latter as the "drop by drop" method of giving chloroform is preferable to what may be termed the "dram at a time" method, and for the same reasons.

The administrator, his knowledge, experience, skill and aptitude in this particular direction, will be a most important factor in the question of the amount of the anesthetic. It is a striking fact that men differ greatly in their ability to administer anesthetics. Some acquire the art quickly, others slowly or never. A very great percentage of medical men actually dislike to anesthetize, and these never should.

I am convinced that the smallest amount of the anesthetic compatible with quiet, relaxation and freedom from reflex manifestations during the operation, will give the patient the least possible after-disturbance attributable to the anesthetic. While the actual amount used has not as much significance as the amount of effect produced, there is very apt to be a rather direct proportion between these facts, and the man who uses a pound of ether an hour is vastly more liable to have after-troubles than the one who uses four ounces an hour.¹

7 East Eighty-seventh Street.

NITROUS OXID AND ITS MODIFICATIONS IN PROLONGED SURGICAL OPERATIONS.*

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One year ago I presented in this hall a paper on anesthesia, in which nitrous oxid in a general way was principally discussed. I now wish more particularly to bring to notice the possibilities of this and its modifications in prolonged surgical operations. We may consider nitrous oxid, nitrous oxid and carbon dioxid, nitrous oxid and oxygen.

In the early days of nitrous oxid administration, the effects produced by the gas were unsatisfactory, due to impurities, besides a large admixture of air, which produced excitement giving rise to the term "laughing gas." Apparatus with more perfect valve arrangement, by which air was excluded, then came into use, and more perfect anesthesia is attainable. Nitrous oxid has been used in isolated cases, in long operations, but from what we are told in many instances the narcosis was anything but satisfactory, the patient often crying and squirming throughout the entire procedure, though unconscious of having done so. It is usually supposed that nitrous oxid is only applicable in the short operation, the time available ranging from thirty seconds to two minutes, which is the period intervening between the removal of the face-piece and return to consciousness. Operations in the mouth, as tooth extraction, etc., also require rapidity on the part of the operator. It has always seemed remarkable to me that the dentists do not use the Rose position. All text-books mention the danger of fragments of teeth falling into the larynx. I think this position would effectually prevent this, and hemorrhage—which is always free in oral operations—would flow from the mouth instead of into the larynx.

¹As a rough estimate, allowing for different methods of administration, I believe the average amounts of the different anesthetics mentioned necessary for one hour will be nearly as follows: Ether, 3iv to vi; chloroform, about 3i; A. C. E., about 3iii.

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There is no objection to using gas repeatedly in operations in the mouth. It requires many interruptions for the surgeon, but this is more than compensated by the quick return to consciousness and the elimination of risks due to a more dangerous anesthetic.

Operations not in the mouth, where the inhaler may be removed or air admitted and gas as quickly readmitted, may be prolonged indefinitely. For this purpose a valved device in most perfect working order is essential. A close-fitting inhaler without valves may be employed in the hands of one experienced, for shorter narcoses. The very best stop-cock at present made is that of Barth & Co., London, for the reason that it is air-tight and has indestructible valves, in my estimation a great advantage over that of Dr. Hewitt. This stop-cock is exceedingly simple, light and durable. It may be said that all stop-cocks are made much the same way, the only difference being that the valves in some work through vertical, in others through horizontal, axes. It occurred to me that in gas administration the valve arrangement might be dispensed with, making the apparatus much simpler, an important factor for the occasional administrator or the hospital interne, as it permits him to give his entire attention to the patient, and not to the apparatus. By this method the gas can be given as well as with the valved inhalers, and with a little practice it works particularly well where the gas is given as a precedent to etherization.

In the inhalation of nitrous oxid for a long operation, say an hour or so, it is recommended that the following precautions be particularly observed: Always have a sufficient supply of gas on hand. Nothing is more unsatisfactory than to have to continue with another anesthetic, a narcosis which would have been satisfactory with gas alone. If, as is usual, the recumbent position is employed, the stop-cock should be turned at right angles to the face-piece. The administrator may then stand at the head of the patient.

During a long narcosis the gas cylinder will often become covered with hoar frost, which is of no importance, but frequently with this the gas will freeze in the tap. The best manner to remedy this is to apply a towel wrung out of hot water around the valve of the cylinder—not the cylinder itself. A simple precaution, but one often conducive to a good anesthesia, is to have the patient's head turned fully to one side, as I recommend in all anesthetization. By this means the pharynx and larynx remain unobstructed by mucus; as in anesthesia by nitrous oxid it is not only essential that the patient breathe the gas easily, but that the air-passages should be free, that it may be exhaled as easily, when air is inhaled.

There are few contraindications to the use of nitrous oxid, and those principally depend on organic lesions of the circulatory apparatus, which I do not think it necessary to enter into here. There are few operations which contraindicate the use of the gas. These are principally operations of delicate dissection, or where venous engorgement is undesirable. Abdominal operations do not contraindicate its use, providing sufficient relaxation can be obtained. A question frequently asked is one regarding relaxation in abdominal cases. I might say, this can often be obtained, providing a small device which I have never before seen mentioned, is employed: that is, flex the legs and thighs fairly well. This will effectually produce relaxation of the abdominal wall in many cases, which would be absolutely tense otherwise, and another anesthetic would become necessary.