On the administration of nitrous oxide and oxygen for inducing anaesthesia / by James Paton Boyd, M.B., F.F.P.S.G., Assistant Physician to the Glasgow Royal Infirmary.

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The administration of nitrous oxide, combined with regulated percentages of oxygen, has within recent date been receiving more general recognition as an anaesthetic of much value.

It has the advantage over nitrous oxide alone of producing a more tranquil anaesthesia, lasting some fifteen or twenty seconds longer, and unattended with the phenomena of asphyxia. In addition, when the operation is not in the neighbourhood of the mouth, we can continue to give the combined gases till the operation is completed; while, when nitrous oxide alone is employed, the inhalation must be stopped as soon as signs of asphyxia occur.

I propose to describe the apparatus employed and its method of use, and, lastly, to consider the various forms of operation in which it may be employed.

The apparatus used for the administration of nitrous oxide and oxygen is that devised by Dr. Frederick W. Hewitt, of London, and made for him by Messrs. George Barth & Co., Oxford Street.

In describing the apparatus I shall draw largely from Dr. Hewitt's little book on the administration of nitrous oxide and oxygen.

Figure 1 represents the complete apparatus, consisting of two nitrous oxide cylinders, one oxygen cylinder, a combined

stand and union, double india-rubber tubes (one running inside the other) for conducting the two gases from the cylinders to the bags, two india-rubber bags joined together by a septum common to both, a combined regulating stop-

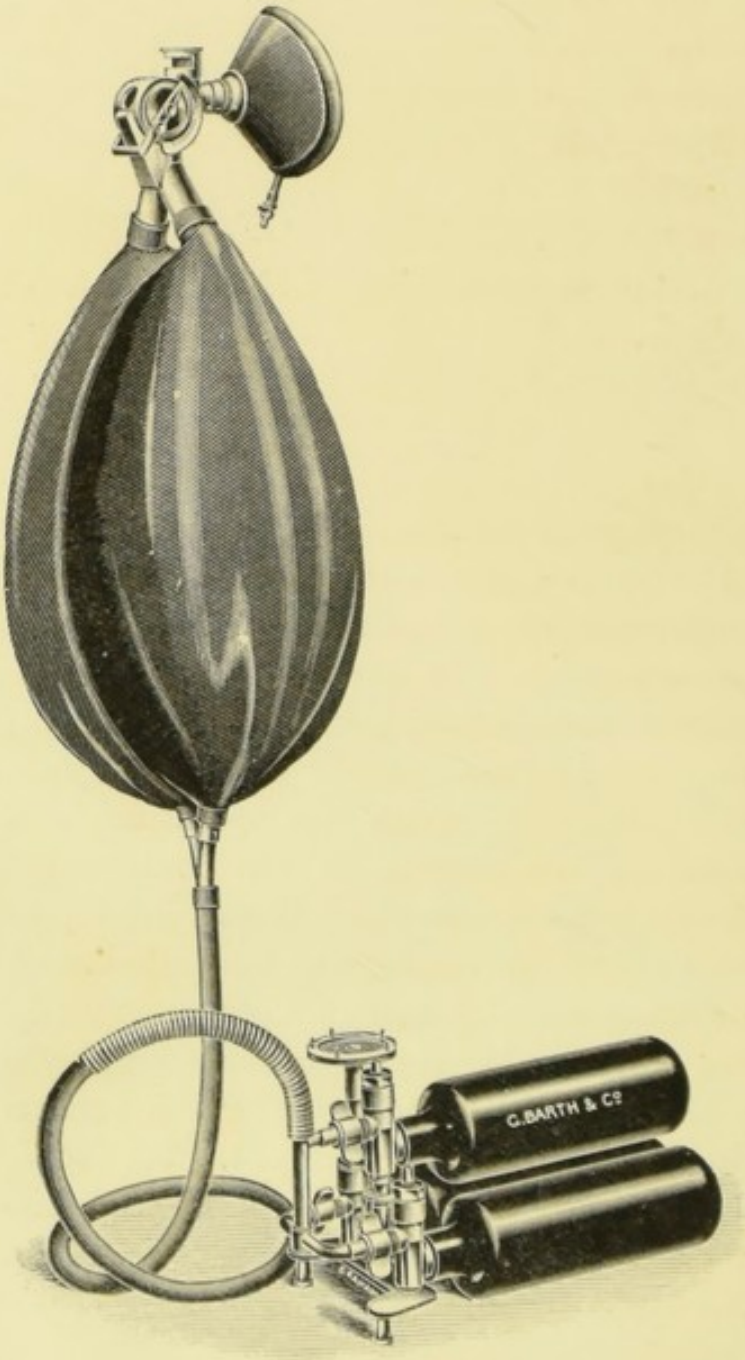

Fig. 1.

cock and mixing chamber, and a face piece. Each nitrous oxide cylinder will furnish 50 gallons of nitrous oxide gas; and each oxygen cylinder about 15 gallons of oxygen. When the foot key is placed upon one of the nitrous oxide cylinders,

and is turned, the liberated nitrous oxide passes to its bag through brass and india-rubber tubes of comparatively large calibre. When oxygen is similarly released from its cylinder, it passes to its bag through brass and india-rubber tubes, which are so much smaller than the nitrous oxide tubes that they are made to travel inside the latter.

The regulating stop-cock and mixing chamber are shown in detail in Figure 2.

The nitrous oxide bag is attached to the tube N O T, the orifice of which N O O is shown. The oxygen bag is attached to the tube O T, which communicates above with a little oxygen chamber O C. There are ten minute holes between the oxygen chamber O C and the mixing chamber. Only three of these ten holes O O appear in the figure. The tubes O T and N O T are furnished with removable valves, *iv* and *iv'*, which act during inspiration, and which prevent diffusion between the gases of the two bags. A H is the air hole; I V is the main inspiratory valve; E V is the expiratory valve with its chimney C; P D shown in dotted outline is a partial diaphragm mounted upon a removable inner tube which serves to direct the expirations towards the expiratory valve E V. To the circumference of the stop-cock and mixing chamber is fixed a flange with A I R, N_2O, and N_2O+O engraved upon it.

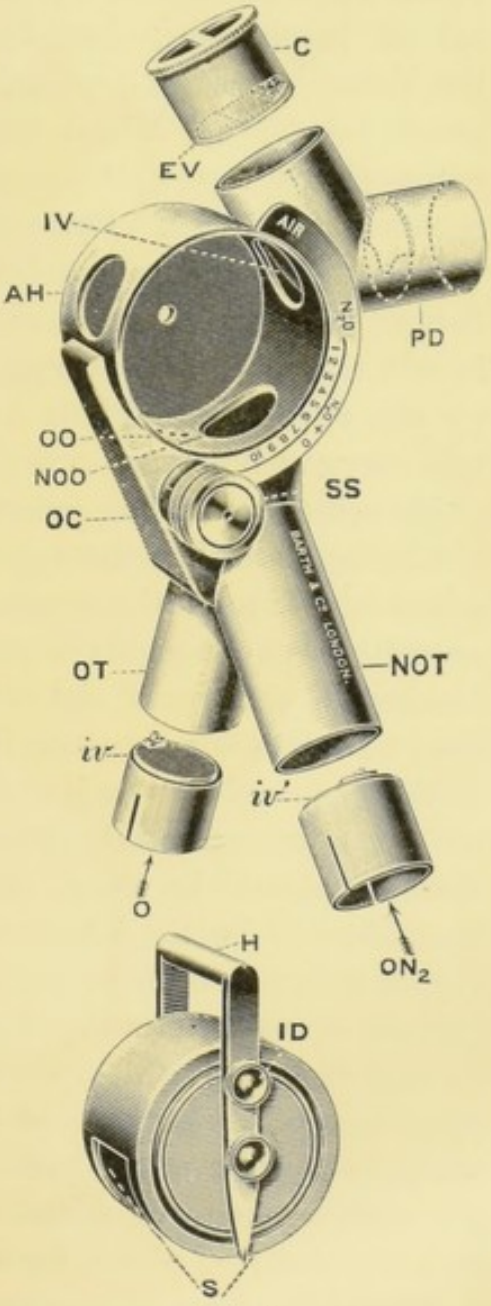

Fig. 2.

There are also figures from 1 to 10 inclusive belonging to the N_2O+O part of the flange. When the indicator of the handle H points to AIR, as in Fig. 1, the slot S of the drum ID allows air to pass through AH and IV during the act of inspiration; but by reason of the other part of the drum covering the orifices NOO and OO, nothing but air is breathed. When the indicator is moved to N_2O, the drum closes AH and opens NOO, the oxygen orifices still remaining covered. Pure nitrous oxide is therefore inhaled. When the indicator reaches I on the N_2O+O part of the flange, the nitrous oxide orifice NOO still remains open, but in addition one of the oxygen orifices OO becomes uncovered by the revolution of the inner drum. When 2 is reached two oxygen holes are open, and so on up to 10, the nitrous oxide orifice remaining patent throughout.

Having described the apparatus, I shall briefly speak of the administration of the combined gases. Patients require no special preparation, as in the giving of chloroform, but it lessens the chances of sickness (which is extremely rare) if no food be taken for three or four hours previous to the taking of the gas. Of course, if a long anaesthesia is required this is all the more essential. The bladder should be empty. All clothing should be loose. Stays, bands, collars, etc., ought to be undone. In the case of any operation on the mouth or throat it is necessary to use a gag, which is inserted before the patient is anaesthetized. The bags (oxygen and nitrous oxide) having been half filled with their respective gases the face piece is applied, the patient being in the sitting posture, with his head resting on the back of the chair, or if a couch is used the head ought to be raised by several pillows. It is well to have several face pieces, for accuracy of application to the face is essential. Two masks, one medium size and the other the smallest procurable, are generally sufficient. The patient, unless a child, should be told to breathe freely as soon as the face piece with the indicator pointing to AIR is put on. The valves should be heard acting, as otherwise the face piece is not fitting accurately. Having satisfied yourself that the breathing is regular, the indicator is turned to 2. The patient is

now breathing nitrous oxide with two per cent. of oxygen. The foot key of the nitrous oxide cylinder should be turned on slightly so as to replace the nitrous oxide which is rapidly inhaled by the patient. It is of the utmost importance to keep the nitrous oxide and the oxygen bags constantly at the same size, viz., half filled. At first we increase the oxygen very slowly, generally allowing the patient to take two or three breaths between each number. In young children and feeble adults the amount of oxygen can be quickly increased till, after the first forty seconds, 7 to 10 per cent. of oxygen is given. A strong, healthy adult rarely requires more than 5 or 6 per cent. of oxygen. We have to guard against the giving of too much or too little oxygen; as Dr. Hewitt puts it, the anaesthetist has to avoid the Scylla of asphyxia on the one hand and the Charybdis of excitement on the other, that is, if too much oxygen be given we get excitement mental and muscular (laughter, shouting, kicking, and struggling), whereas if too little oxygen be given, then lividity, stertor, and muscular twitchings result. The absence of any indications of excitement on the one hand and asphyxia on the other will prove that the proportions of the two gases are properly adjusted. The average period of inhalation required to produce anaesthesia varies; Dr. Hewitt gives it at 110·5 seconds. From a very limited experience, I should feel inclined to put it at rather less. The signs of anaesthesia being fully established are the *loss of conjunctival reflex, breathing regular or slightly snoring in character, and flaccidity of the extremities.* In some cases the conjunctival reflex is not completely lost, but there is always a relaxed condition of the eyelids and a fixed condition of the globes, which indicate the approach of the anaesthetic state. If the operation requires the removal of the face piece, as in teeth extraction, we naturally wish to have anaesthesia fully established before doing so, and the more especially if an attempt is to be made to remove several teeth. Hewitt states that the average duration of the anaesthetic stage is about 44 seconds, but in many cases a much longer period may be obtained. I have frequently obtained a period allowing of the removal of from four to six

teeth, provided no difficulty was experienced in their extraction. Experienced dentists tell me they are quite satisfied that it increases the available period of anaesthesia as compared with the nitrous oxide alone.

For the sake of convenience the uses to which nitrous oxide and oxygen may be put will be considered under the following three groups:

1. Its employment for short operations.
2. For long or comparatively long operations.
3. Its use previous to the giving of ether.

1. *In Short Operations.*—Nitrous oxide and oxygen is *par excellence* the best anaesthetic that can be employed, for anaesthesia is rapidly induced, the after effects pass away quickly, and there is practically no risk to life.

The operation in which it is most constantly employed is of course teeth extraction, and as the mask has to be withdrawn as soon as anaesthesia is established the period of anaesthesia is necessarily short, rarely lasting more than some forty or fifty seconds. In another operation about the mouth, the removal of tonsils and adenoids, it is a most convenient anaesthetic, but, of course, implies rapid operation. I have for some months back given the combined gases to patients of Dr. John Macintyre. They have all been comparatively young children, and the results have been entirely satisfactory. The patient, seated in a chair, is put under the influence of the gas, the mouth opened quickly with a Mason's gag, and both tonsils and adenoids removed. As soon as the operation is completed the head is depressed forwards so as to allow of the blood flowing from the mouth and nostrils. It has the immense advantage over chloroform in that anaesthesia is rapidly induced, and as the patient comes out of the anaesthetic quickly there is no complication from blood trickling into the air passage and causing asphyxia. There is rarely, too, any nausea or after sickness. As I have already said the period of anaesthesia available for operation is a short one, but even if the little patient feels the latter part of the operation there is no special disadvantage. After all the freedom from any risk to life is its chief claim for employment.

For many other minor surgical procedures the combined gases are eminently suitable. One could give a list of cases in which it may be employed, but that is unnecessary. Among the more common may be mentioned bending of stiff joints, opening superficial and deep abscesses, passing catheters, applying the actual cautery, forcibly dilating the anterior nasal passages, and setting fractures. Its advantage in cases where the operation is not about the mouth is apparent, for the inhalation of the gases is gone on with till the operation is completed—some operations requiring an anaesthesia of say five minutes or so can in this way be readily performed. It is undoubtedly difficult to regulate the percentage of oxygen, but in the event of any undue lividity from insufficient oxygen the removal of the face piece now and again causes the lividity to disappear. The difficulty which can only be overcome by experience is the giving too much or too little oxygen, for if the former results then we have excitement manifested by screaming and struggling, whereas if too little oxygen be given then lividity and clonic spasms may ensue. Still, in operations limited in their duration these difficulties are comparatively rarely encountered, and a little practice would prevent their occurrence.

2. *For Long or comparatively Long Operations.*—Mr. Bellamy Gardner, of London, was the first to employ gas and oxygen for prolonged periods, and in the *Lancet* for June 12, 1897, published cases in which successful anaesthesia was maintained for over fifteen minutes, thus allowing of major operations being performed. Since then, Mr. H. Patterson, of St. Bartholomew's Hospital, has described cases in which anaesthesia was kept up for nearly an hour, permitting amputations of limbs and excisions of joints to be performed. The longest period I have ever given it for was thirty-five minutes in a case of tumour of the breast excised by Dr. Rutherfurd. Anaesthesia was readily effected and maintained without difficulty, and within a comparatively short time after the withdrawal of the face piece consciousness returned. No sickness followed. I cannot, however, believe that nitrous oxide and oxygen will ever be generally employed for long operations. Surgeons as

a rule in major operations desire profound anaesthesia, and that is what one cannot guarantee for any length of time. It is true that its chief claim for employment—its absolute safety as regards risk to life—might induce anaesthetists to consider its claims, but the difficulty of maintaining efficient anaesthesia and the consumption of large quantities of nitrous oxide (100 gallons will last about half an hour) will militate against its employment unless under special circumstances.

3. *Lastly, Nitrous Oxide and Oxygen may be given previous to the Employment of Ether.*—Many of the London anaesthetists advocate its use, as it allows the patient to be anaesthetized without any of the disagreeable initial effects of ether. In nervous subjects especially it is of great advantage, for you get rapid loss of consciousness, and as the patient, as soon as he is under the influence of the gas, breathes regularly and deeply, we have none of the holding of the breath and struggling so apt to occur in the initial stage of etherization.

The gas and oxygen are given until anaesthesia occurs, and then an Ormsby inhaler with its sponge charged with ether is substituted, and anaesthesia gone on with in the usual way. Nitrous oxide alone is usually recommended in preference to the combined gases, but I find that with the addition of oxygen you can get a more thorough degree of anaesthesia before applying the ether mask.

In conclusion I would urge the claims of nitrous oxide and oxygen for at anyrate minor surgical procedures. Its practical freedom from any risk to life, the rapidity of anaesthesia, and the absence of after effects must surely appeal to surgeons. Perhaps its disadvantages, namely, initial cost of apparatus, trouble of getting the gas bottles refilled, and unacquaintance with the methods of administration, will prevent its general adoption.