Experiences

IN

THE USE OF NITROUS OXIDE AND OXYGEN WITH REBREATHING IN MILITARY SURGERY.

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MR. PRESIDENT AND GENTLEMEN,—The anæsthesia produced by the combination of nitrous oxide and oxygen with rebreathing, and ether, or chloroform and ether when necessary, is one that should appeal to anyone who has the interests and welfare of his patients at heart. The easy induction, the rapid and comfortable recovery are factors that all men who are interested in anæsthesia will at once appreciate. This method of anæsthesia has been largely employed in the U.S.A., and it has been written about and papers have been read before the Section of Anæsthetics of the Royal Society of Medicine by Chaldicott, Page, and Flemming.

My own interest in the matter is due entirely to Dr. James T. Gwathmey, of New York, whom I met at the Congress in 1912. He persuaded me to get a machine and try for myself, and I have not regretted it. Gwathmey, as most of you know, is one of the greatest authorities on anæsthesia in the United States, and it has been my privilege and pleasure to have him by me whilst I have been working at the 1st London General Hospital.

The anæsthesia and the technique that I shall attempt to describe is what I have been using at the 1st London General Hospital. To begin with, the patients are given a preliminary injection of morphia, atropine, and scopolamine about half an hour before the time of operation. I think that half an hour is sufficient to enable one to get the full value of the injection during the anæsthesia. Of course, it is not always possible to be sure that half an hour has elapsed before starting the anæsthesia, for it is obvious that in a busy morning of 12 to 15 cases it is at times difficult for the sisters to estimate correctly the exact time at which any one case will get to the theatre. I know that I have anæsthetised patients who had only just had the injection, and patients who had had it an hour or more beforehand. The proportions of the injection that I use are: morphia tartrate, 1/6 gr.; atropine sulphate, 1/120 gr.; scopolamine, 1/100 gr. This is made up so that 5 minims is the dose. We found when this was made up in bulk for hospital use that unless the injection was used at once it became flocculent, so our dispenser added one drop of pure carbolic to 4 oz. of the mixture, and we find that this acts as a preservative, so that the ward supply does not become flocculent and can be used until the bottle is empty. I do not know whether the small amount of carbolic acid has any effect on the anæsthesia—one can hardly imagine that it does, since it is such a minute quantity—1 drop to 4 oz. and the dose of the mixture 5 minims.

The apparatus that I use is Gwathmey's, and consists, as you see, of four cylinders, two N₂O and two O. The supply of N₂O and O is controlled by means of two graduated taps, which permit the gases to flow through the glass bottle containing water in a proportion that can be seen, so that one has visual evidence of how much of each gas is being inhaled by the patient. The gases may go direct to the patient via the rebreathing bag, or may be directed through the bottle containing either ether or chloroform and ether, or such mixture as the administrator chooses to place there. The face-piece has at its top a valve to permit a certain amount of intake and output of air and mixed gases, but in actual practice one does not use this valve a great deal except for those patients who will not stand prolonged rebreathing, on account of attempts at vomiting during the anæsthesia.

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TECHNIQUE OF ADMINISTRATION.

One of the most important factors in the production of good anæsthesia is that during the induction the room should be absolutely quiet. And I would here say that there is not enough attention paid to this point by the vast majority of surgeons, anæsthetists, and nurses. During an induction the patient's hearing is at its acutest, and it is, to say the least of it, not encouraging to the patient who—for him—is going through one of the ordeals of his life, to hear the surgeon discussing some matter totally irrelevant to the occasion, whilst in all probability the nurse or somebody is busy clattering bowls and generally making a noise and babel. There should be absolute quiet whenever a patient is being anæsthetised. This condition, great as I know the importance of it to be, is well-nigh impossible at a base hospital, as those of us who work there well know, but it can be ensured even there, and in private practice we ought to insist on it.

Position on the Table.

Gwathmey lays great stress on the importance of having the patient absolutely flat, without even a small pillow, alleging that he finds that breathing is better. My own experience leads me to think that patients as a rule do not like their heads quite so low as Gwathmey would have them, and my usual practice is to have the head slightly raised during the induction, and when anæsthesia is complete I gently lower the head to the horizontal.

Mouth Prop.

I frequently insert a small dental prop between the teeth before starting the anæsthesia. It is my routine to do this when I am giving gas and ether with a Clover, for I have found that it makes induction easier and quieter. With gas and oxygen, however, it does not appear to be so generally necessary as with gas and ether; but the point to be careful about is to observe whether the patient breathes easily through the nose, and if he does not, or if the nose is a narrow one, with very thin alæ nasi, then I always insert a prop. I have found that patients who have these thin alæ nasi will give trouble unless a prop is inserted. The alæ nasi are drawn in towards the septum and the patient makes violent efforts to breathe, but gets nothing or next to nothing into his lungs. I have observed that when this happens the patient becomes pale, with a bluish tint around the mouth, the pupils dilate, and sweating comes on. Treatment for this condition is to open the mouth and get air and oxygen into the lungs.

ADMINISTRATION.

The bag is three-parts filled with N₂O and O in the proportion of 4 to 1; that is to say, oxygen is allowed to bubble through one hole and nitrous oxide through four. The face-piece is adjusted to the face and the gas-valve turned on. And here let me say that the face-piece must fit accurately. If air is allowed to get in at the sides the even course of the anæsthesia will be greatly hampered, and there will be a period of excitement and struggling. The valve at the top of the face-piece is kept open for a few breaths and then turned off, so that rebreathing starts almost from the beginning. The supply of nitrous oxide is now increased until it is flowing in freely through all the apertures and even through the tube itself. I do this to lessen the period of induction, for I hold strongly that the period of induction ought always to be as short as possible—seeing that it is the most unpleasant. In a very short time the patient's breathing grows deeper and more regular until eventually in about three to four minutes it takes on that *automatic rhythm* which is such a constant sign of anæsthesia.

It is necessary to keep a strict watch on the patient's colour, and any degree of cyanosis must at once be remedied by the addition of a little oxygen. It is remarkable how readily these patients respond to oxygen, so much so that only a very little is needed to change the colour back to pink. In my early cases I did not realise this fully and gave oxygen until the pink colour returned, and in consequence in a few cases I very nearly brought my patient out of the anæsthetic state. I now find that it only needs a short sharp turn of the oxygen valve which opens three or four holes for about two seconds.

As soon as anæsthesia has been attained the amount of nitrous oxide coming over is reduced to 4, the oxygen being at 1. With this rate most patients will go on perfectly well

and rebreathing can be continued most of the time. If, however, the patient begins to retch or vomit then I think that there is too much rebreathing and one opens the valve on the face-piece and increases the supply of both oxygen and nitrous oxide.

If it is required to deepen the anaesthesia the pressure in the bag must be increased until when an expiration takes place the bag becomes taut. This will deepen the anaesthesia in a few seconds, but the patient needs careful watching lest he get blue.

Page¹ prefers to give ether to deepen the anaesthesia rather than to push the N_2O under pressure, and on the whole I agree with him.

The signs of overdosage are first of all noisy and stertorous breathing, followed by twitchings of the muscles and accompanied by cyanosis. None of these signs ought to occur in a well-given anaesthetic. The remedy, of course, is more oxygen.

The aim of the administrator should be to get an even anaesthesia, and this is best obtained by being quite sure that the true state of anaesthesia is present before the operator starts, and then keeping the supply of gases at as constant a level as is possible. *Anxious movements of the supply taps only lead to bad anaesthesia.* In this, as with other methods of anaesthesia, the importance of the open and free airway must never be forgotten.

Ether or Mixture.

It sometimes becomes necessary to add either ether or C.E. mixture to the gas and oxygen in cases where extra relaxation of the muscles is required, or during amputations when the nerves are being severed. And here let me say that I have observed that when large nerves are cut in nearly every case the patient moved unless he was being given ether or C.E. This movement does not appear to do any harm, but is troublesome for the operator. Occasionally, if one is having a little difficulty during the induction in obtaining anaesthesia, I find that the addition of ether for a few seconds is frequently enough to produce the required state, but one must be careful not to keep the ether on for long, as this causes coughing and holding of the breath. Just turn it on and off, the whole movement taking about two seconds, and repeat this at intervals of one to two minutes until anaesthesia is complete. Page, in his paper on this subject, says: "The addition of ether during induction makes the administration easier all through even when none is added afterwards." I have seldom found it necessary to give ether or mixture continuously for long—three to four minutes being probably as long as it is ever necessary.

I am not at present prepared to make any definite statement as to the relative values of ether or chloroform and ether with this method, and have up to the present only added chloroform when I have come across some especially burly or alcoholic patient who needed something more potent than ether alone. I find on going through my cases that 38 per cent. have had ether or chloroform and ether.

Regulation of Rebreathing.

On this point Gwathmey in his book on "Anaesthesia," p. 166, says—

"For an even anaesthesia and as an aid to the avoidance of surgical shock a certain amount of rebreathing is of benefit; approximately the rate of flow of the gases should be such that from a quarter to a half of the volume of each respiration is of freshly added gas mixture. Such a proportion reduces to within reasonable limits the expense of gas-oxygen anaesthesia. Too much rebreathing is apt to be followed by post-operative discomfort, usually in the form of headache, and it may cause an increase of post-operative nausea and vomiting. Vomiting during the progress of the anaesthesia is often an indication of excessive rebreathing for that particular patient, although in comparison with other patients it may not appear excessive. At all events, increasing the volume per minute of the gas mixture frequently clears up the symptoms. Our observations on the effect of rebreathing, so far as they go, agree clinically with the laboratory findings of Henderson. Our observations of the blood pressure under nitrous oxide-oxygen (ether) anaesthesia is that there is a distinct rise, not only at the commencement but also throughout the operation."

For my own part, the observations that I have so far made completely confirm Gwathmey's views on this important point—important, because I consider it to be one of the most

essential features of the method. Those of us who were in the habit of giving prolonged nitrous oxide and oxygen with a Hewitt's apparatus know that it was a wasteful method, wasteful of the gases, but, what is more important still, wasteful of the patient's energies. A long nitrous oxide and oxygen without rebreathing frequently left the patient in a very exhausted state. They often had profuse sweatings, and in a good many instances patients were far from well for some hours afterwards. With regulated rebreathing, however, this is not the case. The patients keep a good colour and their temperature is, if anything, slightly raised, and there should be no sweating. The temperature of the expired air as felt when the valve at the top of the face-piece is opened is warm to the hand. I have not thought it of sufficient importance to have this air analysed or to record its temperature.

Overdose.

On this point I feel that I cannot do better than quote to you Gwathmey's own words:—

"Surgical anaesthesia is never obtained when the patient appears in the least degree cyanotic on account of asphyxial spasm and rigidity. On the contrary, the patient must always be pink. Any anaesthesia accompanied by cyanosis is dangerous."

"The symptoms of an overdose of nitrous oxide in the presence of sufficient oxygen to keep the patient pink is, first, stertorous respiration, and second, the onset of an excessive secretion of mucus. Unless the percentage of nitrous oxide is then decreased, the patient's face and hands take on a death-like pallor (not cyanotic). There is an absolute loss of all the facial reflexes; the respirations become shallow and probably the blood pressure falls (that is, the temporal cannot be found so readily although the rate is not excessive). This condition, if pushed, would probably lead to death from paralysis of the respiratory centre, though we know of no experimental evidence to support the hypothesis."

The treatment for overdose is rapidly to remove the mask and start artificial respiration together with the administration of oxygen, remembering always to keep the airway clear.

POST-OPERATIVE CONDITION.

The post-operative condition of patients who have been anaesthetised with nitrous oxide and oxygen with rebreathing and with a little ether when necessary, is to me one of the most striking points of the method. The patients are conscious within two or three minutes of the removal of the anaesthetic, and in the majority of cases are not sick. At the 1st London General Hospital I have had records kept of consecutive cases, and the result is that of 200 consecutive cases 13 were sick once, 4 twice, and 3 had prolonged sickness (i.e., 2 most of the night and 1 for 2 days).

There is in a fair proportion of cases a feeling of nausea which lasts for about 20 minutes, and occasionally there is some headache, which is probably due to too much rebreathing for the particular patient, but beyond that the recovery is perfect. There is no horrible taste of ether in the mouth, no waves of ether vapour coming over as the patient eliminates the drug. And this holds good, even if a little ether has been given during the early stages of the anaesthetic.

One of my most striking cases was an officer who had had the semilunar cartilage removed; the operation lasted about 40 minutes, and finished at 5.30 P.M. At 7.30 P.M. he enjoyed a full dinner, a result that I think is unobtainable with the older methods.

Since both of the gases are non-toxic it follows that this combination is especially suited to those cases of which we have all seen such a number—the badly wounded and septic man. These cases do particularly well, and at the 1st London General Hospital we have records of three cases of amputation at the hip in men who were profoundly septic and who have all done splendidly.

I wish that I were possessed of sufficient power of oratory to paint you a real word-picture of the after-condition of the patients, but, alas, I am unable to do it justice. For a proper appreciation of the condition one should see the operation and the patients afterwards. There is one point, however, that I should like to bring before you as a result of my analysis of 200 consecutive cases at the 1st London General Hospital. It is that I observe that in most of the cases there is no appreciable rise in temperature after the operation. We are most of us familiar with the rise of

¹ H. M. Page: Royal Society of Medicine, February, 1913.

temperature as shown on the temperature charts after an operation. This does not appear to be the case after an administration with this combination.

At Queen Alexandra's Hospital for Officers at Highgate, where I have used this method extensively, Mr. H. J. Paterson—who is in charge of the hospital—has observed and commented on the fact that there is no rise in temperature after this anæsthetic, and I hope that he will tell us the results so far as the officers under his charge are concerned. The temperature remains steady when clean cases are being dealt with, and even in septic ones I find that the rise is not as great as with other anæsthetics.

SUMMARY OF CASES.

Administered by H. E. G. Boyle	...	...	...	...	550
" " J. F. Trewby and residents at 1st	...	...	...	...	161
London General Hospital	...	...	...	...	161
Total	...	...	...	...	711

Of these, 5 have had bronchitis, and 1 of these five has had slight broncho-pneumonia.

Of the 550 cases administered by H. E. G. B., 38 per cent. have had either ether or C.E. mixture (2 have had CHCl_3 alone).

Fatal cases ... Nil.

Analysis of 200 Consecutive Cases at 1st London General Hospital.

		Once	...	...	13
		Twice	...	...	4
		Bad vomiting:			
		2 most of the night,			
		1 for 2 days	...	...	3
Vomiting	...	1	...	20	

Thus only 1.5 % had what could be termed "bad" vomiting.

Temperature: Highest rise 101° – 105° (drainage of buttock). Average rise 0.9 of a degree.

3 men complained of pain (all of them were bone cases).

2 men said that they preferred to come round 2–3 hours after operation.

1 appendix. CHCl_3 added for relaxation, but this was not good.

1 hæmorrhoids. C.E. added, but was difficult to keep quiet.

1 amputation above ankle required 1 oz. of ether. (This is the largest amount of ether that any of the 200 cases have had.)

LIMITATIONS OF THE ANÆSTHETIC.

It must not for a moment be thought that this combination of anæsthetics is suitable for all cases. It is not, but it forms a most useful addition to our armamentarium as anæsthetists.

I think it will be easier if I give you the type of operation in which, at any rate in my hands, the method is unsuited.

1. Cases when *absolute* relaxation is required all the time.

2. Some abdominal cases—e.g., gall-bladder operations. These can be done, but unless the surgeon is prepared to make a large incision and to inject the muscles with some analgesic mixture the operative procedure will be very difficult. And this holds good to a lesser extent for appendix operations, but here it is quite possible to do them if the surgeon is going through the muscles over McBurney's point, but if he prefer to go behind the rectus then, unless there is to be injection of the muscles, I would not advise gas and oxygen from the point of view of the surgeon's comfort.

3. So far I have not done much with intra-oral cases, but the few that I have done have been fairly successful. Gwathmey, however, assures me that he has perfected a technique for tonsils and adenoids, and I hope soon to try it for myself.

I have used this combination in a large variety of cases; the list includes, amongst others, such cases as: amputation of breast, hernia, varicocele, varicose veins, trephining, glands in neck, appendicectomy, hysterectomy, gall-bladder, prostate, and various others, including, of course, the many cases of wounded officers and men and their numerous ailments.

CONSUMPTION OF GASES.

I find that 200 gallons of nitrous oxide and 60 gallons of oxygen are sufficient to last for $2\frac{1}{2}$ hours under ordinary circumstances. I have, of course, done better and also

worse than that; but in my experience that amount is about the average. The longest case that I have so far administered the combination for lasted $2\frac{1}{2}$ hours.

Nursing Point of View.

The work of the nurses is considerably lessened when this combination is employed, for it is obvious that if on the return to the ward the patient is conscious and not vomiting he does not need the undivided attention of a skilled nurse. And this point is of extreme importance in a large military hospital, since it often happens that 8 or 10 operations may be all from the same ward during a morning's work. The contrast between 8–10 semi-conscious and probably vomiting patients and 8–10 men who are conscious and not sick is one that appeals greatly to an overworked nursing staff.

I have been at some pains to discover the opinion of the sisters and nurses with regard to their patients after this anæsthetic, and from inquiries which I have made at the various private hospitals for officers to which I am attached, as well as at St. Bartholomew's and the 1st London General Hospital, the consensus of opinion is that they much prefer to have their patients given gas and oxygen to anything else.

CONCLUSION.

In conclusion, let me say that my reasons for bringing this matter forward are because I am quite convinced that it is an advance on the older methods of anæsthesia and, from the patient's point of view, it is infinitely a better form of anæsthetic than ether or chloroform; for after this combination the recovery in the great majority of cases is devoid of those unpleasant and distressing conditions with which most of you are familiar.

This paper, then, may be taken as an attempt to procure a more extended use of gas and oxygen with regulated rebreathing in major surgical procedures, and especially in the treatment of our wounded.

My own experience of this method with our wounded men has been confined to work at the 1st London General Hospital and to various hospitals for officers in London, and I unhesitatingly say that in my opinion the combination of anæsthetics which I have attempted to describe is infinitely better for most of the men than ether, chloroform, or mixtures thereof. Of conditions at the front I cannot speak with such certainty, as I have, unfortunately, not been there, but it appears to me that it would be of considerable advantage out there if after most of the operations the patients were conscious within a few minutes. It would lessen the work of the orderlies and nurses, and, apart from this aspect of the matter, we must remember that this anæsthetic is non-toxic, and therefore there is less strain put on to the patient, seeing that he does not have to eliminate the drug, be it ether or chloroform, from his system. Moreover, there is no shock after gas and oxygen.

Finally, let me give one word of warning. This combination of anæsthetics is not one to place in the hands of the careless or inexperienced—it requires skilful administration, and if used carelessly will inevitably lead to disasters.

HOSPITAL SUNDAY AT EXETER.—Hospital Sunday was held at Exeter on Oct. 21st. There was a special service at the Cathedral, when the staff, committee, and governors of the Royal Devon and Exeter Hospital attended. The mayor and corporation and representatives of other public bodies were present. The preacher, Rev. Prebendary F. Buckingham, made a strong appeal for funds to reduce the deficiency between the income and expenditure of the hospital, which is about £2200.

THE NATIONAL MEDICAL UNION.—At a meeting of the council of the National Medical Union, held at 346, Strand, London, on Oct. 19th, Mr. V. T. Greenyer, F.R.C.S., presiding, the following resolutions were unanimously passed:—

1. The National Medical Union advises its members and all other non-panel medical practitioners to refrain from attending discharged disabled soldiers and sailors under "the special arrangements" of the Insurance Commissioners, but encourages treatment in their private professional capacity.

2. The National Medical Union regrets that it has been considered necessary to replace British medical men capable and desirous of retaining their appointments in the war hospitals by foreigners holding foreign qualifications.

3. The council of the National Medical Union deprecates that section of the General Order of the Local Government Board, which instructs and allows the diagnosis and notification of measles and German measles by the lay public.