

ART. XI.—*Nitrous Oxide and Oxygen as an Anæsthetic in General Surgery.*^a By VICTOR G. L. FIELDEN, Hon. Anæsthetist to the Royal Victoria Hospital, Belfast, to the Ulster Hospital for Children and Women, and to the Belfast Ophthalmic Hospital.

At the meeting of the Ulster Medical Society in December, 1901, I showed a portable apparatus for the combined administration of nitrous oxide and oxygen, and very briefly referred to its use. I propose in the present paper to go more fully into the administration of this mixture as an anæsthetic in general surgery.

In text-books, to the question, which is the safest anæsthetic? the answer given is, nitrous oxide. But except in dental surgery this gas is seldom employed, because few operations can be completed in the short period of anæsthesia which it induces. This has been timed (by metronome) by Dr. F. W. Hewitt in 20 cases, and found to vary from 15 to 45 seconds, with an average duration of 30·3 seconds. Dr. Dudley Buxton says the probable available anæsthesia from nitrous oxide is 30 to 40 seconds. Binz quotes 22 to 28 seconds as the figures arrived at by “an English committee.”

By administering a little air along with the gas anæsthesia is produced rather more slowly and the resulting duration of anæsthesia is rather more prolonged. Even this is insufficient for most surgical operations. An attempted “continuous” administration of this mixture of gas and air is not quite successful, as can be readily understood when it is remembered that a quantity of inert nitrogen is inhaled. For example, suppose about 7 per cent. of atmospheric oxygen is admitted; this is diluted with about 26 per cent. of inert nitrogen and only about 67 per cent. consists of the active anæsthetic N_2O . As a matter of fact, Dr. Hewitt has shown that dilution of N_2O with 33½ per cent. of air—*i.e.*, 7 per cent. of atmospheric oxygen—produces a mixture which is incapable of inducing complete anæsthesia. The introduction of a piece of apparatus by which it would be possible to replace the nitrogen with N_2O , was attempted, and the one I show (the invention of

^a Read before the North of Ireland Branch of the British Medical Association, on July 17th, 1902.

Dr. Hewitt) is ingenious and excellent. By it N_2O can be given with an amount of oxygen, which can be readily altered at will within wide limits—viz., from nil to considerably over the percentage contained in atmospheric air. Consequently, oxygen starvation, which is the drawback to simple N_2O , is entirely done away with. It proves the falsity of the theory that the anæsthesia produced by N_2O is due to oxygen-starvation of the tissues. Equally untrue is the theory that it is due to increased oxygenation of the tissues by the breaking up in the organism of the N_2O into its elements. In fact, N_2O has a specific anæsthetic effect which differs entirely from the asphyxial anæsthesia which can be produced by the administration of pure nitrogen or hydrogen.

The duration of the anæsthesia produced by the mixture of gas and oxygen may be considered from two aspects—firstly, what is the period of insensibility after the patient has been anæsthetised and the face-piece has been removed, as happens in operations about the mouth? Dr. Buxton gives it as “slightly longer” than with gas alone. Dr. Hewitt carefully timed 69 dental cases, and found the period to vary between 21 and 90 seconds, with an average of 44 seconds.

Secondly, how long can the mixture be continuously given with safety during operations upon other parts of the body than the mouth? One word might be given in answer—viz., indefinitely. Dr. Hewitt has given it for 35 minutes without removal of the face-piece. Claude Martin, of Lyons, administered N_2O with which 15 per cent. of oxygen was mixed for 72 consecutive hours to a dog which suffered no ill effects whatever. In my own limited experience of 28 cases, 7 administrations were for less than 4 minutes, 13 were from 4 to 8 minutes, and 8 were for more than 8 minutes, the longest being for $12\frac{1}{4}$ minutes. Arrangements have been introduced for administering N_2O , or $\text{N}_2\text{O} + \text{O}$ through the nose, whereby inhalation may be continued during operations about the mouth. I have had no experience of this, so I do no more than mention it.

The time necessary to produce anæsthesia is about two minutes. The operation can be commenced and takes, say, 10 minutes, after which in 44 secs., say a minute, the patient recovers consciousness; that is, that in 13 minutes from the beginning of inhalation the patient is anæsthetised, operated

upon, and wide awake again—a period of time often necessary to administer one of the other general anæsthetics before the operator can commence his work. It will be seen, then, that the saving of time to the surgeon in certain short operations is very considerable when this mixture is employed. Recovery is so complete as well as rapid that the patient will be able to assist, if need be, in the application of dressings, bandages, &c. Again, he is able to rise from the couch or table, should his condition not demand his being in bed, and he is able to adjust his dress and move about almost immediately. The dislike that surgeons have of administering an anæsthetic in their own consulting rooms on account of the time it occupies, and also of the more or less tedious recovery, would be absent were this anæsthetic employed.

Similar precautions are advisable, or indeed necessary, in preparing a patient, when it is possible, as for the administration of chloroform or ether—the recumbent posture should the nature of the operation allow of it, removal of tooth-plates if worn, loosening of the clothing so that the breathing be not hampered, &c. ; and as vomiting occasionally occurs it is well, when possible, that no food should have been taken for 3 or 4 hours previously. It may be necessary to insert a mouth prop should there be evidence of difficult breathing, and this is especially so should there be any evidence of nasal obstruction. But should nasal respiration be perfect, the use of a prop is undesirable. Of the different forms of props I need not speak. My only remark concerning them is that to the prop a ligature be attached by which it may be rapidly withdrawn should it happen to fall back into the pharynx or larynx.

The patient is, as a rule, anæsthetised without any trouble except he be very nervous, or by the supervention of involuntary muscular spasm. Rigidity is liable to occur in alcoholics, and may appear in other subjects, but it is not so common as with N_2O alone. Obstructed breathing, which is prone to occur with N_2O in patients with adenoid growths or enlarged tonsils, is much less frequent when the mixture with oxygen is given. Once, in my experience, was the muscular spasm so marked that the operation—cataract extraction—was not attempted, but was subsequently performed under cocaïn. One other patient showed an unusual condition.

To this young gentleman I gave gas and oxygen on three occasions. On the first, whilst going over and before being touched by the surgeon, he struck out boldly with his hands. He afterwards told us he remembered doing it, but felt impelled to do so. On the second occasion he waved his arms but did not strike, and on the third time he again struck out forcibly. I may here mention that this same patient, several minutes after return to consciousness, on the first and second occasions complained of need of air, but on the third this was absent. The duration of inhalation in the first administration was 11 minutes, on the second 6 minutes, and third $4\frac{3}{4}$ minutes.

Middle aged and elderly women prove to be the best subjects for this anæsthetic. Weakly males and children also take it well. Indeed, in the case of children it is well always to administer oxygen with nitrous oxide for two reasons—(1) The duration of anæsthesia with N_2O in children is exceedingly short, so that the extended period by the admixture of oxygen is of great advantage; (2) Muscular twitching is marked, if not excessive, under N_2O , and this is reduced to a minimum under the combined administration. Robust adult males may give a little trouble, due to muscular spasm, but I have found that satisfactory anæsthesia may be produced. Alcoholic and obese patients are not good subjects. Men with beards are not so satisfactory from the inability to fit the mask thoroughly to the face. My youngest patient was a boy of 6, and my oldest a man of 81 years. Sixteen patients were males, and 12 were females.

The operations for which this anæsthetic may be employed are legion. My apparatus is fitted with 50 gallon cylinders, and, were all quite full, anæsthesia might be maintained for about half an hour. I have not given it for such an extended period, the operations performed being of shorter duration; for example, the forcible movement of joints, incising and scraping out of suppurating cysts, abscesses, &c., twice for excision of portion of the lobe of the ear, excision of epithelioma of the lower eyelid, circumcision in an adult, excision and suture of external hæmorrhoids, removal of an exostosis of the great toe, removal of wire ligatures from a compound fracture of the tibia, avulsing a finger nail, and such like. I have had only two gynæcological cases, one of curetting and

one of incising and scraping a pelvic abscess through the abdominal wall. One dental case only is included in my list, although I have many times given gas and air for dental and other short operations. The mixture of gas and oxygen has been given for more prolonged operations than the foregoing by other anæsthetists, *notably*, Dr. Hewitt, who can include amputation of the breast, Syme's amputation, lithotrity, excision of varicose veins, &c., in his list. Klikowitsch has employed it in obstetric practice, and also with success for relieving the symptoms of certain diseases, as asthma, angina pectoris, &c.

The *advantages* of this mixture as an anæsthetic in suitable cases are:—(1) Its absolute safety—no death has been reported from its use, and rarely does any cause for anxiety arise. The N_2O itself possesses no irritant action upon the lungs, kidneys, or intestinal tract, and is a cardiac stimulant, whilst the oxygen overcomes any tendency to untoward symptoms due to de-oxygenation of the blood and tissues. Dr. Geo. Oliver has estimated the effect of N_2O , alone and combined with oxygen, upon the arterial calibre. He finds that “nitrous oxide causes a slight expansion, followed by a reduction either to the normal calibre or to a point or two below it; the latter, however, fails to take place when the gas is inhaled along with oxygen,” and concludes from his observations that this mixture is the safest anæsthetic for short operations, maintaining, as it does, the heart's action and the fulness of the arteries.

(2) From the lack of strain upon the heart and circulation it is eminently suitable in cases of *morbus cordis*.

(3) The diminution or absence of embarrassed breathing which is prone to result with nitrous oxide alone in patients with enlarged tonsils, adenoids, &c.

(4) The rapidity with which anæsthesia is produced and with which recovery takes place, allowing of the completion of a short operation in the time frequently necessary to induce anæsthesia with one of the other general anæsthetics.

Its *disadvantages* are:—(1) Its inapplicability for operations which produce a profound impression, due to the fact that the anæsthesia is light.

(2) The risk of either of the gases running short in a portable apparatus, large quantities being necessary to maintain anæsthesia for a prolonged period.

(3) The muscular spasm which may occur in certain subjects.

(4) The liability of venous oozing to occur in a wound. This was noticed by my friend Dr. Mitchell, and might possibly have been caused by the percentage of oxygen in the mixture being rather low.

After-effects are not severe, although rather more liable to occur than after N_2O alone. This may be due to the fact that as the administration is longer, larger quantities are inhaled. I have already referred to vomiting as an after-effect. This, or simply nausea, may result from the swallowing of some of the gas by a nervous patient. In one of my cases, the patient had had chloroform three weeks previously, and had suffered from sickness for three days after it. After nine minutes' inhalation of gas and oxygen for the removal of wire sutures from a severe compound fracture of the tibia he recovered completely without any sign of nausea or vomiting. Twice I have seen vomiting occur, both in men. In one it was slight, but in the other case the patient, contrary to advice, had eaten a hearty dinner an hour or two before, and after an administration of $7\frac{1}{2}$ minutes vomited very freely. One female retched twice, but did not vomit on recovering consciousness. About five hours later, however, she vomited, but I can hardly blame the anæsthetic for that. I have also referred to a patient who after two out of three administrations complained of need of air several minutes after return to consciousness—indeed on the first occasion it was only after I had left the house (probably 10 or 15 minutes) that he complained. Faintness, headache, and vertigo occasionally occur, and Dr. Hewitt has seen transient maniacal excitement occur in three men of powerful build.

To summarise—(1) A mixture of nitrous oxide and oxygen constitutes an excellent anæsthetic for short, painful examinations, dressings and operations.

(2) The dangers are practically nil.

(3) After-effects, if any, are very slight.

(4) Anæsthesia is rapidly induced, and the recovery to perfect consciousness is even more rapid.

(5) The patient is able to move about almost immediately, so that it is the best anæsthetic to administer when one is desired in the surgeon's consulting-room.