SYMPOSIUM ON METHOXYFLURANE*

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GENERAL

THE HALOGENS, particularly fluorine, are playing an increasing role in medicine. Fluorine is a normal constituent of the body, being found especially in the bones, the hair, and the skin. It enters into the chemical composition of the synthetic gluco-corticoid dexamethazone (Decadron); it is also present in certain synthetic tranquilizers derived from phenothiazine: Vesprin, Permitil, Stelazine. Fluorine is the most active and lightest of the halogens and is also the most electronegative. This electronegativity is the basis of the combination of diethyl ether and halothane in the formation of the azeotrope.

There is also a fluorinated methane, Freon, which is used in industry as a refrigerant. Halothane, $\text{CF}_3\text{—CHClBr}$, is a fluorinated ethane used in anaesthesia. There are three other fluorinated ethanes, $\text{CFCl}_2\text{.CFCl}_2$, $\text{CF}_2\text{Cl.CHCl}_2$, and $\text{CF}_2\text{Cl.CHClF}$, which are not suitable for use as anaesthetics since they cause excitation, convulsions, and serious hypotension. They block transmission through autonomic ganglia and cause cardiac arrhythmias. The fluorination of ethers has given rise to a compound which can cause excitation and trembling, $\text{CFHClCF}_2\text{—O—CH}_3$, and two other compounds of which the therapeutic dose closely approaches the fatal dose, $\text{CFHClCF}_2\text{—O—CH}_2\text{CH}_3$ and $\text{CFHClCF}_2\text{—O—CH(CH}_3)_2$. A fourth fluorinated ether is represented by methoxyflurane or Penthrane, $\text{CHCl}_2\text{CF}_2\text{—O—CH}_3$. It is 2,2-dichloro-1,1-difluoroethyl methyl ether, of which the structural formula is:

It is a clear, colourless liquid, with a characteristic fruity odour. Its boiling point is 104.65°C . (220.37°F .) at atmospheric pressure (760 mm. Hg), and its freezing point is -35°C . (-31°F .). The density or specific gravity is 1.4224 at 25°C . (77°F .).

Penthrane is stable in the presence of alkalis. It may therefore be used with soda lime in a closed circuit. It is stable on exposure to the air, to light, and to humidity.

*Presented at the Canadian Anaesthetists' Society, Quebec Division meeting, at the Faculty of Medicine, Laval University, March 10, 1962.

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Liquid Penthrane discolours if it is stored in contact with copper, brass, or bronze. With these metals and with aluminum, it gives a precipitate. Penthrane vapour does not cause these reactions; however, it attacks and penetrates rubber but not nylon.

Study of the physical constants of methoxyflurane reveals the following:

Purity (vapour-phase chromatography): 99.9 per cent

Flash point (Cleveland open cup): $62.8 \pm 2.2^\circ \text{C.}$ ($145 \pm 5^\circ \text{F.}$)

Oil solubility (liquid/liquid): miscible in all proportions

Water solubility (polarographic titration): 2.2 gm./litre

Vapour density (absolute) at 37°C. (98.6°F.): 7.36 gm./litre

Absolute viscosity at 20°C. (68°F.): 1.056 centipoises

Absolute viscosity at 50°C. (122°F.): 0.690 centipoise

Surface tension at 20°C. (68°F.): 25.98 dynes/cm.

Surface tension at 50°C. (122°F.): 22.45 dynes/cm.

Latent heat of vaporization: 49 cal./gm.

The vapour density establishes that 1 c.c. of methoxyflurane gives rise to 193 c.c. of vapour. One cubic centimetre of diethyl ether gives 220 c.c. of vapour and 1 c.c. of water gives 700 c.c. of vapour.

It takes 49 calories to change 1 gm. of methoxyflurane liquid into vapour without change of temperature. For water, 580 calories are required and for diethyl ether, 87 calories. Methoxyflurane vaporizes 12 times faster than water even though their vapour pressures and boiling points are similar, and this fact is due to the latent heat of vaporization of methoxyflurane.

Methoxyflurane is compatible chemically and physiologically with drugs commonly used in medicine and surgery. However, it potentiates Arfonad (trimethaphan camphorsulphonate) and non-depolarizing relaxants. The relaxant action of methoxyflurane does not occur at the same level as that of *d*-tubocurarine or of gallamine and does not appear at the same stage of anaesthesia as that produced by diethyl ether. Nonetheless, this relaxation is not dependent upon the appearance of apnoea. The use of epinephrine during methoxyflurane anaesthesia should be approached with caution but perhaps to a lesser extent than during anaesthesia with halothane.

Methoxyflurane is a complete inhalation anaesthetic. Its intravenous use is presently under study. It will produce surgical anaesthesia without the need for any supplementation, and produces a state of analgesia which lasts for a long time following awakening. The production of rapid analgesia, rapid amnesia, and rapid relaxation are three of its characteristics. With increasing depth of anaesthesia, respiration and circulation are comparably depressed. As with all other fluorinated anaesthetics, it is necessary to assist respiration either manually or mechanically. It does not stimulate salivary or tracheobronchial secretions and does not increase pulmonary resistance. Walker, Eggers, and Allen have studied the cardiovascular effects of methoxyflurane compared with those of halothane in man:

(a) The cardiac index (litres/minutes/m.³) is depressed by 9.8 per cent by methoxyflurane and by 11.6 per cent by halothane.

(b) The vascular resistance is diminished by 11 per cent by methoxyflurane and by 16.6 per cent by halothane.

(c) The mean arterial pressure is lowered by 19.9 per cent by methoxyflurane and by 24.4 per cent by halothane.

(d) The pulse rate is increased by 9.5 per cent by methoxyflurane and diminished by 4.4 per cent by halothane.

These data indicate that methoxyflurane has less direct depressant effect on the myocardium than halothane in patients with similar levels of surgical anaesthesia. Liver function tests show no greater variation than is produced by anaesthesia with ether or with cyclopropane. Methoxyflurane raises the blood sugar, as does ether.

Blood studies show no interference with the coagulation mechanism, and methoxyflurane does not increase capillary bleeding.

Studies of the distribution and excretion of methoxyflurane show that this anaesthetic has a predilection for the adrenal cortex, the liver, the bile, and fatty tissues, where it is stored before being eliminated by the lungs. This storage in fatty tissues is perhaps an explanation for the persistent postoperative analgesia which follows methoxyflurane anaesthesia.

INDUCTION OF ANAESTHESIA WITH METHOXYFLURANE

Induction of anaesthesia with methoxyflurane is possible with procedures similar to those used with other volatile anaesthetics. It is therefore equally possible with open or semi-open systems, open drop, or by closed or semi-closed circuit. The open or semi-open circuit or open-drop methods are particularly applicable to children. The technique is the same as with open-drop ether.

However, since methoxyflurane is much more potent, less is used, only two or three drops being given at a time. Induction is smooth without irritation to the respiratory passages and without excessive salivation. The fruity odour is not unpleasant and children accept it readily enough. Generally, the excitation stage is absent or slight and nausea or vomiting is rare. However there is slight respiratory depression, varying with the depth of anaesthesia. For this reason, oxygen should be given under the mask as soon as consciousness is lost. The Guedel eye signs do not apply in methoxyflurane anaesthesia and the most reliable guides are the respiration and the arterial pressure. During induction, the pupils remain small, the eyes becoming central and fixed as soon as the child ceases to respond to verbal command. The depth of respiration gradually diminishes; arterial pressure remains constant or tends to fall a little, proportionate to the depth of anaesthesia. With induction by the open-drop method, anaesthesia is established in two or three minutes. Methoxyflurane by the open-drop method compares very favourably with ether.

Induction by methoxyflurane in semi-closed circuit is easy to produce in the adult. In the anaesthesia service at l'Hôtel-Dieu de Québec, different vaporizers have been used including the Heidbrink No. 8, the Vernitrol, the Azeotec, and the Fluotec in combination with Boyle's closed-circuit bottle. It has been found best to use nitrous oxide as well as oxygen during induction. For induction, a methoxyflurane concentration of from 0.8 to 3 per cent is necessary.

Using the Heidbrink No. 8 vaporizer, 2 litres of oxygen and 2 litres of nitrous oxide are given and methoxyflurane gradually introduced starting at setting No. 1 and increasing fairly rapidly until the full-on position at setting No. 10 is reached. Here again, induction proceeds smoothly without nausea or vomiting and with little or no excitatory stage. The pupils remain small during the induction stage and the eyes remain central following loss of consciousness. Arterial pressure stays normal or decreases slightly. The respiration is depressed proportionate to the increasing depth of anaesthesia and for this reason it is preferable to assist respiration when the stage of surgical anaesthesia begins.

Induction takes from 5 to 10 minutes with the Heidbrink No. 8 vaporizer, which is the most rapid and potent of vaporizers.

With the Vernitrol ether vaporizer calibrated at 1 litre/minute, induction will take a little longer and varies between 10 and 15 minutes. On the other hand we have several specially made vaporizers calibrated at 3 litres/minute, which speed up the induction stage to from 8 to 10 minutes. We believe that induction is considerably shortened by the use of nitrous oxide in the circuit. With the Boyle's closed-circuit bottle, we use either the Fluotec or the Azeotec at its maximum opening with a mixture of equal parts of nitrous oxide and oxygen. The Fluotec or Azeotec alone will deliver a methoxyflurane concentration of 0.45 per cent. Since this concentration is insufficient for induction, we use also the Boyle's closed-circuit bottle, at setting No. 5, which will give an additional 1 per cent. The two vaporizers together will thus deliver a total of 1.45 per cent, a concentration which is sufficient for the induction of anaesthesia. Induction with a closed circuit is not practicable since it takes far too long because of the low flow used and the resultant insufficient concentration.

In our Service, a technique which has been most pleasing to us, and above all to the patient, is to start with a small quantity of thiopentone, 250 to 375 mg., to produce loss of consciousness. Induction is then completed at setting No. 8, or from No. 8 to No. 10, which is continued for 5 to 10 minutes and reduced as soon as anaesthesia begins to deepen.

The Vernitrol and Boyle's ether bottle should both be used in the fully open position for 5 to 10 minutes, the concentration being reduced as anaesthesia deepens. Nevertheless, with this technique using thiopentone, one must be cautious because the arterial pressure has a tendency to fall rapidly and the respiration to become easily depressed owing to the combined depressant effects of thiopentone and methoxyflurane. One must therefore be a little more careful and reduce the concentration of methoxyflurane if the arterial pressure tends to fall below acceptable limits. At this stage, when respiration is depressed and arterial pressure has fallen, the patient is sufficiently asleep to permit intubation either with or without a relaxant.

In summary, methoxyflurane has been found to be an excellent anaesthetic for the induction of anaesthesia either with open circuit, semi-closed circuit, or as a supplement to induction with thiopentone. The potency of methoxyflurane, its flexibility, its margin of safety, its non-flammability, and its lack of toxicity all make for an anaesthetic which will occupy an advantageous position among other volatile agents.

MAINTENANCE OF ANAESTHESIA WITH METHOXYFLURANE

Methoxyflurane offers numerous advantages during maintenance of anaesthesia.

Whatever the anaesthetic used for induction, there is no contraindication to using methoxyflurane for the maintenance of anaesthesia. Following induction with thiopentone and a relaxant, following cyclopropane, following halothane-ether, the use of methoxyflurane for maintenance is indicated not only because it is without any disadvantages but above all because of its muscular relaxant property and the small amount of hypotension which this agent produces.

If the induction has been achieved by thiopentone in a dose not greater than 375 mg. together with a relaxant, methoxyflurane can be used immediately. However, if the dose of thiopentone exceeds 375 mg., one must be careful in using methoxyflurane at once because it has been found in such cases that this combination favours very marked circulatory depression, owing to the fact that the hypophyseal-adrenal axis is cut. Therefore, after using thiopentone in a dosage greater than 375 mg., one should wait 15 to 20 minutes before using methoxyflurane. In any case, in such instances it is not generally necessary to employ another anaesthetic agent before this time.

Generally, very satisfactory anaesthesia can be maintained with a methoxyflurane percentage between 0.5 and 0.8. At this percentage, muscular relaxation appears to be sufficient but, sometimes, fractional doses of gallamine or of *d*-tubocurarine will be necessary. But in a large number of cases, one dose of succinylcholine or decamethonium for intubation will be sufficient and methoxyflurane will give entirely satisfactory muscular relaxation. Deeper muscular relaxation can be obtained at deeper levels of anaesthesia but at the expense of recovery time. It should be stressed here that the muscular relaxation which methoxyflurane produces, in contrast to that of other agents, is a direct effect of this agent on the spinal cord. This explains the fact that the stimuli arising from surgical trauma do not produce their habitual effects even during light anaesthesia. Another interesting fact is that methoxyflurane, while giving good muscular relaxation, does not produce apnoea.

However, during surgical anaesthesia, it is necessary to assist respiration because methoxyflurane produces a slight diminution of the respiratory minute volume leading to hypoventilation. With this agent in particular, assistance or control of respiration, either manually or mechanically, is easy to carry out and certain writers believe that the compliance of the lungs and chest wall is increased.

In numerous cases which we have controlled with the electrocardioscope, the cardiac rate and rhythm have remained stable. After an injection of epinephrine 1/50,000 in procaine 1 per cent, arrhythmia has not been observed. The only fact worthy of note during maintenance is a slight depression of arterial pressure, which in general does not exceed 10 mm. of Hg.

In order to gauge the depth of anaesthesia, one relies on the respiratory minute volume and above all on the arterial pressure. If the arterial pressure falls more than 20 mm. of Hg without apparent cause, anaesthesia is becoming too deep. Another indication of too great a depth of anaesthesia is if the pupils, which

normally are contracted, should begin to dilate. In cases such as this, stopping the administration of methoxyflurane or reducing the percentage will cause the signs to return to normal.

Methoxyflurane has been used in male and female patients of all age groups. It has also been used in a wide variety of surgical operations. We particularly appreciated this anaesthetic in neurosurgical procedures where it was necessary to have the patient in a sitting position. It proved extremely useful in such cases since it had scarcely any effect on the arterial pressure or on ventilation and because it is non-flammable and non-explosive.

In order to assure the earliest possible awakening following methoxyflurane, it is necessary to stop the administration 15 minutes before the end of the operation. In this way the patient is in possession of all vital reflexes by the time the operation is finished. Complete awakening follows 1 to 2 hours later. The rapidity of awakening and recovery depends upon the degree of saturation obtained during anaesthesia and also on the obesity or thinness of the subject. Because it is eliminated in two ways, through the lungs and into the fatty tissues, an obese patient will eliminate methoxyflurane faster than a thin one. Nausea and vomiting in the recovery room are less than with other anaesthetics.

We were pleased to note that following methoxyflurane anaesthesia, pulmonary complications were very rare. This can be explained by the absence of the diaphragmatic reflex, which favours a better respiratory exchange, as well as by the calming effect of methoxyflurane (analgesia) which permits a good depth of respiration immediately the patient enters the recovery room.

METHOXYFLURANE IN OBSTETRICS

We have found methoxyflurane to be an agent of first choice in obstetrics and one which has enabled us to fulfil most satisfactorily the demands of obstetrical analgesia, as follows:

1. The agent should relieve the labour pains while conserving uterine tone.
2. It should permit relaxation of the perineum at the time of expulsion of the head but at the same time the laryngeal and glottic reflexes should be preserved so as to guard against the inhalation of vomitus or regurgitated matter, which is always a possibility in these patients, who may frequently arrive at the hospital as an emergency.
3. It should avoid respiratory and circulatory depression both in the mother during induction and maintenance of anaesthesia as well as in the foetus.
4. It should permit the giving of oxygen in sufficient concentration from 50 to 100 per cent during induction or maintenance.
5. It should give an easy and reasonably rapid induction without a marked excitation stage followed by adequately rapid awakening. The calming effect on the patient should be sufficient to permit the use of interrupted inhalation techniques if desired.
6. The agent should reduce to a minimum the incidence of vomiting during or immediately after anaesthesia.
7. It should be compatible with oxytocic agents.

More than any other volatile anaesthetic, methoxyflurane has the properties necessary to fulfil these criteria for obstetrical anaesthesia:

1. It produces satisfactory and rapid analgesia even in low concentrations (0.5 per cent). This analgesia is accompanied by sufficiently rapid loss of consciousness without, however, producing uterine inertia during the course of delivery. If anything, the contrary is true since it has often seemed to us that the force and rhythm of uterine contractions have been increased to such an extent that certain obstetricians have asked us if this anaesthetic possessed oxytocic qualities. Also, we have never experienced significant inertia of the uterus following delivery. The uterus responds normally to the administration of oxytocic drugs if there should be occasion to give them.

2. During the stage of analgesia, methoxyflurane does not produce circulatory depression and only rarely respiratory depression, which is easily corrected by lightly assisting the respiration.

3. Owing to its action on spinal reflexes, which are diminished during light anaesthesia, methoxyflurane relaxes the perineum, which facilitates the expulsion of the foetus.

4. The rarity of vomiting during or following anaesthesia is a characteristic of methoxyflurane. One of our residents, Dr. Michel Boisvert, after a study of 500 cases of methoxyflurane anaesthesia for obstetrical deliveries in our Service at l'Hôtel-Dieu de Québec, reported an incidence of 2.3 per cent for vomiting during delivery and of 2.0 per cent a few hours after delivery. In none of these 500 cases, even in those who did vomit, did any pulmonary complications occur following delivery.

5. The small number of cases of respiratory depression in the child at the time of birth is also noteworthy. The infants cry spontaneously following birth and have satisfactory muscular tone. In the report of Doctor Boisvert on 500 cases, only two children presented a period of prolonged apnoea lasting from 15 to 30 minutes following birth. Resuscitation was carried out and the progress of the infant was then uneventful. In one of these cases, the respiratory depression could have been due to meperidine, which the mother was given 45 minutes before delivery. We have not determined the cause of the prolonged apnoea in the second case. Labour was hard and particularly long and perhaps an overdose of the anaesthetic was the explanation.

6. In addition to these advantages, methoxyflurane is easy to administer in obstetrics and allows the use of an oxygen concentration of from 50 to 100 per cent. Thus, as mentioned above, one can accomplish induction and maintenance with methoxyflurane and oxygen. Generally, we administer nitrous oxide and oxygen in a 50 per cent mixture in order to accelerate induction. The semi-closed method is our usual technique. We use the Heidbrink No. 8 wick vaporizer on the inspiratory side with a gas flow of 4 litres per minute, that is 2 litres of oxygen and 2 litres of nitrous oxide. Before beginning anaesthesia, we turn on the flow meters for oxygen and nitrous oxide as well as the key of the vaporizer, which is opened to setting No. 4 or 5, which will give a concentration of from 0.4 to 0.5 per cent of methoxyflurane. We fill the bag and then the mask is placed on

the patient's face. At this concentration, methoxyflurane vapour is not irritant so that the patient accepts it well. Generally, consciousness is lost after 8 or 10 inspirations and, when the respiration has become stabilized after a few minutes we close the vaporizer to setting No. 2, where it is allowed to stay as a maintenance dose. Often, even before respiration becomes steady, we have noted an increase in the intensity of uterine contractions and progression in the descent of the foetus. We have no good explanation for this increase in the intensity of contractions, but it is a clinical reality which obstetricians as well as anaesthetists have often observed. The birth generally proceeds without difficulty, doubtless owing to the effect of methoxyflurane on the spinal cord by which it produces muscular relaxation. In passing, it should be noted that the perineolaryngeal reflex during expulsion is absent. Awakening is rapid and without vomiting in 98 per cent of cases. Worth noting also is the fact that the patients are peaceful and not suffering during the post-delivery stage.

This, then, is a description of methoxyflurane anaesthesia in a normal obstetrical delivery. In cases where labour is prolonged and the patient needs calming, we can also use interrupted inhalational anaesthesia and obtain excellent results. Finally, in combination with nitrous oxide and oxygen it is an excellent anaesthetic agent for Caesarean sections. We have been able to confirm this fact on many occasions.

In conclusion, we consider that methoxyflurane sets a new standard among obstetrical anaesthetics because of its wide margin of safety.

VAPORIZATION OF METHOXYFLURANE

Methoxyflurane can be given easily either by open drop or by standard ether vaporizers. The word "easily" may appear to be sarcastic when one realizes that the boiling point is as high as 104° C. Did not Adriani say in his book *The Chemistry and Physics of Anesthesia* that a liquid with a boiling point higher than 60° C. is unsuitable for use as an inhalation anaesthetic? However, the potency of methoxyflurane, which necessitates only 15 mg. per 100 ml. of blood to maintain surgical anaesthesia, compared to 150 mg. for ether, overcomes this difficulty.

Furthermore, its potency and its low latent heat of vaporization (49 cal./gm. at 20° C.) make for a liquid anaesthetic that one can use almost as though it were a gas.

In order to understand this last point, let us say that it is necessary to have a continuous vaporization of 150 mg. of ether to maintain surgical anaesthesia. Now ether has a latent heat of vaporization of 87 cal./gm. at 20° C., necessitating the continuous provision of 13.05 calories. Methoxyflurane, on the other hand, needs only 0.73 calory to achieve the same result. Therefore there is practically no drop in temperature during the vaporization of liquid methoxyflurane, whereas it is well known that with ether the anaesthetist's fingers become frozen in trying to warm up the bottle.

Some people say that we should take the flow meters off our anaesthetic machines and rely entirely upon the clinical signs. This pronouncement appears to

us to have a certain content of intellectual snobbery. This is why we shall now consider different vaporizers and how they are calibrated when using methoxyflurane.

With the Vernitrol ether vaporizer, the method used to calculate the percentage of methoxyflurane is as follows. At a room temperature of 22.2°C . (72°F .), which is the temperature maintained by the air-conditioning system at l'Hôtel-Dieu de Québec, the oxygen which passes through the reservoir is saturated with methoxyflurane at about 3 per cent. This means that the vapour pressure of methoxyflurane at 22.2°C . is about 25 mm. of Hg, and 25 mm. of Hg divided by 760 mm. of Hg (the atmospheric pressure) multiplied by 100, in order to obtain the percentage, gives 3 per cent. If 1 litre of oxygen is passing through the vaporizer, this litre, with a saturation of 3 per cent, contains 30 ml. of methoxyflurane vapour, which can then be diluted by the other gases which are not passing through the vaporizer. If there are 3 litres of these other gases, the 30 ml. methoxyflurane will be contained in 4 litres of gas, which is a concentration of 0.75 per cent. By this means, we may calculate any desired concentration.

According to certain workers, the Heidbrink No. 8 ether vaporizer used on the inspiratory side with a gas flow of 4 litres will give a concentration of 0.2 per cent at setting No. 3, of 0.4 per cent at No. 4, of 0.5 per cent at No. 5, of 0.8 per cent at No. 6, of 1.3 per cent at No. 7, of 1.7 per cent at No. 8 to 9, and of 1.9 per cent at No. 10. Having observed clinically the behaviour of patients anaesthetized with this vaporizer and with the Vernitrol, we are disposed to accept these figures. With the Boyle's apparatus, we can use the Fluotec or the Azeotec and divide the indicated percentage by 10. If we open the Fluotec to 4.5 per cent we shall have a 0.45 per cent concentration of methoxyflurane. In order to increase the concentration we use the closed-circuit bottle which, at a setting of No. 5, will give approximately 1 per cent. If one opens it further than that, bubbling will occur and the concentration can rise to 3 per cent.

Using the Boyle's apparatus with the ether bottle outside the circuit, with a 7-litre flow, we shall have a concentration of about 3 per cent with the tap fully open and bubbling taking place, and of 0.5 per cent when the plunger is raised to its highest position. But if we use a flow of 4 litres, the gas will be more saturated and there will be some rebreathing taking place; in order to get not more than 0.5 per cent it will then be necessary to close the tap to at least the half-way position.

Fraser Sweatman Inc. are now making a Pentec vaporizer which works on the same principle as the Fluotec and Azeotec. The calibration runs from 0.5 to 1.5 per cent at intervals of 0.1 per cent. The variability of concentration is linear between a 4 and 15 litre gas flow and it is exact between 55°F . and 95°F . (13°C . and 35°C .).

When using the copper kettle, it is necessary to divide by 10 the concentration which one would obtain if halothane or the azeotrope were being used.

Ayre's technique with or without rebreathing has been used a great deal at l'Hôtel-Dieu de Québec, especially with plastic surgery in children. Finally, to assist or control breathing, the Parcel Set, an M.I.E. apparatus for children, is used at l'Hôtel-Dieu de Québec.

In the child, the open-drop method using the Yonkauer mask and eight thicknesses of gauze necessitates only 5 or 6 drops per minute to obtain surgical anaesthesia and permits intubation without a relaxant after 4 minutes. Doctor Hudon, using a thermocouple, has found that the temperature under the mask was 94° F. (35° C.), thus giving a vapour pressure of methoxyflurane of about 40 to 45 mm. of Hg.

Finally, we should like to mention one case in which 4 or 5 drops of methoxyflurane were poured onto a small piece of gauze about 2 inches square which was applied to the nose of a 15-day-old baby. Within 4 minutes, the baby was sufficiently asleep for a corrective plaster to be applied to a club foot.