FURTHER EXPERIENCES WITH HALOTHANE

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It is many years since a new anaesthetic agent has claimed so much attention as halothane has done since its introduction in 1956. Granted normal precautions, its general safety is now well established by the large number of successful administrations on record, the striking absence of serious complications of a non-avoidable nature and, even more striking, its wide acceptance for use in patients suffering from grave cardiac disabilities.

Between June 1957 and October 1958, this department, with the generous assistance of Messrs I.C.I. (S.A.) Ltd., made a detailed clinical survey[1] of halothane in a comparatively small series of 540 cases. Caution was the keynote in this trial, but it created sufficient confidence in the agent to justify its release for use by all reasonably experienced personnel. Subsequently, despite the fact that no positive attempt was made to encourage its use, halothane has been safely administered to 5,380 cases in the Johannesburg Hospital, between October 1958 and December 1959. In this series there were no deaths or serious complications attributable to its use. The added experience largely confirmed previous conclusions though, to a certain extent, some early views have been modified.

The pharmacology of halothane has been widely investigated and there is now a large volume of literature on the subject. It is therefore only intended to refer briefly to 2 of its more important aspects, namely (1) the effect of halothane on the heart and blood vessels, and (2) its effect on pulmonary ventilation.

The Effect of Halothane on the Heart and Blood Vessels

The hypotension associated with the administration of halothane has been variously attributed to ganglionic blockade,[2] to a direct antisympathetic action on the smooth muscle of the peripheral vessels,[3] and to depression of the myocardium.[4] With moderate concentrations, the diastolic blood pressure is usually well maintained but the pulse pressure is reduced,[1,5] all of which suggests a diminished ventricular stroke volume. Serious overdose with halothane may rapidly lead to cardiac arrest and, in cases requiring deep anaesthesia, circulatory collapse may supervene before satisfactory relaxation is established. For this reason the administration of strong halothane vapour should never be persisted in if adequate anaesthesia is not readily obtained. There is, however, no evidence that halothane will cause the sudden arrest of a normal heart in the absence of overdose or gross anoxia. Arrhythmias are usually harmless, although when they occur it is advisable to check the vapour concentration and to exclude the presence of anoxia or hypercapnia. The greatest caution should always be observed in using adrenaline in association with halothane anaesthesia.

With concentrations of 1·5% and below, hypotension is seldom a noteworthy feature and, in the rare cases where it is excessive, normal blood pressure can be rapidly restored by the use of atropine or vasopressor agents. Peripheral vasodilatation thus seems to be the main cause of the fall in blood pressure, although in deeper anaesthesia myocardial depression may play a part. A few cases of hypotension after return to the ward have been reported, but they all responded to simple treatment without serious consequences. Johnstone[6] has pointed out that the effect of halothane on the peripheral vessels somewhat resembles that of a spinal anaesthetic. This suggests the need for very careful handling in the immediate postoperative period, particularly in avoiding undue movement or injudicious positioning.

The Effect of Halothane on Pulmonary Ventilation

Unlike ether, halothane is not a reflex respiratory stimulant in light anaesthesia while, in the deeper planes, respiration is depressed. With the Wright spirometer[7] it has been possible to study the effect of halothane on pulmonary ventilation in more detail, and to compare it with that of ether under normal working conditions where anaesthetic concentrations ranged between 1% and 1·5% but at no time exceeded 2%.

It was found that the respiratory rate was usually higher and the tidal volume lower in cases under halothane than in those under ether, but that the difference in the minute volume was not pronounced. When the halothane was stopped at the close of the operation, the usual response was a rise in tidal volume accompanied by a fall in the respiratory rate. This contrasted with the normal reaction to surgical stimulation, when the minute volume, tidal volume and respiratory rate all showed an increase. The tachypnoea (up to 50 per minute or more) associated with surgical stimulation was always accompanied by a marked increase in both minute and tidal volumes. When the stimulus ceased, the minute volume usually decreased more rapidly than the respiratory rate, leading to a reduction in the tidal volume. Any differences between the behaviour of pulmonary ventilation under ether and that under halothane, were insignificant compared to the effects of surgical stimulation or hypercapnia.

It can safely be assumed that normally there is no danger of inadequate pulmonary ventilation during light or moderate halothane anaesthesia if over-sedation is avoided. The tendency to a reduction in the tidal volume suggests the need for an adequate supply of fresh gases when the semi-closed method of administration is in use. Endotracheal intubation also helps in reducing the mechanical dead-space, but pulmonary ventilation adjusts itself physiologically and it was noted that when a facepiece is used the tidal volume increases considerably.

THE PLACE OF HALOTHANE IN ANAESTHESIA

With so many excellent drugs and techniques available for anaesthesia, one would hardly expect an extremely expensive agent to find much favour, and this makes the popularity of halothane with anaesthetists the more remarkable. In the ensuing paragraphs an attempt is made to assess the main factors that have been responsible for its present wide use in this group of hospitals.

Non-inflammability

The increased use by surgeons of various types of equipment that create a fire hazard, coupled with the complex recommendations and regulations relating to precautions against explosions, is rapidly making the use of certain well-tried but potentially explosive anaesthetics an unbearable responsibility. The intrinsic flexibility of inhalation anaesthesia can never be entirely achieved in other techniques and the need for a potent and non-inflammable gas or vapour was acutely felt long before the advent of halothane. In a large proportion of the cases where halothane was chosen the advisability of avoiding an inflammable agent was a major factor.

Potency and Range

With the exception of chloroform, the only non-inflammable inhalation anaesthetics have either a low potency or a very restricted range of safety and utility. Notwithstanding the present wide reliance on intravenous methods, it is often a great advantage to dispense with the need for repeated injections in limbs where the veins have already been overworked; while the numerous assistants that are such a feature of modern surgery sometimes make it difficult or even hazardous to maintain access to a vein. A good inhalation anaesthetic does much to solve these technical problems.

A Non-irritating Vapour

The inhalation of halothane results in rapid loss of consciousness, and surgical anaesthesia is reached within a few minutes. It is non-irritating to the respiratory tract even in concentrations beyond the limits of safety and thus provides a pleasant and convenient method of induction. In this respect, it is sometimes of great value in cases where there is a danger of vomiting or where, because of physical deformities or pathological causes, the development of intractable respiratory obstruction is a hazard.

After a normal intravenous induction and intubation, it is convenient to control the patient with light halothane anaesthesia while he is being prepared for surgery and positioned on the operating table. This enables the anaesthetist to supervise the procedure without interruption and to give his attention where it is most required. The vasodilatation will greatly facilitate the subsequent placing of a Gordh needle.

If the use of an inflammable agent is permissible, a halothane-ether sequence (with or without previous intravenous sodium-thiopentone) gives a rapid, smooth and safe induction.

Postoperative Effects

With judicious use, halothane is a flexible anaesthetic contributing to rapid recovery of reflexes and consciousness. In freedom from nausea, vomiting and other post-operative complications it compares favourably with most other anaesthetics.

Control of Pulmonary Ventilation

Early impressions suggested that the chief scope of halothane was as a main agent for cases in which a moderate depth of anaesthesia was sufficient, but further experience has proved it to be equally valuable when used with muscle relaxants in abdominal and thoracic surgery. This is because with halothane pulmonary ventilation can easily be controlled and the dose of muscle relaxant reduced. Since it has been commonly used in this type of case there has been a great deal less postoperative apnoea and respiratory depression. The use of prostigmin is usually unnecessary.

The analgesic properties of halothane are inferior to those of ether, but because of the low concentration (0·5 - 1%) that is required to keep the patient lightly anaesthetized when muscle relaxants are used there is little depressant effect on the circulation. Halothane has been generally employed in cardiotomies, including the pre- and post-bypass stages of the extracorporeal circulation procedure.

THE ADMINISTRATION OF HALOTHANE

In the present series the semi-closed method has been almost always employed and, with spontaneous breathing, gas flows approximating to normal minute-volume requirements have been used. Where the patient is artificially ventilated through a soda-lime filter, the supply of fresh gases may be considerably reduced (say to half the normal minute volume) without serious prejudice to the efficiency of pulmonary ventilation, thus securing some reduction in the consumption of halothane.

The extremely high cost of the agent has led many anaesthetists to develop techniques involving total (or near-total) re-breathing.[8,9] Two arrangements of the circuit are possible depending on whether the vapourizer is placed outside the breathing system or within it. The principles concerned have been admirably put forward by Newman.[10] When the vapourizer is *outside* the breathing system the danger of overdose is very small. In such a case, should the need to deepen the anaesthesia arise, one would naturally revert to a semi-closed technique until the desired depth was attained. If the vapourizer is *within* the breathing system a satisfactory balance may be established if its efficiency and the fraction of the patient's minute volume that is allowed to pass through it are sufficiently low. Any attempt, however, to deepen the anaesthesia by increasing the proportion of the minute volume that perfuses the vapouriser would demand the greatest care and attention. In the making of adjustments, changes in vapour strength can be effected with greater flexibility and accuracy when the administration is semi-closed. It is felt that techniques in which total re-breathing is approached are not suitable for general use for, apart from the risk of overdose, it is doubtful whether adequate pulmonary ventilation can always be assured with closed systems.

Up to the present only 1 compensated vapourizer has been available in this hospital; and so in the great majority of the present series of administrations a simple vapouriser (Boyle's or Rowbotham's) was used. Although the com

pensated instrument is both a convenience and a safety factor, care and experience should enable the simpler type to be used without undue risk.

SUMMARY

The administration of halothane in a series of over 5,000 cases has been reviewed. With due appreciation of its dominant pharmacological properties and its high potency, the claims that have been made for it as a safe anaesthetic have been confirmed. The effects of halothane on pulmonary ventilation have been further observed, the conclusion is that hypoventilation is not a serious hazard; in cases showing marked tachypnoea the respiratory exchange was more than adequate. The chief advantages of halothane are its non-inflammability, potency and flexibility, and the ease with which pulmonary ventilation is controlled. It gives a rapid and comfortable induction

and is of great value where intravenous methods are inconvenient or contra-indicated. Except on the grounds of economy, closed methods are not favoured.

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