HALOTHANE ("FLUOTHANE") IN A COUNTRY HOSPITAL

BY

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Reports on the extensive clinical trials of halothane carried out by Johnstone (1956), Bryce-Smith and O'Brien (1956), and Brennan, Hunter and Johnstone (1957) will have been studied with great interest by most anaesthetists. Many, like the writers, must have wondered whether the new discovery could bring about a basic change in current anaesthetic practice.

For more than ten years some variant of balanced anaesthesia has been used in most anaesthetic rooms. The aim has been to produce a flaccid narcosis less harmful to the patient than the toxic depths of chloroform and ether anaesthesia.

The pioneers of halothane proved to their own satisfaction that a deep narcosis free from toxic after-effects, explosion risks and cardiac catastrophe could be obtained with this drug. We decided in July 1957 to attempt to duplicate their results in the theatres of the North Down Hospitals Group.

This group includes Ards Hospital (320 beds), a busy general hospital with the usual departments including a 36 bed maternity unit, and Bangor Hospital, a converted cottage hospital of 40 beds, where intermediate and minor surgery, gynaecology, oto-laryngological surgery and casualty work are carried out. This Hospital Group is self

### Table I

Classification of operations under halothane anaesthesia

<table>
<thead>
<tr>
<th>General surgery</th>
<th>333</th>
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<tbody>
<tr>
<td>Gastrectomy</td>
<td>4</td>
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<tr>
<td>Gastro-enterostomy</td>
<td>1</td>
</tr>
<tr>
<td>Cholecystectomy</td>
<td>12</td>
</tr>
<tr>
<td>Hemicolectomy</td>
<td>3</td>
</tr>
<tr>
<td>Laparotomy</td>
<td>19</td>
</tr>
<tr>
<td>Perforated viscus</td>
<td>10</td>
</tr>
<tr>
<td>Colostomy</td>
<td>8</td>
</tr>
<tr>
<td>Short circuits</td>
<td>5</td>
</tr>
<tr>
<td>Appendicectomy</td>
<td>124</td>
</tr>
<tr>
<td>Hernia repair</td>
<td>22</td>
</tr>
<tr>
<td>Strangulated hernia</td>
<td>2</td>
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<tr>
<td>Hydrocele operation</td>
<td>3</td>
</tr>
<tr>
<td>Haemorrhoidectomy</td>
<td>10</td>
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<tr>
<td>Thyroidectomy</td>
<td>3</td>
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<tr>
<td>Minor procedures</td>
<td>125</td>
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<tr>
<td>Mastectomy</td>
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<table>
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<th>Gynaecology</th>
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<tbody>
<tr>
<td>Hysterectomy</td>
<td></td>
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<tr>
<td>Pelvic floor repairs</td>
<td>49</td>
</tr>
<tr>
<td>Wertheim's hysterectomy</td>
<td>3</td>
</tr>
<tr>
<td>Laparotomy</td>
<td>21</td>
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<tr>
<td>Caesarean section</td>
<td>16</td>
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<tr>
<td>Vulvectomy</td>
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<tr>
<td>D. and C</td>
<td>165</td>
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<table>
<thead>
<tr>
<th>Genito-urinary</th>
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<tbody>
<tr>
<td>Prostatectomy</td>
<td>18</td>
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<tr>
<td>Nephrectomy</td>
<td>2</td>
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<tr>
<td>Suprapubic cystotomy</td>
<td>9</td>
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<tr>
<td>Nephro-lithotomy</td>
<td>1</td>
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<tr>
<td>Cystoscopies</td>
<td>50</td>
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<table>
<thead>
<tr>
<th>Orthopaedics</th>
<th>80</th>
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<tbody>
<tr>
<td>Smith-Petersen pinning</td>
<td>9</td>
</tr>
<tr>
<td>Open reduction of fractures</td>
<td>9</td>
</tr>
<tr>
<td>Meniscectomy</td>
<td>7</td>
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<tr>
<td>Tendon repairs</td>
<td>18</td>
</tr>
<tr>
<td>Minor procedures, including fractures</td>
<td>101</td>
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<table>
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<th>E.N.T.</th>
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<tbody>
<tr>
<td>Tonsillectomy</td>
<td>82</td>
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<tr>
<td>S.M.R.</td>
<td>14</td>
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<tr>
<td>Intranasal antrostomy</td>
<td>5</td>
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<tr>
<td>Others</td>
<td>11</td>
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<table>
<thead>
<tr>
<th>Ophthalmic</th>
<th>112</th>
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<tbody>
<tr>
<td>Squint correction operation</td>
<td>5</td>
</tr>
<tr>
<td>Iridectomy</td>
<td>1</td>
</tr>
<tr>
<td>Excision of eyeball</td>
<td>1</td>
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<tr>
<td>Needlings</td>
<td>3</td>
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</table>

<table>
<thead>
<tr>
<th>Dentals</th>
<th>307</th>
</tr>
</thead>
<tbody>
<tr>
<td>In hospital</td>
<td>7</td>
</tr>
<tr>
<td>In dental surgery</td>
<td>300</td>
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sufficient except for cases involving thoracic surgery and neurosurgery which are referred to specialized units in Belfast. The work done, therefore, is a fair sample of general anaesthetic practice (see table I).

TECHNIQUES

Evolution of technique.

In our earliest cases we employed the original method described by Johnstone, 5 litres each of nitrous oxide and oxygen flowing over halothane in the trichloroethylene bottle of a Boyle's machine, via a Magill's rebreathing attachment, to the patient. This proved so wasteful of halothane that we soon changed to (2) a semi-closed circuit including a Waters canister. A 50/50 mixture of nitrous oxide and oxygen at a rate of 2-4 litres per minute was used to vaporize halothane in the trichloroethylene bottle. Satisfactory anaesthesia was produced with considerable economy. However, as the Waters canister proved cumbersome it was replaced by (3) the Coxeter-Mushin circle absorber into which was fed the same anaesthetic mixture as in method (2). Convenience led us to adopt this as our standard technique, and it was used in every case for some weeks. During this time we gained experience, some facility in the use of the new agent, and confidence in the accuracy of the claims made by those who had introduced it into clinical anaesthesia. The only difficulty we encountered was an economic one. Halothane is expensive, and we soon found that our consumption of it was greater than could be justified.

Following Marrett's paper, we decided to employ a closed circuit technique (4). Boyle Mark II and Coxeter-Mushin circle absorbers were available and both gave excellent results. Unfortunately halothane caused some of the washers, gaskets, and other components to deteriorate, and two of our machines were rendered unserviceable. Specially made spare parts of more resistant materials had to be fitted before we could continue with our closed circuit series. Full details of our technical problems and an account of their solutions appear in another paper (Brit. J. Anaesth., this issue, p. 338).

Detailed techniques at present used (table II).

In all cases atropine sulphate only is used for premedication.

<table>
<thead>
<tr>
<th>Technique</th>
<th>No of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semi-open Boyle 8-10 litre flow</td>
<td>125</td>
</tr>
<tr>
<td>Semi-closed with absorption 4 litre flow</td>
<td>56</td>
</tr>
<tr>
<td>Closed circuit 500 ml flow</td>
<td>880</td>
</tr>
<tr>
<td>Walton machine (dental cases)</td>
<td>300</td>
</tr>
</tbody>
</table>

(1) For infants and young children:

About 1 inch of halothane is placed in the trichloroethylene bottle of the Boyle’s machine and a gas flow of 6-8 litres per minute of nitrous oxide-oxygen 50/50 delivered via a Magill’s rebreathing attachment to the patient with or without an Ayres T-piece. With the plunger fully withdrawn the bottle control is gradually over 2-3 minutes advanced to “full on”. When anaesthesia has been established the control lever can be returned to the half-way mark for maintenance.

(2) For older children:

The Coxeter-Mushin circle absorber is used, the halothane level in the vaporizer being kept below the bottom of the copper vanes. The soda lime must be renewed every 2 hours to ensure efficient absorption. With the halothane control at zero a flow of 10 litres per minute of nitrous oxide is delivered to the facepiece which is held close to, but not against, the child’s face. When amnesia has been produced, the nitrous oxide is turned off, the rebreathing bag emptied and filled with oxygen, and the mask firmly applied. With the soda lime control turned “full on” and 500 ml of oxygen per minute flowing, the vaporizer control is turned “½” on. After a few breaths this is gradually advanced to “½” on and kept there until the jaw relaxes, when an airway or endotracheal tube can be inserted and the control returned to half way between the “½” and “½” marks. This setting can usually be left untouched throughout the operation.

(3) Adults:

For out-patients and for elderly, debilitated, shocked, or very ill patients a pure halothane induction is used, employing the circle absorber.
With the rebreathing bag filled with oxygen, the soda lime in circuit, and 500 ml of oxygen per minute flowing, the mask is applied to the face and the vaporizer control turned to “½” on. After 8–10 breaths the control is gradually advanced to “¼” on. Automatic respiration and relaxation of the jaw usually occur in 2–3 minutes, but in more robust patients a mild stage of excitement may require the vaporizer control to be advanced to the “¼” mark. When anaesthesia supervenes the control is returned to the “½” position, and finally to half way between this and the “¼” mark.

Patients of average fitness are normally given a sleep dose of thiobarbitone sodium (3–7 ml of 10 per cent solution) followed by 50 mg of suxamethonium, if immediate intubation is intended. We then proceed as in method (3), assisting respiration until spontaneous breathing returns. If intubation can be deferred until the jaw relaxes under halothane, suxamethonium is completely unnecessary.

**SIGNS OF ANAESTHESIA**

In surgical anaesthesia with halothane the skin is pink and dry. The superficial veins of the extremities are dilated. The pupils are fixed, contracted and central, and the skeletal muscles extremely relaxed, the jaw muscles being among the first to become flaccid. Respiration is automatic, rather shallow, and faster than normal (30–50 per minute). Bradycardia (p.r. 40–60 per minute) and hypotension (systolic pressure 70–90 mm Hg) are a constant finding but appear to have no alarming significance.

If anaesthesia lightens, respirations become deep and more purposeful, eye movements appear, and reflexes quickly return causing flinching and coughing.

In deepening anaesthesia, however, the respirations become progressively more shallow, the pupils dilate, and the blood pressure tends to fall as respiratory arrest is approached.

**CONDUCT OF ANAESTHESIA**

Owing to variations of individual susceptibility to halothane and to differences in the efficiency of apparently identical vaporizers, rule of thumb instructions can only provide a rough guide to procedure. The exact depth of narcosis can be deduced at any moment from the physical signs exhibited by the patient, and can be lessened or increased in the course of a few breaths by altering the vapour concentration of halothane in the mixture being inhaled. This extreme flexibility is one of the most valuable attributes of halothane anaesthesia.

Muscular relaxation is so complete that most abdominal operations can be completed with spontaneous respiration. If very deep relaxation or a completely quiet abdomen is demanded it can be produced either (a) by injection of 50 mg of suxamethonium intravenously followed by fractional doses as required, or (b) by increasing halothane concentration with the circle vaporizer set at “¼” on.

In either case, as soon as breathing has almost ceased the rebreathing bag should be emptied and filled with oxygen and the vaporizer control turned to zero before inflating the patient’s lungs. If this precaution is not taken too high a vapour concentration will be built up, anaesthesia will deepen still further, and spontaneous respiration will not return until the excess halothane has been washed out of the blood by artificial respiration with oxygen at a flow rate of 5 litres per minute. Fears expressed that a lethal concentration of halothane vapour would build up during closed circuit anaesthesia have proved groundless in the case of the Coxeter-Mushin absorber. In no case where the vaporizer control has been kept at the “½” mark or less has any progressive deepening of anaesthesia taken place even in cases where the control has been left untouched for nearly two hours.

Towards the end of long closed circuit anaesthetics nitrogen replacement should be effected by admitting air to the circuit to avoid post-anaesthetic pulmonary collapse.

As halothane consumption continues at a rate of 6–10 ml per hour during maintenance, we believe that halothane vapour must percolate quickly through the thin rubber of the hoses and rebreathing bag.

To study this problem we selected a number of cases in which cuffed endotracheal tubes had been passed, and all obvious mechanical leaks eliminated from the closed circuit. In each case, when the operation was nearly over, we turned off the vaporizer and cut the oxygen supply from 500 ml per minute to the estimated basal re-
quirement of the patient. The rebreathing bag was then partly emptied and the exhaust valve shut, thus completely separating the circulating gases from the outer air.

In every case progressive lightening of the anaesthesia became obvious after a few minutes. As a result of these observations we decided to accept the fact that the rubber components of the circle absorbers in use are extremely permeable to halothane vapour. This property affords valuable protection against the unintentional and insidious deepening of anaesthesia which might otherwise occur.

POSTOPERATIVE OBSERVATION
Recovery from halothane is rapid. The reflexes normally return within 5 minutes and conscious
ness within 20 minutes after stopping the anaesthetic even following operations lasting up to 3 hours.

Nausea and vomiting sometimes occur but are of much shorter duration than after other agents. Patients frequently feel hungry and enquire anxiously about their next meal shortly after returning from theatre.

We agree with Johnstone that postoperative shock is much less severe in patients given halothane than in similar cases anaesthetized by the balanced technique.

SPECIAL INDICATIONS FOR USING HALOTHANE
Though halothane has been adopted as a routine general purpose anaesthetic in our practice, certain types of cases seem particularly to benefit from its use.

(1) Poor risk patients—elderly, ill, toxic, or shocked. These are the kind of patients who figure all too frequently in case reports of persistent curarization when techniques requiring relaxants have been used. They do amazingly well with a pure inhalation technique, especially as adequate relaxation can be obtained without giving relaxants. It is of great advantage to such patients as presumably no breakdown products of the anaesthetic are left to embarrass further their excretory organs.

(2) Obstetric cases. Our small series of Caesarean sections has led us to believe that halothane may become a very useful agent for obstetric anaesthesia, both in hospital and domestic prac-
tice. It produces quick pleasant induction without vomiting, early muscular relaxation and quick recovery. Uterine contraction and retraction are not affected. The infants are not born with respiratory depression due to the anaesthetic, and usually cry readily.

(3) Outpatients. While it is potent enough to subdue even robust individuals safely, the quick recovery and freedom from unpleasant after-effects make it invaluable in the casualty room.

(4) Otolaryngological cases. Minor procedures in children, such as tonsillectomy, adenoidectomy and antrum puncture are greatly facilitated by the easy induction, quick jaw relaxation and the speedy recovery. In adults the relatively bloodless field afforded is audibly appreciated by the surgeon.

(5) Ophthalmology. A feature of halothane anaesthesia is the progressive decrease in intraocular tension as narcosis deepens. Our ophthalmologist has found this fact and the recovery without coughing or retching to be especially valuable in certain cases. She comments upon the marked reduction in bleeding, especially notable in extra-ocular operations.

(6) Dentistry. In more than 300 cases we have used halothane (vaporized in a Rowbotham's bottle) to supplement nitrous oxide-oxygen anaesthesia in the dental chair, using a Walton intermittent flow machine. A smoother anaesthetic, with better jaw relaxation and quicker recovery, can be obtained than when trichloroethylene is used in the same way. An added advantage is the higher percentage of oxygen permitted by the greater potency of halothane. The absence of any increase in secretion of saliva and mucus due to the anaesthetic makes conditions more pleasant for both dentist and anaesthetist.

Though our series of cases has included some difficult clearances demanding extended operating time we have never felt in the least apprehensive about the patients. The temporal pulse remains steady and full, the colour good, and the respirations automatic and deep.

CLINICAL ASSESSMENT
Halothane has been used in nearly every case anaesthetized by the writers for more than seven months. About 1361 operations have been done,
the ages of the patients varying from a few days to more than 90 years and their conditions from the robustly healthy to the almost moribund. Considering this experience, we know of no other anaesthetic or combination of anaesthetics which can give results so acceptable to the three individuals principally concerned in a surgical operation.

The patient has a quick easy induction, a safe anaesthesia, and a quick recovery with few unpleasant after-effects.

The surgeon has a pink spontaneously breathing patient who is well relaxed, shock resistant, and less haemorrhagic than usual.

The anaesthetist is possibly the most satisfied of the three. He has the pharmacological effects of only one drug to consider and can control the depth of anaesthesia almost from breath to breath to meet the needs either of the surgeon or the patient. Above all he is absolved from the necessity of watching the condition of his patient slowly deteriorate under the combined attack of surgical shock and long acting narcotics in spite of every available supportive measure.

Economically, when closed circuit technique is employed, the saving effected in nitrous oxide, oxygen, narcotics and relaxants is almost enough to neutralize the comparatively high cost of halothane, but this argument is only useful for soothing agitated hospital pharmacists.

We believe that any anaesthetist who gives halothane a fair trial will become enthusiastic.

SUMMARY

The administration of halothane ("Fluothane") in a series of 1361 cases including most general surgical procedures is described. Special reference is made to the use of halothane in the ether vaporizer of closed circuit apparatus. The clinical findings and the special advantages of halothane in particular operations are discussed.

ACKNOWLEDGMENTS

We are deeply indebted to Mr. John Beale, of Imperial Chemical Industries Ltd., for his help in making the technical resources of his organization available to us and for the personal interest he has taken in our work Mr. G. Donnelly, B.Pharm., Imperial Chemical Industries Ltd., medical representative in Northern Ireland, has been tireless in effecting liaison with the various departments of his firm on our behalf. Mr. J. Cockton, Ph.C., Department of Pharmacy, Imperial Chemical Industries Ltd., carried out many investigations at our request, and arranged for the fabrication and fitting of the various special components required for our closed circuit units. We are also indebted to Dr. K. G. Green, I.C.I., for helpful advice and supplies of halothane.

Finally we would like to thank our surgical colleagues for the patience they showed during our early cases. We are pleased to accord that the good-humoured scepticism they then displayed has now given way to solid approval.

REFERENCES


