INCREASE IN HALOTHANE CONCENTRATION FOLLOWING REFILLING OF CERTAIN VAPORIZERS

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SUMMARY

A case of cardiovascular collapse during halothane anaesthesia raised the question of the halothane concentration delivered by vaporizers after refilling. The rise in halothane concentration following replenishment has been measured in three commonly used vaporizers; the calibrated Boyle bottle was found capable of delivering a dangerous concentration in certain circumstances.

A case of unexpected cardiovascular collapse during nitrous oxide, oxygen and halothane anaesthesia recently occurred in the hospital. A flow rate of 8 l./min was in use via a Magill attachment. Effective treatment was instituted and the patient made a satisfactory recovery. Some days later discussion of the event brought to light the fact that the halothane vaporizer, a calibrated Boyle bottle, had been refilled shortly before the episode. This led to the possibility being considered that an unduly high concentration of halothane might be delivered by a recently refilled vaporizer because of the inevitable splashing of the sides of the bottle with liquid halothane. This possibility had not been thought of at the time, and the interval between refilling and the collapse, therefore, was not noted.

Since a Hook and Tucker halothane meter was available, reading from 0 to 5 per cent, it was decided to repeat the experiment on the three types of vaporizer in common use for halothane in this hospital. These are the calibrated Boyle bottle, the Boyle bottle modified for halothane (BOC type, without a cowl), and the Fluotec. Two of each were used.

METHOD

A flow of 8 l./min was used (2 l./min of oxygen and 6 l./min of nitrous oxide), through a Magill attachment with the reservoir bag switched out of circuit. The emerging gases were sampled continuously through a wide-bore needle inserted through the corrugated rubber tube just beyond the bag. The peak concentration of halothane was noted from the halothane meter. In the case of the bottles, 20 ml of halothane was put in and a lever setting giving 1 to 2 per cent halothane chosen. The halothane was replenished to 50 ml in four different ways:

1. The lever was switched off, the cowl (if present) was lowered, the cork was removed. After refilling, the cowl was raised and the lever put back to the previous position. This was the method used during anaesthesia in the case of the patient reported here.

2. Leaving the vaporizer turned on, the cowl was lowered after removal of the cork. After refilling and raising the cowl (if present) the cork was replaced after a short interval to allow any concentrated vapour to be flushed out with the escaping gases.

3. The lever was switched off, the bottle unscrewed, and the vaporizer refilled. The bottle...
was then replaced and the lever returned to its previous position.

(4) The vaporizer was refilled via a polyethylene tube passing through the cork with its end below the surface of the liquid. This is essentially the method of Samuel (1958).

In the case of the Fluotec the vaporizer was almost emptied, then refilled to the mark whilst switched off.

All experiments were performed at room temperature in warm weather.

RESULTS

Calibrated Boyle bottle.

(1) Turning off and filling through hole. Both vaporizers behaved similarly, giving a peak concentration which appeared to be well above 5 per cent (instead of the 1 to 1½ per cent anticipated) and remaining beyond the range of the meter for about 15 seconds. Pouring the halothane through a funnel reduced the peak concentration to a little under 5 per cent.

(2) Not turning off and filling through hole. The peak concentration was reduced to about 4 per cent in both vaporizers.

(3) Removing the bottle. Here the peak concentration was only 3 per cent. This appeared to be the safest way of refilling without using extra apparatus.

(4) Filling via a polyethylene tube. There was a slow rise from 1.3 to 1.6 per cent without any peak concentration.

Boyle bottle modified for halothane.

(1) Turning off and refilling through hole. A peak concentration of about 5 per cent occurred in both vaporizers.

(2) Not turning off and filling through hole. The peak concentration was reduced to 4 per cent in one case and no change occurred with the other vaporizer.

(3) Removing the bottle. A peak concentration of about 3 per cent was observed. Again this appeared the safest way of refilling without using extra apparatus.

(4) Filling via a polyethylene tube. There was a slow rise from 1.2 to 1.4 per cent without any peak concentration.

Fluotec.

Neither vaporizer showed any increase in concentration.

DISCUSSION

Galley (1949) emphasized the need to lower the plunger during refilling in order to avoid liquid entering the U-tube. Burton (1958), using an infra-red gas analyzer, noticed a slight increase of a fluctuant nature for some 3 to 5 minutes after refilling a Rowbotham bottle with halothane in a closed circuit. It appears that under certain conditions the calibrated Boyle bottle is capable of delivering dangerous concentrations of halothane following replenishment. This appears to be due mainly to the effect of splashing, since it can be entirely avoided by using Samuel's method of refilling via a polyethylene tube through the cork. In practice there will also be a rise due to the addition of warmer halothane but this was probably not observed in these experiments since the vaporizers were not switched on for more than a very few minutes. Although the reservoir bag will tend to dilute this high concentration, it seems that the acute hypotension mentioned above could have been so caused, although we have not enough evidence to be sure.

Clearly these dangers can be avoided by using a vaporizer designed to supply saturated halothane vapour through a bypass, such as Young's. It also appears from the results obtained that the Fluotec vaporizer is free of this disadvantage. If a Boyle bottle is used it would seem that Samuel's method of refilling is quite safe, but if the necessary apparatus is not available it appears advisable either to keep the vaporizer switched on during refilling, so as to flush the bottle out, or by unscrewing and removing the bottle to refill it.

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REFERENCES


BOOK REVIEW


This little book is described by the author as an attempt to present to anaesthetists, other physicians, and students "an outline for the selection of patients with heart disease to whom cardiac surgery will prove beneficial". The presentation of such a subject for such a broad spectrum of readers would seem to be a task difficult to perform without delving too deeply into the subject for some, or being too superficial for others. The author has, one would suggest, leaned rather towards the superficial.

Chapter II, headed "Selection of the Patient" consists of five pages. One of these is devoted to an anecdote describing the author's handling of a situation in which a cardiologist was indiscreet enough to advise on anaesthetic management, another advocates consultation between the various disciplines which comprise the team, and the third of these pages quotes the author's reply to the patient's question, "Will I survive this procedure?" The concluding sentence of this answer is: "All of us will do our best to see you safely through your surgical intervention in the most optimum physiologic state." One felt that were we in this country to say this to our patients the more highly educated would criticize our qualifications of optimum, and the less highly so would be inclined to gape at us! One sought in vain in this chapter for any account of the factors which govern the selection of patients for surgery.

Chapter III, on "Cardiac Catheterisation Criteria" by Dr. Martz, defines the terms used in reporting catheter findings and gives the formulae by which the various values may be calculated from the measurements made. He succeeds in doing this very well from the space allowed in the book. Chapter IV on radiological diagnosis is also well done, but could have been made very much more valuable by inclusion of illustrations, of which there are none.

The selections on anaesthetic management are short, and do not discuss the real problems of anaesthesia in cases with cardiac pathology; one would have hoped for some discussion on the effects of anaesthesia and controlled ventilation on the haemodynamics in the various situations which the cardiological anaesthetist faces. Great emphasis is given to the value of vasopressor drugs, but there is no discussion of disadvantages. One was also surprised to find no mention here of the necessity to monitor and correct acid base changes. There is, however, a brief mention of the value of sodium bicarbonate in patients undergoing total body perfusion in the chapter by Moffit and Theye, which is good, but describes only the Mayo-Gibbon pump oxygenator.

There are sections which describe the various "surgical" lesions and abnormalities of the heart, illustrated by excellent drawings, and it is this part of the book which the postgraduate student of anaesthesia will find the most valuable.

The only relaxant drugs mentioned are decamethonium bromide and suxamethonium, and these are used by the author solely for intubation, and although the desirability of light anaesthesia is pointed out, there is no suggestion that relaxant drugs might permit the very lightest planes to be utilized.

It is felt that there is little likelihood of wide acceptance of this book in Great Britain, as it would be inadequate for the candidate for postgraduate examinations, and of little help to the anaesthetist who was faced with the problems of cardiac surgery in his practice.

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