COAXIAL SCAVENGER FOR PAEDIATRIC ANAESTHESIA

RICHARD M.M. FLOWERDEW

THE JACKSON REES MODIFICATION OF Ayre's T-piece¹ has found wide acceptance in paediatric anaesthesia. The advantages of simplicity, accurate control of inspired gas concentration, good carbon dioxide wash-out and minimal resistance to respiration are offset by the large volumes of overflow of anaesthetic gases and agents spilled into the atmosphere.

In line with the current practice of maintaining waste anaesthetic gases below recommended levels for atmospheric contamination² a scavenging device was developed which still retained the essential flexibility and safety of the Jackson Rees modification, in particular avoiding mechanical clamps, clips or spring loaded valves. This device is currently termed the coaxial scavenger.

DESCRIPTION

The device is essentially a tube within a tube, each being open at opposite ends. The Bobby connector is the special link between the tail of the reservoir bag and the evacuating system (Figure 1).

Exhaust gases leave the reservoir bag (a) at the Bobby connector (b) and enter the inner tube (c) which may rotate within the outer tube (d) at coaxial carrier (e). The exhaust gases leave the inner tube (c) at its terminal (f) and enter an active disposal system (g), which is set to aspirate at 30 l/min at port (h) in the outer tube (d). The outer tube (d) is open to the atmosphere at coaxial carrier (e). The volume of the outer tube minus the inner tube was set at 200 ml, as this is approximately equivalent to the tidal volume of a 20 kg child with assisted respiration, yet still keeps the length of the device manageable.

MODE OF USE

The coaxial scavenger is attached to the tail of

Richard M.M. Flowerdew, M.D., F.F.A.R.C.S., Assistant Clinical Professor, Tufts University School of Medicine, Department of Anaesthesia, Maine Medical Center, Portland, Maine, U.S.A.

Work undertaken at The Hospital for Sick Children, Toronto, Canada.

FIGURE 1

the reservoir bag and the active scavenging system is attached at the vacuum port. This should be done before any administration of anaesthesia. Minimum fresh gas flow is 3 l/min.

If it is desired to assist or to control the patient's respiration manually, the Bobby connector is shaped so that the tail of the reservoir may be compressed, usually between thumb and forefinger, and the bag squeezed between the remaining fingers and the palm.

If mechanical ventilation is required the reservoir bag is disconnected and the ventilator is connected in the conventional manner.

PERFORMANCE

Flow pressure characteristics

Pressure generated by a constant fresh gas flow was measured at the T-piece tracheal tube connector junction.

No flow. With no fresh gas flow and active scavenging set at 30 l/min a pressure of -0.3 cm H_2O was generated. At 50 l/min a pressure of -0.75 cm H_2O was generated. The open end of the reservoir acts as a pressure relief pathway. A fresh gas flow over 3 l/min will balance the sub-atmospheric pressure generated by the active scavenging flow of 30 l/min (Figure 2).

Normal Flows - 0-10 l/min. Resistance to exhaust flow for different fresh gas flows were measured for both an Ohio valve and the coaxial scavenger (Figure 2). At a fresh gas flow of 7.5 l/min with active scavenging, the resistance of the coaxial scavenger is about 0.7 cm H_2O . Without scavenging this increases to about 1.0 cm H_2O .

High Flows. The high flows produced by the oxygen flush button may generate high pressures. Figure 3 shows a comparison of expiratory resis-

FIGURE 2

FIGURE 3

tance for high gas flows for the coaxial scavenger, a Heidbrink valve and an Ohio valve at different settings. The performance of the coaxial scavenger would seem reasonable. Should flow exceed the capacity of the active scavenging system the open end of the external reservoir supplies an alternative pathway and pressure relief mechanism.

Kinking of reservoir bag

The possibility of complete obstruction exists at the tail of the reservoir bag either by flexion or rotation or both. The shape of the Bobby connector together with the freedom of the inner tube to rotate has been designed to reduce this hazard to an acceptable minimum.

Nitrous oxide Levels

A concurrent experiment³ demonstrated a nitrous oxide level that did not exceed 30 parts per million under specified controlled conditions.

Evacuation system

An active evacuating system set at a flow of 30 l/min was used. Suitable precautions should be taken with pumps and final disposal especially if flammable agents are to be used. The exhaust port is color coded and may be easily modified to any proposed international standard.

Mode of use

The device has been in use at The Hospital for Sick Children, Toronto, since August 1976, and found to be convenient and easy to use.

DISCUSSION

Current policy of several national bodies^{2,4,5} is to maintain atmospheric contamination with anaesthetics below certain levels. The high flows of the Ayre's T Piece system makes this circuit a significant source of contamination. Several systems^{2,6} have been devised but the majority require a clamp or clip mechanism at the scavenging interface with the related hazards of such devices.

A special concern in designing any scavenging apparatus is that it avoid accidental exposure of the patient to excessive positive or negative pressures. It was found that on deliberately turning up the vacuum suction flow rate to 50 litres per minute ($1.8 \times$ the recommended flow) the sub-atmospheric pressure generated at the T connector next to the patient was $0.75 \text{ cm H}_2\text{O}$. (See "Performance - no flow" above.) If the fresh gas flow was raised to 40 litres per minute (see Performance characteristics above) the pressure recorded at the T connector was $16 \text{ cm H}_2\text{O}$. A transient pressure of $48 \text{ cm H}_2\text{O}$ was generated when the oxygen flush button was activated. It is recommended that a pressure relief valve (e.g., Norry) be fitted in the fresh gas line to protect against all such high pressure surges.

Excessive positive pressure may also be generated if the outflow tract is occluded. This is most likely to occur at the open-ended tail of the Jackson-Rees modification of Ayre's T system. Even with a 180-degree kink or flexion, and 360 degrees of rotation of the reservoir bag, the Bobby connector is able to maintain an outflow channel, provided that the extremity of the Bobby connector projects within the body of the reservoir bag.

The scavenger may be sterilized by ethylene oxide. To aid in cleaning, the outer tube D (Figure 1) may be detached at coaxial carrier E. The Bobby connector is firmly secured to one end of the rigid part of the inner tube by a stainless steel sleeve. The flexible part of the inner tube is secured to the distal part of the rigid inner tube by a tension clip.

The coaxial scavenger retains the Jackson Rees modification of the Ayre's T as nearly as possible. The open-end reservoir serves to prevent excessive positive or negative pressure and to contain the pulsatile flow of tidal respiration. Gases will only be spilled into the atmosphere when the exhaust gas flow exceeds the active scavenging system flow long enough to displace the reservoir volume.

This system applies only to exhaust gases. It will not prevent pollution from leaking anaesthetic machines, cylinders and pipelines, and other sources.

SUMMARY

A new scavenging device suitable for the Jackson-Rees modification to the Ayre's T-piece is described. This device maintains the essential components of the modification while effectively scavenging the circuit.

RÉSUMÉ

L'auteur décrit un système de vidange des gaz

anesthésiques applicable à la modification de Jackson Rees de la pièce en T d'Ayre. Ce système permet une vidange efficace tout en protégeant le malade contre des pressions positives ou négatives accidentelles excessives et ceci sans emploi de pinces ou de valves à ressort.

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