ANAESTHETIC EQUIPMENT FOR THE FIRST 6 MONTHS OF LIFE

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General anaesthesia for the newborn and infants in the first 6 months of life is potentially more dangerous and difficult to conduct than in the older age groups. It is generally agreed that many of the hazards are inherent in the equipment currently in use.

Although the available equipment is suitable for older infants, it does not comply correctly with the physiological and anatomical requirements of small infants.

Disadvantages of Existing Equipment

Besides being rather cumbersome and difficult to maintain in position, the chief drawbacks are dead-space and resistance to expiration arising from excessive tubing through which the expired gases have to travel.

To overcome dead-space, high flow rates of gases (these are dry) are used—but the lungs are then subjected to increased pressure from the incoming gases.

Another disadvantage of high flow rates is the cost of the anaesthetic due to wastage. This is proportionally high, depending on the cost of the anaesthetic agents.

The equipment, designed by myself, conforms to the ventilatory requirements of the very young and overcomes the objections raised above.

Principles of New Device

Dead-space and resistance have been curtailed to a bare minimum, namely 1·5 ml. The re-breathing tubing seen between thumb and forefinger (A in Fig. 1), is only a few inches in length and its lumen, although considerably reduced, will offer no resistance to the expired gases if re-breathing is permitted. This tubing must not be confused with the tubing from the anaesthetic machine which delivers the gases into the bag mount (B in Fig. 1).

The 350 - 400 ml. re-breathing bag, the smallest previously available, is replaced by a miniature rubber bag which, in reality, is a balloon with a capacity of approximately 100 ml. It is now comparatively easy to acquire the 'feel' of the patient, namely, the resistance of the thoracic cage and assess the correct amount of ventilation.

The equipment, made of plastic (acrylic—Perspex), is extremely light and simple to handle. It is so compact and small as to fit literally into the palm of the hand.

Since dead-space and resistance have been minimized, it is now possible to administer effective and safe anaesthesia with considerably reduced minute-volumes.

It is also possible to reduce the cost of the anaesthetic. Indeed, a saving of as much as R1.50 an hour can be effected when agents such as nitrous oxide, oxygen and halothane are administered.

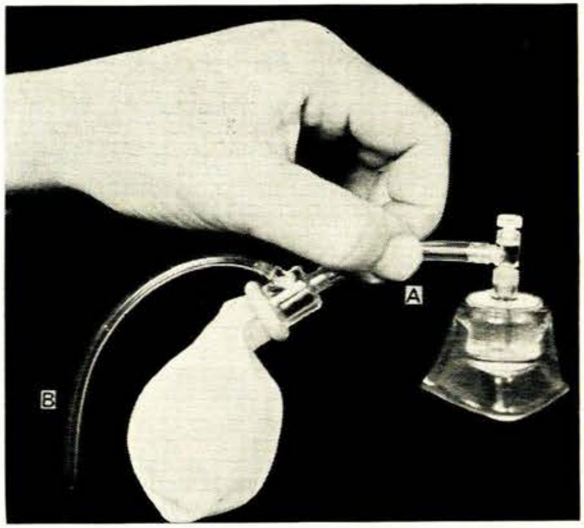

Fig. 1. See text.

A great deal of the improvements can be ascribed to the device (Fig. 2A, 2B) which is used with a face-mask (Fig. 1), or with an endotracheal tube (Fig. 3).

Features

The device embodies the following features:

1. Its over-all dead-space is less than $\frac{1}{3}$ ml. and rebreathing during spontaneous respiration can be prevented with small gas flow rates.

2. The fresh gases enter the vertical limb via the horizontal limb and are evenly dispersed (Fig. 2B). There is therefore less hindrance to expiration from the incoming gases than with other devices (Fig. 2C).

3. The mechanism for the escape of gases from the circuit is housed in the upper portion of the vertical limb. It consists of a tap (Fig. 2B) which can be screwed in and

out to alter the size of the escape vents. When the latter are fully opened—as they should always be during spontaneous respiration—no resistance is offered to the expired gases as they flow into the ambient atmosphere.

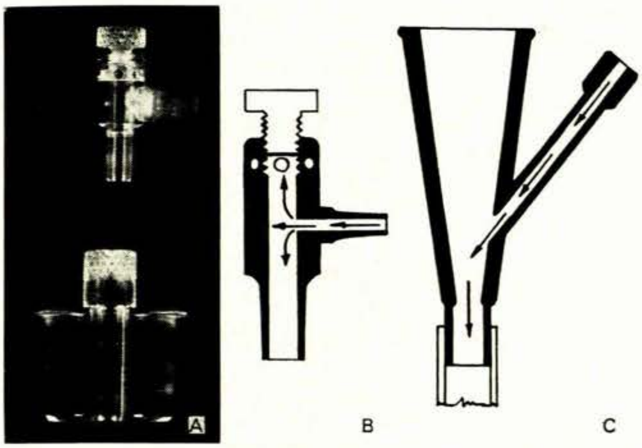

Fig. 2. See text.

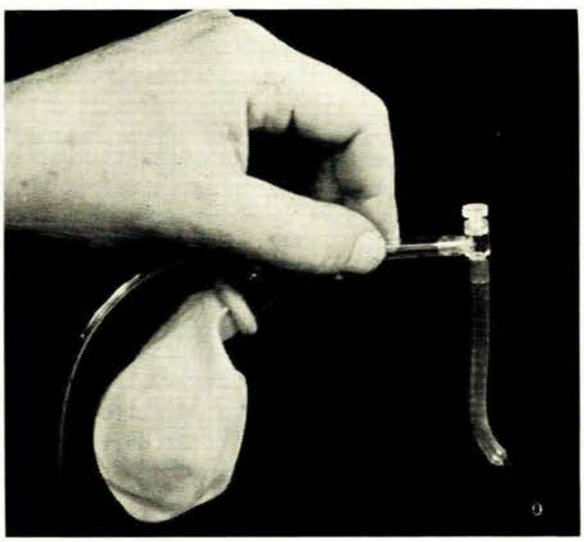

Fig. 3. See text.

Provided the minute-volume is adequate, very little or no air will be sucked through the vents during inspiration.

4. For controlled respiration, the necessary pressure for insufflating the lungs is obtained by directing more of the expired gases to the bag. This is accomplished by screwing in the tap to restrict their escape through the vents.

As mentioned previously, the tubing connecting the device with the bag mount will not offer any resistance to the recoil of the thoracic cage. It should also be remembered that it is the hand, and not the lungs, which overcomes the resistance created by the narrowed vents.

5. Aspiration of the lungs can be undertaken during anaesthesia without having to disconnect the device from the endotracheal tube. The tap can be removed and the aspirating tube fitted over the upper portion of the vertical limb of the device.

The Face-mask

Not a little of the success of the equipment is due to the face-mask which is incorporated. The Rendell-Baker Soucek type of face-piece seen in Fig. 1 is translucent and is undoubtedly the best fitting mask available, especially for neonates. Dead-space within it is negligible. While the 5 ml. in the chimney (unavoidable in a mask using the new international standard 22 mm. orifice) is practically completely taken up by the bush (Fig. 2A) which holds the device.

Gas Flow Rates

Since dead-space and resistance need not be taken into consideration, the correct minute-volume which should be delivered by the anaesthetic machine depends on the following factors:

(*a*) the tidal volume of the infant;

(*b*) the normal rate of respiration for the weight-group; and

(*c*) whether air is to be prevented from entering the circuit during spontaneous respiration.

A rough, but practical method of ascertaining the TV of an infant, is to multiply its weight, in pounds, by 3.

Thus, supposing the weight is 6 lb., the TV will be about $6 \times 3 = 18$ ml. If the respiration is, say 40 to the minute, the minute-volume to satisfy the infant is 18×40, namely, 720 ml. But the inspiratory phase is only one-third of the respiratory cycle. In order, therefore, for the lungs to obtain 18 ml. of the anaesthetic whenever the infant inhales, the anaesthetic machine must deliver $720 \times 3 = 2{,}160$ ml. into the lumen of the vertical limb. Any amount short of this will be supplemented by air sucked in during inspiration.

In actual practice, a little air diluting the anaesthetic mixture is of no consequence. However, a 2-litre minute flow is ample for an infant of 6 - 8 lb. when a volatile synergist is used—the volume of its vapour makes good the deficit.

Controlled Respiration

During controlled respiration the correct minute-volume is affected by any leaks. Generally, the larger the endotracheal catheter, the fewer the leaks.

In general a slightly higher minute-volume will be necessary for controlled respiration than for spontaneous respiration, since there is a tendency to hyperventilate.

The danger of CO_2 arising from re-breathing can be discounted with adequate minute-volumes and provided respiration is correctly controlled or assisted, as it should always be.

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BIBLIOGRAPHY

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