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A Variable-deadspace Device for Use with the Engström Respirator

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During long periods of artificial ventilation it is important to keep Pa_{CO_2} constant, slightly below the normal range. In practice, this can be difficult. Studies of patients requiring long-term ventilation have shown that large tidal volumes at slow frequencies are necessary to expand the lung and prevent atelectasis.[1] Further, this ventilatory pattern minimizes excessive shunting and compensates for the increased physiologic deadspace.[2] An undesired sequel of this process has been a very low Pa_{CO_2}. Three methods are available to maintain a near-normal P_{CO_2}: 1) decrease respiratory rate; 2) increase inspired CO_2; 3) add mechanical deadspace. Since it is not always possible to decrease the respiratory rate sufficiently, and the addition of CO_2 to the inspired gas mixture necessitates additional flowmeters, tanks, and computation, the only practical method is the use of additional mechanical deadspace.[3, 4]

This report describes a mechanical variable-

deadspace device for use with the Engström Respirator. The device, which replaces the Y piece of the respirator, is made from a Foregger to-and-fro canister. Two sizes are used, the smaller with a volume of 315 ml, the larger with a volume of 510 ml (fig. 1). The canister is connected to the patient's tracheostomy or endotracheal tube via a Foregger right-angle adaptor. The wire mesh at the patient end is fastened and left in place. At the other end, a 20 mm hole is drilled into the cylindrical body of the canister and a short metal pipe of the same diameter is soldered to it at a right angle to its central axis. A 17.5-cm-long metal pipe 20 mm in diameter is now pushed through the opening at the distal end of the canister, after removal of the wire mesh normally closing this side of the canister. This 20-mm pipe is supported by a rubber ring, which also seals the canister. The function of the device is that of a Y piece. The central long pipe is connected to the inspiratory tubing from the ventilator; the expiratory tubing is connected to the short pipe soldered to the canister.

Since the centrally located metal pipe is movable, it can be pushed in until its tip

CONSTANT   VARIABLE V_{Dm}

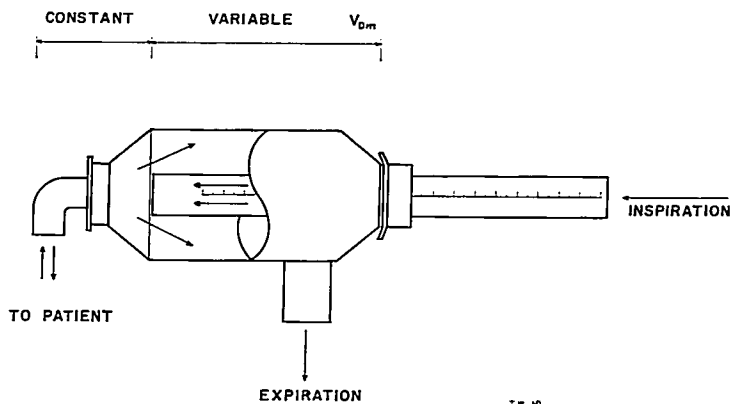INSPIRATION

TO PATIENT

EXPIRATION

Fig. 1. Variable-deadspace device.

reaches the wire mesh at the patient end of the canister, thus giving a minimal deadspace. Pulling the pipe out in the opposite direction increases the deadspace. The movable pipe has a scale on which deadspace can be read. The changes in mechanical deadspace (ΔV_{Dm}) due to retraction of the central pipe are computed using the equation $r^2 \pi \cdot l = \Delta V_{Dm}$, where r = radius of the canister, l = length of the retraction. Markings on the scale are made for each 0.5-cm length in ml V_{Dm}. By retracting the pipe from one terminal position to the other, any desired deadspace between 25 and 315 ml or, with the larger model, 40 to 510 ml can be achieved.

COMMENT

The use of additional mechanical deadspace has been described by several authors.[3,4] Their experience has shown that the additional mechanical deadspace needed usually varies between 170 and 500 ml in adults.[5] With the device described and two canister sizes, these requirements are easily met.

This mechanical variable-deadspace device has proven very useful and easy to regulate. Its compactness and relatively small size, compared with plastic or corrugated tubing used for the same purpose, has been found to be of great advantage. The device also eliminates

searching for tubing of appropriate length and diameter when changes of Pa_{CO_2} occur during ventilation because of variations in $\dot{V}_{CO_2}$ or physiologic deadspace.

SUMMARY

Foregger to-and-fro canisters were used to construct a mechanical variable-deadspace device for use with the Engström respirator. The device replaces the Y piece of the respirator and can be adjusted to any V_{Dm} desired within ranges of 25–315 ml and 40–510 ml.

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