has a fresh gas inlet as shown by the right-hand arrow) and a fresh gas flow rate of 4-6 litre min\(^{-1}\), the ventilator fails to operate. Patient ventilation ceases and, after 20 s, the "Low Press" alarm is activated. In the conditions described it is not possible to restart the ventilator.

The ventilator is designed to permit spontaneous ventilation and will not initiate a respiratory cycle if the respirometer unit detects "breathing". When the flow transducer is placed as shown with the Boyle Mk III absorber (and only the Mk III) and the flow rate described, the "end of breath detector" function "sees" the fresh gas flow as a continuous expiration and, consequently, disables the ventilator. This does not occur with flow rates of less than 4 litre min\(^{-1}\), or if the transducer is placed at the patient end of the circuit as the manufacturer recommends. However, it is our experience that it is not uncommon for anaesthetists to use flows in excess of 4 litre min\(^{-1}\) when initiating ventilation following induction of anaesthesia.

The foregoing combination of circumstances initially proved elusive to detect, occasionally embarrassing, and is clearly not without risk. The manufacturer now acknowledges the problem, although, as they correctly point out, the Mk III absorber is old and soon will be withdrawn from service. Nevertheless, a substantial number are currently in service. Ohmeda have agreed to alter the software to eliminate the "end of breath detection" facility, thus overcoming the problem.

Finally, it may be appropriate to remind users of the OAV 7710 that, if the gas flow is inadequate or if disconnected from the anaesthetic gas outflow, the ventilator will continue to function but will entrain room air without warning to the operator, with a consequent risk of patient awareness and reduced inspired oxygen concentration.

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A NEW METHOD FOR CALCULATION OF VENTILATORY DEADSPACE

Sir,—Deadspace measurements are becoming common in research and clinical work. The single breath test for carbon dioxide (SBT-CO\(_2\)) permits "on-line" measurement, and allows detailed analysis of derangements in gas exchange. Our original method for calculating deadspace from SBT-CO\(_2\) \(^{[1]}\) produced deadspace values identical to those obtainable by conventional Douglas bag experiments. As in a conventional Douglas bag experiment, \(F_{\text{CO}_2}\) was regarded as zero.

This method is theoretically incorrect. Rebreathing increases \(F_{\text{CO}_2}\), changing the denominator in equation (1). More importantly, the apparatus deadspace associated with rebreathing is attributed to the patient. Consequently, \(V_{\text{CO}_2}^{\text{phys}}\) and \(V_{\text{CO}_2}^{\text{biv}}\) are overestimated. The revised method of calculation is intended to avoid this problem by measuring the patient's gas exchange rather than that of patient plus apparatus; the new deadspace values are thus smaller.

In the new method, \(F_{\text{CO}_2}\) in equation (1) is obtained from "registered \(V_{\text{CO}_2}\) divided by \(V_{\text{TR}}\), that is, no allowance is made for \(V_{\text{CO}_2}^{\text{reb}}\). \(F_{\text{CO}_2}\) previously regarded as zero, is estimated from "\(V_{\text{CO}_2}^{\text{reb}}\) divided by alveolar tidal volume (\(V_{\text{T}}-V_{\text{CO}_2}^{\text{reb}}\))".

We present here the new and old estimates for \(V_{\text{CO}_2}^{\text{phys}}/V_{\text{TR}}\) and \(V_{\text{CO}_2}^{\text{phys}}/V_{\text{TR}}\) (table I), and graphs (fig. 1) showing the new relationship between \(V_{\text{CO}_2}^{\text{phys}}/V_{\text{TR}}\) and \((P_{\text{aCO}_2}-P_{\text{E}_CO}_2)/P_{\text{aCO}_2}\). All the deadspace ratios are reduced, and the ratio \((P_{\text{aCO}_2}-P_{\text{E}_CO}_2)/P_{\text{aCO}_2}\) (where \(P_{\text{E}_CO}_2\) is end-tidal \(P_{\text{CO}_2}\)) is now closer to \(V_{\text{CO}_2}^{\text{phys}}/V_{\text{TR}}\) than previously. This relationship is of particular interest for the anaesthetist, as \(P_{\text{aCO}_2}-P_{\text{E}_CO}_2\) may be regarded as a "poor man's" measure of alveolar deadspace.

Which values should be referred to in future? When comparing our results with those of workers who have collected mixed expired gas, the old method of calculation may be preferred. However, the revised values for \(V_{\text{CO}_2}^{\text{phys}}/V_{\text{TR}}\) are more suitable as "reference values", representing a fairer measure of alveolar gas exchange under ideal conditions. The theoretical minimum value for \(V_{\text{CO}_2}^{\text{phys}}/V_{\text{TR}}\) in healthy patients

| Table I. Old and new deadspace ratios calculated from the 58 patients in the study of Fletcher and Jonson \(^{[1]}\). The ventilator settings were: mean tidal volume 450 ml; frequency 17 b.p.m.; mean \(V_{\text{T}}\) 743 ml at a frequency of 9 b.p.m. |
|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|
| \(V_{\text{CO}_2}^{\text{phys}}/V_{\text{TR}}\) | \(V_{\text{CO}_2}^{\text{phys}}/V_{\text{TR}}\) |
| Median | 0.44 | 0.42 | 0.29 | 0.24 |
| 5th percentile | 0.32 | 0.28 | 0.17 | 0.10 |
| 95th percentile | 0.58 | 0.55 | 0.49 | 0.43 |
| Median | 0.31 | 0.29 | 0.22 | 0.17 |
| 5th percentile | 0.22 | 0.20 | 0.13 | 0.10 |
| 95th percentile | 0.49 | 0.47 | 0.43 | 0.38 |
is approximately 0.03 [3]; children almost achieve this value [3, 4]. Use of single breath tests to analyse deadspace has clear advantages over the Douglas bag method. $V_{Dp}^{aw}$ can be broken down into its component parts, and phase III slope, which gives information about the nature of pathological gas elimination, can be measured. As more workers switch to this methodology, it is important that we state clearly what we are measuring!

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REFERENCES