pg/ml (compared with 2556 and 2888 pg/ml after infusion at 80 ng/kg/min in the neonate reported here). The same workers found ANP infusion to attenuate the pulmonary response to hypoxia in pigs.

On the first day of infusion the infant showed a slight fall in PaO2 at the end of the infusion followed, 90 minutes later, by an appreciable rise that lasted for approximately two hours. The initial fall might be explained by increased perfusion of poorly ventilated lung units but the late rise is difficult to explain, though the cGMP secretion rate did remain elevated for two hours. A dose dependent relaxation of pulmonary arteries, induced by ANP, has been shown in bovine arterial rings but in our case ANP concentration returned to baseline by around 25 minutes.

In this infant high dose ANP infusion was relatively well tolerated. Although we do not claim that this child's satisfactory outcome was related to treatment with ANP, we do believe that ANP should be added to the list of therapeutic options in the management of persistent pulmonary hypertension of the newborn that require further study.

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An indirect calorimetry system for ventilator dependent very low birthweight infants

Sir,—While the need for measurement of energy expenditure and nutrient utilisation in sick ventilator dependent infants is undisputed, we have several reservations about the indirect calorimetry system described by Forsyth and Crighton. On p316 of the paper underdiscussion VO2 by 12% if ROQ = 0-7 and overestimate it by 8% if ROQ = 1.2; calculated values of ROQ will be biased towards

\[ V_{O_2} = V_{in} \times \left( F_{I_2} - F_{E_2} - F_{I_2} - F_{E_2} \right) \]

a similar expression exists for carbon dioxide production. When F_{I_2} = 0-4 the equations in the paper underdiscussion VO2 by 12% if ROQ = 0-7 and overestimate it by 8% if ROQ = 1.2; calculated values of ROQ will be biased towards

\[ V_{O_2} = V_{in} \times \left( F_{I_2} - F_{E_2} - F_{I_2} - F_{E_2} \right) \]

1, with true ROQs of 0-7 and 1-2 being computed as 0-80 and 1-11 respectively.

In the gas infusion studies reported in table 1 it is unclear how to assess the values calculated for VO2 when nitrogen is infused into the system. This part of the study calculates VO2 as if the results were from a patient; the first equation on p316 then allows the calculated VO2 to be checked in terms of nitrogen flow rate and FIO2. If VO2 is calculated correctly then this check equation is

\[ \frac{V_{in}}{W_{N_2} \times F_{I_2} - F_{E_2} - F_{I_2} - F_{E_2}} = \frac{V_{in} + V}_{W_{N_2} \times F_{I_2} - F_{E_2} - F_{I_2} - F_{E_2}} \]

For the nitrogen flow rates given in table 1 (10-10, 14-10 ml/min) and FIO2 is 0-40, the expected values of VO2 would be, from the first equation, 6-73, 9-40 ml/min and from the approximate version of the second equation, 4-04, 5-64 ml/min. From the results for the higher nitrogen gas infusion, one might appear to have been used (as would be consistent with the earlier part of the paper) but the agreement is poor at the lower flow rate.

Finally, we were disappointed that gas infusion studies were performed using only one ventilator setting. Increasing the inspired oxygen concentration (while keeping VO2 constant) causes a reduction in the inspired oxygen concentration (FIO2 - FEO2). Thus as FIO2 - FEO2 decreases, the error sensitivity in the measurement of VO2 is magnified. It is not uncommon for sick ventilated infants to need FIO2 up to 1.0 so the errors in the measurement of energy expenditure at high oxygen concentrations will be markedly increased and must be acknowledged.

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**Dr Forsyth comments:**

Although the general principles of indirect calorimetry may apply to all systems and subjects, there are some features which require specific consideration depending upon the nature of the system and the size of the subject being studied. In our system for ventilated low birthweight infants, there are at least two important aspects which differ from adult systems, first the effect of changes in ROQ on expiratory flow volume (VE) and second, the validity of excluding FEO2 from the calorimetry calculations.

Adult calorimetry systems commonly use an inspiratory flow volume (VI) in the region of 40 l/min, and for a 70 kg individual with an oxygen consumption (VO2) of 320 ml/min and ROQ of 0-7, the difference between VI and VE will be 96 ml (0.24% of VI). In our system VI is 6 l/min (inspiratory flow from the ventilator), and for a 1500 g ventilated infant with a VO2 of 9 ml/min and RQ of 0-7, the difference between VI and VE is 2-7 ml, that is 0.045% of VI. In order to correct for this difference, Drs Matthews and Matthews offer a formula based on adult data, and which involves the value of four different measurements. Not only is there a risk that the overall error of these measurements may exceed the error induced by the difference in the VE and VI flow volumes but their equation for the RQ system is: If it is applied to the 1500 g infant, the corrected VO2 will be 7-79 ml/min compared with the actual VO2 of 9-0 ml/min (an underestimate of 13%). This underestimate is constant, and not limited to the margins of RQ. Using our simpler equation the calculated VO2 at RQ 0-7 is 7-9 ml/min (underestimate 12%), but this error reduces to 0% as the RQ approaches 1-0. The large persistent error with the Matthews' equation is due to the omission of FEO2. In adults this is usually less than 1% of FEO2 and commonly ignored, but for a low birthweight infant in our system the FEO2 would be 22.9% of actual VO2. The formula should therefore be corrected to

\[ V_{O_2} = V_{in} \times \left( F_{I_2} - F_{E_2} - F_{I_2} - F_{E_2} + F_{I_2} \times F_{E_2} \right) \]

A simpler and potentially more accurate adjustment is the traditional Haldane correction, VI - VE.FEO2/FIC02 and as our system is continually measuring inspiratory and expiratory nitrogen this can be easily accommodated. In our nitrogen infusion studies the mean FEO2 was 0.421 and VE 5.257 l/min. By using the measured values for VE, FIO2, and FEO2 the predicted Wn2 were compared with the actual Wn2, and using our last equation the actual oxygen consumption as opposed to the simulated VO2 was confirmed to be zero. The VO2 data reported with the nitrogen infusions were calculated as for an infant study using the described software calculations and were included, albeit with the limitations as discussed above, to relate the infusion data to actual levels of VO2 which are seen in low birthweight infants. Unfortunately we did transcribe the wrong data point for the VO2 for the nitrogen infusion of 10-1 ml/min and this should have been 4-20 (0-22) ml/min. We are grateful for this being drawn to our attention.

Although we will compare the clinical and technical data on the use of our system with higher levels of FEO2, it is our experience that in the present surfactant era considerably fewer babies are requiring a very high FIO2 for a long period of time. We realise that some babies do require an FIO2 as high as 1.0, but we believe that for those babies there are more urgent priorities than a measurement of energy expenditure.


**Imposed upper airway obstruction and covert video surveillance**

Sir,—Covert video surveillance (CVS) may be extremely useful and is often the only method to prove that some cases of apparent life threatening events (ALTE) are caused by imposed upper airway obstruction. Samuels