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.[1]

On the first day of infusion the infant showed a slight fall in Pao_2 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[3] but the late rise is difficult to explain, though the cGMP excretion rate did remain raised for two hours. A dose dependent relaxation of pulmonary arteries, induced by ANP, has been shown in bovine arterial rings[2] but in our case ANP concentration returned to baseline by around 23 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.[1] On p316 is $\dot{V}_E$ the inspired or expired minute ventilation? The equations given appear to take these to be equal, even though this amounts to assuming that the respiratory quotient (RQ) is 1. If instead the inspired and expired volumes of *inert gas* are assumed equal the oxygen consumption ($\dot{V}O_2$) can be found as

$$\dot{V}O_2=\dot{V}_{inspired}\left\{\frac{FIO_2-FEO_2-FIO_2.FECO_2}{1-FEO_2-FECO_2}\right\};$$

a similar expression exists for carbon dioxide production. When $FIO_2=0{\cdot}4$ the equations in the paper underestimate $\dot{V}O_2$ by 12% if RQ= 0·7 and overestimate it by 8% if RQ=1·2; calculated values of RQ will be biased towards 1,[2] with true RQs 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 $\dot{V}O_2$ when nitrogen is infused into the system. This part of the study calculates $\dot{V}O_2$ as if the results were from a patient; the first equation on p318 then allows the calculated $\dot{V}O_2$ to be checked in terms of nitrogen flow rate and FIO_2. If $\dot{V}O_2$ is calculated correctly then this check equation is

$$\dot{V}O_2=\frac{\dot{W}N_2\ .\ FIO_2}{1-FIO_2};$$

if the equations on p316 are used then this becomes:

$$\dot{V}O_2=\frac{\dot{V}_{inspired}\dot{W}N_2\ .\ FIO_2}{\dot{V}_{inspired}+\dot{W}N_2}\cong\dot{W}N_2\ .\ FIO_2.$$

For the nitrogen flow rates given in table 1 (10·10, 14·10 ml/min) and FIO_2 is 0·40, the expected values of $\dot{V}O_2$ 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 flow rate it would appear that the second equation has 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 $\dot{V}O_2$ constant) causes a reduction in the inspired–expired oxygen difference (FIO_2-FEO_2). Thus as FIO_2-FEO_2 decreases, the error sensitivity in the measurement of $\dot{V}O_2$ is magnified.[3] It is not uncommon for sick ventilated infants to need FIO_2 up to 1·00. The errors in the measurement of energy expenditure at high oxygen concentrations will be markedly increased and this must be acknowledged.

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1 Forsyth JS, Crighton A. An indirect calorimetry system for ventilator dependent very low birthweight infants. *Arch Dis Child* 1992;67: 315–9.
2 Ferrannini E. The theoretical basis of indirect calorimetry: a review. *Metabolism* 1988;37: 287–301.
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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,[1] there are at least two important aspects which differ from adult systems, first the effect of changes in RQ on expiratory flow volume ($\dot{V}E$) and second, the validity of excluding $FICO_2$ from the calorimetry calculations.

Adult calorimetry systems commonly use an inspiratory flow volume ($\dot{V}I$) in the region of 40 l/min, and for a 70 kg individual with an oxygen consumption ($\dot{V}O_2$) of 320 ml/min and RQ of 0·7, the difference between $\dot{V}I$ and $\dot{V}E$ will be 96 ml (0·24% of $\dot{V}I$). In our system $\dot{V}I$ is 6 l/min (inspiratory flow from the ventilator), and for a 1500 g ventilated infant with a $\dot{V}O_2$ of 9 ml/min and RQ of 0·7, the difference between $\dot{V}I$ and $\dot{V}E$ is 2·7 ml, that is 0·045% of $\dot{V}I$. In order to correct for this difference, Drs Matthews and Matthews offer a formula based on adult data,[2] and which involves the values 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 $\dot{V}I$ and $\dot{V}E$ flow volumes but their equation is not valid for our system. If it is applied to the 1500 g infant, the 'corrected' $\dot{V}O_2$ will be 7·79 ml/min compared with the actual $\dot{V}O_2$ of 9·0 ml/min (an underestimate of 13·3%). This underestimate is constant, and not limited to the margins of RQ. Using our simpler equation the calculated $\dot{V}O_2$ 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 $FICO_2$. In adults this is usually less than 1% of $FECO_2$ and commonly ignored, but for a low birthweight infant in our system the $FICO_2$ can account for up to 22% of $FECO_2$. The formula should therefore be corrected to

$$\dot{V}O_2=\dot{V}_I.\left\{\frac{FIO_2-FEO_2-FIO_2.FECO_2+FEO_2.FICO_2}{1-FEO_2-FECO_2}\right\}$$

A simpler and potentially more accurate adjustment is the traditional Haldane correction, $\dot{V}I=\dot{V}E.FEN_2/FIN_2$, and as our system is continually measuring inspiratory and expiratory nitrogen this can be easily accommodated.

During the nitrogen infusion study the mean FIO_2 was 0·421 and $\dot{V}E$ 5·257 l/min. By using the measured values for $\dot{V}E$, FIO_2, and FEO_2 the predicted $\dot{W}N_2$ were compared with the actual $\dot{W}N_2$, and using our last equation the actual oxygen consumption as opposed to the simulated $\dot{V}O_2$ was confirmed to be zero. The $\dot{V}O_2$ 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 $\dot{V}O_2$ which are seen in low birthweight infants. Unfortunately we did transcribe the wrong data point for the $\dot{V}O_2$ 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 shortly be providing clinical and technical data on the use of our system with higher levels of FIO_2, it is our experience that in the present surfactant era considerably fewer babies are requiring a very high FIO_2 for a long period of time. We realise that some babies do require an FIO_2 as high as 1·0, but we believe that for those babies there are more urgent priorities than a measurement of energy expenditure.

1 Forsyth JS, Crighton A. An indirect calorimetry system for ventilator dependent very low birthweight infants. *Arch Dis Child* 1992;67: 315–9.
2 Ferrannini E. The theoretical basis of indirect calorimetry: a review. *Metabolism* 1988;37: 287–301.

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