108 Correspondence

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Drs Watkins and Weindling comment:

We thank Dr Stow for highlighting a potential source of error in the monitoring of end tidal CO₂ in neonatal intensive care.

He is correct in surmising that we were using time cycled pressure limited ventilators with continuous gas flow (Vickers Neovent and SLE Newborn 250). It is the practice in this unit to use a flow rate of 7 l/minute in all cases unless high pressure and ventilator rates dictate a higher rate. All except two readings were at this rate and it is of interest that these (at 10 l/minute) were both inaccurate. This infant did, however, also have severe respiratory disease (alveolar/arterial oxygen difference 660 mm Hg) and so it is difficult to separate the two effects. We did find good correlations between end tidal CO₂ and paCO₂ measurements in some infants with milder respiratory disease despite the continuous gas flow, and so we felt that the effect of dilution was probably minimal. Our impression is that the effect of parenchymal lung disease far outweighs other effects in these infants.

The use of time cycled, pressure limited ventilators is almost universal in neonatal intensive care units. They are cheap and simple to use, and seem to be more effective in infants with hyaline membrane disease and its complications. Experience suggests that results are better than with volume cycled devices.¹

Sampling of end tidal CO₂ from the tip of the endotracheal tube may well minimise any error due to gas flow. The majority of very low birthweight infants with hyaline membrane disease are ventilated using a 2.5 mm endotracheal tube. The luminal diameter is already critically small and considerably increases total respiratory resistance.² Any further impingement on the lumen should be avoided unless absolutely necessary.

We have already acknowledged³ the important role of end tidal CO₂ monitoring in anaesthetics, when most of the patients have normal lungs. This is clearly not the case in infants ventilated in a neonatal intensive care unit, in whom we feel end tidal CO₂ monitoring to be inappropriate.

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Evaluation of nebulisers

Sir,

We were interested in the paper by Tsanakas *et al.*¹ and agree that it is important to have a nebuliser with the minimum variation in output when performing bronchial challenge tests. We were concerned, however, that the authors calculated the output of the nebuliser by weighing the device before and after nebulisation. This method does not give a true idea of the output of the nebuliser. As the nebulised cloud forms there is a huge cumulative surface area formed by the aerosol droplets. Most of these droplets are returned to the nebuliser solution by a series of baffles, allowing only the finer particles to escape. At the same time some evaporation takes place. The weight loss from the nebuliser, therefore, is due to dispersion of particles of the drug, such as histamine solution, but also to evaporation. Depending on which nebuliser is used, calculating the output by weighing the device before and after nebulisation may result in an overestimate of drug output of up to 50% (unpublished observations).

To measure the output of our nebulisers we used a multi stage liquid impinger which catches the nebuliser cloud as it emerges from the nebuliser. The impinger separates the cloud into fractions comprising particles of varying sizes and we then assayed the amount of drug in each fraction, so determining not only the actual amount of drug that leaves the nebuliser but also the amount of drug in particles that are likely to reach the lungs.

Reference

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Sudden and unexpected death between 1 and 5 years

Sir,

The report by Southall *et al.*¹ that one third of the deaths in their series of infants between 1 and 5 years were unexplained begs the question of why such a common phenomenon is not more widely recognised nor apparent from the Registrar General's annual mortality figures. I think that most pathologists would concede that unexplained deaths occur throughout childhood, adolescence, and adult life although not with the frequency seen during the first postnatal year.

When the sudden infant death syndrome was officially recognised by the Office of Population Censuses and Surveys (OPCS) as a distinct entity, the rise in deaths from this cause was matched by a decline in deaths from respiratory infection.² I can only suppose that the apparent rarity of unexplained deaths between 1 and 5 years has a

similar explanation, in that what is acceptable terminology to the legal and medical professions has distressing practical consequences for parents which a pathologist must steel himself to ignore if he wishes to maintain his scientific honesty. Such honesty is, however, an essential prerequisite to any progress being made in this field. The difficulty hinges on defining an observation or measurement which can be made at necropsy and which is peculiar to the fatal condition. The nearest to this ideal in the sudden infant death syndrome is the biochemical abnormality in the composition of lung surfactant which can be shown by analysis of saline washes of the respiratory tract taken after death.^{3,4} The age distribution of 'true sudden infant death syndrome' might be more clear if this investigation were done routinely for all sudden infant and childhood deaths.

'Fever,' 'apoplexy,' and 'old age' were acceptable causes of death in an age when morbid anatomy was less sophisticated than it has since become. The terms served a valuable purpose in their time as no doubt 'sudden infant death syndrome' will be seen to have done when its pathology has been elucidated. In the meantime perhaps there is a role for a new word to cover unexplained childhood deaths (? pseudo sudden infant death syndrome). I have no doubt that were such a term to be adopted the subsequent apparent rise in the incidence of the disease would cause alarm and astonishment. What disease would necessarily decline as a consequence is something of an imponderable.

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Lower limb deformity and prevention of scoliosis in cerebral palsy

Sir,

We should like to comment on your interesting annotation.¹ Selective posterior lumbar rhizotomy reduces tone in spastic cerebral palsy. This operation, based on the technique described by Fasano *et al*² was first carried out in Cape Town in 1981 by Peacock.^{3,4} The operation is now being performed by one of us (JP) and our total experience is 131 cases.

Selection is of the utmost importance;⁴ the most striking results are observed in the spastic diplegic who walks independently with a typical diplegic gait. In these cases the walking pattern has markedly improved. The operation is also of value in more severely handicapped children. A number who could not walk are now walking independently or with walking aids, others have improved posture and mobility, and even those who have no independent mobility or voluntary function can benefit by reduction of tone in the legs. Care must be taken with those children who use spasm for supported standing and walking and have poor underlying power.

Good physiotherapy is necessary before and for a prolonged period after rhizotomy. Although the benefits can be seen immediately, it is apparent from a long term follow up study currently in progress, that the re-education of abnormal motor patterns is of the utmost importance, as is the building up of strength in weak muscles. Improvement has continued up to six years after the procedure.

Some of the children in our series had had orthopaedic surgery before rhizotomy, others had apparent fixed joint contractures. Many patients were less contracted or their 'contractures' had disappeared after rhizotomy, but appliances or orthopaedic surgery, or both, are still necessary in some cases. The reduced tone plus weak ankle musculature may produce valgus foot deformities and appliances (usually ankle foot orthoses) may be necessary.

We know of no child who has had subluxation or dislocation of hip after reduction in tone, and there has been no deterioration in those cases that had such problems before rhizotomy. No case of scoliosis or other back problem has developed. One quadriplegic without voluntary function or mobility who received only early intermittent physiotherapy and subsequently was left lying in one position has become windswept.

Though rhizotomy only deals with one aspect of a complex disorder, we are impressed by its usefulness in relieving spasticity. Physiotherapists, parents, and those children old enough to remember what their limbs felt like before rhizotomy, are enthusiastic about the results of the operation.

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