PostScript

....

LETTERS

DTP immunisation of steroid treated preterm infants

Preterm infants respond well to the three doses of diphtheria, tetanus, and whole cell pertussis (DTP) vaccine,[1] but dexamethasone treatment may impair immunogenicity.[2][3] We investigated whether four, rather than three, DTP doses may be preferable for primary immunisation of steroid treated preterm infants. Twelve infants born at < 30 weeks gestation who had received dexamethasone for chronic lung disease were given doses of DTP vaccine combined with Hib (ActHIB DTP; Pasteur-Mèrieux-MSD) at 2, 3, and 4 months of age. A fourth dose was administered six weeks after the third immunisation (table 1). With the use of standardised enzyme linked immunosorbent assay (ELISA) methods, paired sera obtained before and eight weeks after the fourth DTP dose were analysed at the Health Protection Agency (Porton Down, Wilts, UK) for antibody titres against diphtheria toxoid (DT), tetanus toxoid (TT), and three pertussis antigens (fimbrial agglutinogens 2+3 (FIM), pertussis toxin (PT), filamentous haemagglutinin (FHA)). A pre-fourth DTP serum sample was available for 12 infants, and 11 infants

had paired sera. Median (range) gestational age was 25 weeks (24–29) and birth weight was 830 g (550–1235). Median (range) duration of dexamethasone treatment was 15 days (3–153), and cumulative dose was 3.9 mg/kg (1.5–25.6).

Antibody titres of 0.1 IU/ml against DT and TT are considered to correlate with individual protection.[4] After three doses, all infants had already achieved titres > 0.1 IU/ml against DT and TT, and titres remained above this concentration after the fourth dose. No significant increase in antibody titres against diphtheria or tetanus antitoxins resulted from the fourth DTP immunisation (table 2). Despite a trend towards higher mean pertussis antibody titres after four DTP doses compared with after three doses, the increase was not significant in any of the three pertussis antibodies. Although there are no reference protective antibody concentrations for pertussis, mean antibody titres achieved against the three pertussis antigens after three DTP doses compared favourably with those in historical cohorts of UK term[1][5] and preterm[1] infants who received the accelerated DTP schedule.

All infants showed excellent immunogenicity to three DTP doses; a fourth dose did not improve antibody responses further. In a recent study using diphtheria/tetanus/acellular pertussis vaccine, responses of 15 preterm infants appeared unaffected by recent steroid treatment.[6] These data suggest that dexamethasone treated preterm infants are able to mount satisfactory responses to a standard three dose DTP regimen administered at the same chronological age as term infants, and that supplementary doses are unnecessary in early infancy.

Acknowledgements

P Clarke, M J Robinson
Neonatal Unit, Hope Hospital, Salford M6 8HD, UK;
paul.clarke@srht.nhs.uk

P J Powell
Department of Paediatrics, Royal Bolton Hospital, Bolton BL4 0JR, UK

References

1 **Ramsay ME**, Miller E, Ashworth LA, et al. Adverse events and antibody response to accelerated immunisation in term and preterm infants. Arch Dis Child 1995;**72**:230–2.
2 **Robinson MJ**, Campbell F, Powell P, et al. Antibody response to accelerated Hib immunisation in preterm infants receiving dexamethasone for chronic lung disease. Arch Dis Child Fetal Neonatal Ed 1999;**80**:F69–71.
3 **Robinson MJ**, Heal C, Gardener E, et al. Antibody response to diphtheria-tetanus-pertussis immunization in preterm infants who receive dexamethasone for chronic lung disease. Pediatrics 2004;**113**:733–7.
4 **World Health Organization**. The control of diphtheria in Europe. Report on a WHO meeting. Copenhagen: WHO, 1990.
5 **Booy R**, Aitken SJ, Taylor S, et al. Immunogenicity of combined diphtheria, tetanus, and pertussis vaccine given at 2, 3, and 4 months versus 3, 5, and 9 months of age. Lancet 1992;**339**:507–10.
6 **Slack MH**, Schapira D, Thwaites RJ, et al. Acellular pertussis vaccine given by accelerated schedule: response of preterm infants. Arch Dis Child Fetal Neonatal Ed 2004;**89**:F57–60.

In utero HIV infection in pregnancies complicated by tuberculosis in Durban, South Africa

At the core of the HIV-1 and tuberculosis (TB) epidemics, a defined effect of these combined pathogens on maternal and child health has been observed at King Edward VIII Hospital in Durban South Africa.[1][2] Here we report on the adverse effect of maternal HIV-1 infection with TB disease on fetal acquisition of HIV-1.

In a prospective cohort study conducted at the hospital between April 1997 and July 1999, 42 HIV-1 infected pregnant women with active TB disease were investigated for intrauterine transmission of HIV-1. Intrauterine infection was diagnosed by a positive HIV-1 RNA polymerase chain reaction (PCR) (Amplicor; Roche Molecular Diagnostic Systems, Branchburg, New Jersey, USA; limits of detection 50 copies/ml) detected on a neonatal sample obtained within the first 72 hours of birth, with a subsequent positive HIV-1 PCR or clinical progression of disease. Assays were performed in a single laboratory which was participating in a continuing quality certification programme for HIV-1 RNA quantitation sponsored by the National Institutes of Health.

Eight newborns were HIV-1 RNA PCR positive by 72 hours of birth resulting in a 19% in utero transmission rate of HIV-1 for singleton live births exposed to maternal HIV-1 infection and TB disease in Durban. The rate of intrauterine transfer of HIV-1 in this category of ill women was much higher than the overall 5–10%[3] in utero transmission rates recorded in resource poor countries. Maternal CD4 (427 (278) v 318 (289) cells/mm^3 (mean (SD)); p = 0.37), plasma viral

---

Table 1 Timing of vaccinations and serum samples

	Age (days)
1st DTP	65 (60–89)
2nd DTP	97 (92–121)
3rd DTP	143 (127–170)
1st blood sample and 4th DTP	205 (164–218)
2nd (post-4th DTP) blood sample	255 (229–274)
Days between 4th DTP and 2nd blood sample	54 (31–59)

Values are median (interquartile range).
DTP, diphtheria, tetanus, and pertussis vaccine.

Table 2 Geometric mean antibody titres (95% confidence intervals) for paired serology measurements after the 3rd and 4th DTP doses

	After 3rd DTP dose	After 4th DTP dose	p Value
Diphtheria			
DT (IU/ml)	2.08 (1.39 to 3.10)	2.11 (1.13 to 3.92)	0.94
Tetanus			
TT (IU/ml)	3.15 (1.67 to 5.93)	3.12 (1.61 to 6.01)	0.97
Pertussis			
FIM	15922 (6869 to 36908)	21477 (11289 to 40859)	0.44
PT	1567 (613 to 4005)	2188 (820 to 5837)	0.14
FHA	3011 (1806 to 5022)	4314 (2443 to 7619)	0.25

Mean titres were compared using Student's t test for paired samples. Diphtheria and tetanus antibody concentrations are reported as IU/ml corrected against National Institute of Biological Standards and Control (NIBSC) reference sera 91/534 and 26/488 respectively; pertussis antibodies are reported as titres corrected against NIBSC reference serum 89/530.
DTP, diphtheria, tetanus, and pertussis vaccine; DT, diphtheria toxoid; TT, tetanus toxoid; FIM, fimbrial agglutinogens 2+3; PT, pertussis toxin; FHA, filamentous haemagglutinin.

burden (median log 5.0 v 4.7), extrapulmonary sites of TB disease, and sputum smear or culture positive rates for *Mycobacterium tuberculosis* were no different between in utero transmitting and non-transmitting mothers. A further nine babies were HIV-1 PCR positive on follow up (intrapartum or postpartum transmission), resulting in an overall HIV-1 mother to child transmission rate of 40.4% (17/42).

This observation augments current knowledge on the impact of perinatal infections on mother to child transmission of HIV-1. High maternal viral burden and CD4 suppression, which are characteristic of advancing AIDS, have been associated with higher overall vertical transmission of HIV-1 and greater risk of rapidly progressive infant HIV-1.[4] Here we quantify this intrauterine risk in HIV-1 infected pregnant women ill with TB disease, and suggest that, in these situations, regimens of antiretroviral therapy which are likely to reduce fetal acquisition of HIV-1 will need to be considered. These should supplement public health programmes to detect and prevent TB disease in HIV-1 infected pregnancies in endemic regions.

T Pillay, M Adhikari, H M Coovadia
Department of Paediatrics and Child Health, University of Natal Medical School, South Africa

J Moodley
Department of Obstetrics and Gynaecology University of Natal Medical School

M Khan, J Moodley
Medical Research Council Pregnancy and Hypertension Unit, Durban, South Africa

J L Sullivan
University of Massachusetts Medical School, Worcester, MA, USA

Correspondence to: Dr Pillay, Peter Medawar Building for Pathogen Research, Room 305.40.24, South Parks Road, University of Oxford, Oxford OX1 3SY, UK; tpillay@gwmail.jr2.ox.ac.uk

References

1 **Khan M**, Pillay T, Moodley JM, et al. Maternal mortality associated with tuberculosis-HIV-1 co-infection in Durban, South Africa. *AIDS* 2001;**15**:1857–63.
2 **Pillay T**, Sturm AW, Khan M, et al. Vertical transmission of Mycobacterium tuberculosis in KwaZulu Natal: impact of HIV-1 co-infection. *Int J Tuberc Lung Dis* 2004;**8**:59–69.
3 **De Cock K**, Fowler M, Mercier E, et al. Prevention of mother-to-child HIV transmission in resource poor countries. *JAMA* 2000;**283**:1175–82.
4 **Abrams EJ**, Wiener J, Carter R, et al. Maternal health factors and early pediatric antiretroviral therapy influence the rate of perinatal HIV-1 disease progression in children. *AIDS* 2003;**17**:867–77.

Quantification of peripheral oxygen consumption by near infrared spectroscopy

Oxygen consumption ($\dot{V}O_2$) is a measurement used to determine the metabolic rate, and is affected by environmental temperature, body temperature, physical activity, blood flow, and nutrition. Measurements of $\dot{V}O_2$ have been used to study energy balance in newborn infants and to determine the optimal thermal environment for nursing preterm babies.[1] More recently it has been suggested that measurements of peripheral $\dot{V}O_2$ may

Table 1 Peripheral and global oxygen consumption ($\dot{V}O_2$) expressed in similar units

Study details	Peripheral $\dot{V}O_2$		Global $\dot{V}O_2$
	mM HbO$_2$.cm/min	ml O$_2$/kg/min	ml O$_2$/kg/min
1. Mild cooling of the hand (n = 10)			
Before	1.38	5.4	9.95
After	1.11	4.35	9.86
2. Moderate cooling of the hand (n = 12)			
Before	1.01	3.96	8.8
After	0.66	2.58	10.35
3. Bath (n = 19)			
Before	1.47	5.76	7.86
After	1.81	7.09	10.27

All values are means.

provide an indication of the need for circulatory support during critical care.

Methods used to assess $\dot{V}O_2$ are either based on the Fick's principle or a gas exchange technique. The standard units used to express $\dot{V}O_2$ are ml O$_2$/kg/min. Neonatal cerebral $\dot{V}O_2$ values using near infrared spectroscopy (NIRS) and jugular venous occlusion have been reported[2] and have been expressed in ml/100 g/min. NIRS has been used to measure $\dot{V}O_2$ in limbs,[3–6] and the results are generally expressed in μmol O$_2$/100 g/min. This non-standard unit makes it impossible to make a direct comparison between global, cerebral, and peripheral $\dot{V}O_2$ values. We describe a method of expressing NIRS derived peripheral $\dot{V}O_2$ units in ml O$_2$/kg/min.

Methods

The basic units for expressing peripheral $\dot{V}O_2$ by NIRS using the arterial occlusion method are mM HbO$_2$.cm/min (mmol HbO$_2$.cm/litre/min). This can be converted into μmol O$_2$/kg/min[5 6] using $4 \times 10/(1.04 \times 3.59 \times L)$, on the basis that the molecular ratio of Hb to O$_2$ is 1:4, and the density of skeletal tissue is 1.04 g/ml.[4] The distance between the light transmitting and receiving probe is L cm, and the path length correction factor is taken as 3.59.[7] This is required to correct for scattering of light within the tissues. This equation reduces to 10.7/L.

Conversion of μmol O$_2$ into ml can be achieved using the molecular mass of oxygen (MO$_2$) which is 16 and the density (dO$_2$) which is 1.429 g/l. Consequently 1 μmol O$_2$ is converted into ml using:

$$(MO_2 \times 10^{-6})/(dO_2 \times 10^{-3}) \text{ or } (16 \times 10^{-6})/(1.429 \times 10^{-3}) = 1.1$$

Therefore conversion from mM HbO$_2$.cm/min into ml O$_2$/kg/min requires a multiplication factor of $1.1 \times 10.7/L$. In studies[5 6] where L is 3 cm the conversion factor is simply 3.92.

Results

We used data from previous studies[5 6] to examine the feasibility. Peripheral $\dot{V}O_2$ was measured by NIRS using arterial occlusion and the oxyhaemoglobin (HbO$_2$) decremental slope. Global $\dot{V}O_2$ values were obtained by open circuit calorimetry. Table 1 gives the converted values of peripheral $\dot{V}O_2$ for comparison with global $\dot{V}O_2$ values.

Discussion

Conversion of standard NIRS units into those normally recognised for $\dot{V}O_2$ has been achieved. This allows comparison between global, cerebral, and peripheral $\dot{V}O_2$ values and comparison between studies. The value of using a range of methods to measure tissue oxygenation is enhanced if the results can be compared through the use of standard units. For example, important relations between global and peripheral $\dot{V}O_2$ have been described.[5 6]

In making the conversion, two key physical variables are used which have so far only been measured in adults. The skeletal tissue density value of 1.04 g/ml has been used for adult muscle studies.[4] The differential path length factor (DPF) value of 3.59 (0.32) has been reported for adult forearm[7] for inter-optrode distances over the range 1–6 cm. It has also been shown that the DPF is "almost constant" beyond 2.5 cm. In the studies[5 6] illustrated in table 1, the inter-optrode distance is 3 cm for all infants, hence variation in the calculated peripheral $\dot{V}O_2$ resulting from changes in DPF is minimal.

Clearly if tissue density and DPF values become available for newborn forearm, then the calculations can be refined. In the meantime, this conversion still provides a valuable method for comparing the relation between cerebral and peripheral $\dot{V}O_2$. No previous NIRS research using peripheral $\dot{V}O_2$ methods has been reported using the proposed units. The units commonly used are confusing and difficult to understand. It is recommended that in future peripheral $\dot{V}O_2$ measurements are reported in ml O$_2$/kg/min.

Y Wickramasinghe
Department of Clinical Technology, University Hospital of North Staffordshire NHS Trust, Stoke on Trent ST4 6QG, UK; bea01@cc.keele.ac.uk

S A Spencer
Neonatal Unit, City General, Newcastle Road, Stoke on Trent ST4 6QG, UK; andy.spencer@uhns.nhs.uk

References

1 **Hey EN**. The relation between environment temperature and oxygen consumption in the newborn baby. *J Physiol* 1969;**200**:589–603.
2 **Yoxall CW**, Weindling AM. Measurement of cerebral oxygen consumption in the human neonate using near infrared spectroscopy: cerebral oxygen consumption increases with advancing gestational age. *Pediatr Res* 1998;**44**:283–90.

3 De Blasi RA, Almerada N, Aurisicchio P, et al. Comparison of two methods of measuring forearm oxygen consumption ($\dot{V}O_2$) by near infrared spectroscopy. J Biomed Optics 1997;2:171–5.

4 Colier WNJM, Meeuwsen IBAE, Degens H, et al. Determination of oxygen consumption in muscle during exercise using near infrared spectroscopy. Acta Anaesthesiol Scand 1995;39(suppl 107): 151–5.

5 Hassan IAA, Wickramasinghe YA, Spencer SA. Effect of limb cooling on peripheral and global oxygen consumption in neonates. Arch Dis Child Fetal Neonatal Ed 2003;88:F139–42.

6 Hassan IAA, Wickramasinghe YA, Spencer SA. The effect of a change in global metabolic rate on peripheral oxygen consumption in neonates. Arch Dis Child Fetal Neonatal Ed 2003;88:F143–6.

7 Van der Zee P, Cope M, Arridge SR, et al. Experimentally measured optical pathlengths for adult head, calf and forearm and the head of the newborn infant as a function of inter optrode spacing. Adv Exp Med Biol 1992;316:143–53.

Umbilical disinfection: lessons from history

A baby girl was born by spontaneous vaginal delivery at 38 weeks to a healthy mother in a district general hospital. She was the second child in the family; there was no family history of concern, her mother was well, and the pregnancy had been uneventful. Breast feeding was established, and mother and baby were discharged home the following day with no specific advice as to umbilical care. At 10 days of life there was a yellowish discharge from her umbilicus; this was treated with topical fucidin by the general practitioner. Six days later there were increasing difficulties with breast feeding as the infant became more listless. The following morning, the mother noted swelling of the left knee: on admission a few hours later the infant was hypotonic, sleepy, and afebrile with a discharging umbilicus.

Aspirate from a tense effusion of the left knee, umbilicus, and blood cultures all grew Staphylococcus aureus, which was sensitive to flucloxacillin but resistant to fucidin. The infant was treated with intravenous antibiotics and a joint washout by a paediatric orthopaedic surgeon that day. The baby appears to have had a good outcome: six months later she shows normal development and equal limb length. This case shows a systemic complication consequent to umbilical colonisation and sepsis by a staphylococcus resistant to fucidin.

Late in the nineteenth century, staphylococci were among the first bacterial organisms to be clinically identified as the causative agent in epidemics of pemphigus neonatorum, a pustular skin condition associated with maternal mastitis.[1] It was found that newborns are rapidly colonised by staphylococci, streptococci, or Escherichia coli on the umbilical stump; infection or toxin production readily led to omphalitis.[2] The application of antiseptic treatments became critical to reducing epidemics of perinatal illness.

Over the last 25 years, the use of umbilical antisepsis has almost disappeared in British hospitals. Concerns about the potential toxicity of chlorhexidine, the unsightly appearance of triple dyes, and the limitations of other methods combined with a low incidence of pathology has resulted in a non-interventionist approach in most maternity units. A Cochrane review has concluded that, in the developed world, simple hygiene is as good as any other treatment.[3] In this same time frame, however, antibiotic resistance has spread, altering the microbial environment of maternity and neonatal units. Rates of neonatal staphylococcal septicaemia—always a changing pattern—may be increasing. Admission times of mothers and infants in district general hospitals have shortened too, facilitating a rapid bacterial exchange between our hospitals and communities among healthy individuals.[4] This combination of events may become a risk factor in the spread of antibiotic resistance in the United Kingdom and a major source of neonatal infection. A parallel pattern has been observed in Japan with neonatal toxic shock syndrome caused by the spread of an methicillin resistant Staphylococcus aureus (MRSA) clone.[5]

It might be reasonably argued that there should be a reintroduction of formal umbilical sterilisation, aimed at reducing the bacterial load in our maternity units. Reducing the burden of colonising organisms by the use of topical or systemic antibiotics has been shown to reduce subsequent invasive infection in renal dialysis.[6][7] This approach has been limited by the emergence of antimicrobial resistance to mupirocin, and antisepsis may therefore be a more appropriate long term strategy. Would the production of an appropriate guideline, ensuring umbilical disinfection as well as maternal and staff hand washing in maternity units reduce risks to infants and limit bacterial traffic and potential antibiotic resistance? The debate on the cost effectiveness of this approach should be reopened and the lessons of history reconsidered.

E Montague, W Lynn, C A Michie
Ealing Hospital NHS Trust, Uxbridge Road, Southall, Middlesex UB1 3HW, UK; dremmamontague@aol.com

References

1 Almquist E. Pemphigus neonatorum, backteriologisch und epidemiologisch beleuchet. Z Hyg Infectionshr 1891;10:253.

2 Zupan J, Garner P. Topical umbilical cord care at birth. Cochrane Database Syst Rev 2000;(2):CD001057.

3 Watkinson M, Dyas A. Staphylococcus aureus still colonises the untreated neonatal umbilicus. J Hosp Infect 1992;21:131–6.

4 Brown S, Small R, Faber B, et al. Early postnatal discharge from hospital for healthy mothers and term infants. Cochrane Database Syst Rev 2002;(3):CD002958.

5 Ritzau J, Hoffman RM, Tzamaloukas AH. Effect of preventing Staphylococcus aureus carriage on rates of peritoneal catheter-related staphylococcal infections. Literature synthesis. Perit Dial Int 2001;21:471–9.

6 Salgado CD, Farr BM, Calfee DP. Community-acquired methicillin resistant Staphylococcus aureus: a meta-analysis of prevalence and risk factors. Clin Infect Dis 2003;36:131–9.

7 Kikuchi K, Takahashi N, Piao C, et al. Molecular epidemiology of methicillin-resistant Staphylococcus aureus strains causing neonatal toxic shock syndrome-like exanthematous disease in neonatal and perinatal wards. J Clin Microbiol 2003;41:3001–6.

Effect of laser photocoagulation for retinopathy of prematurity on C reactive protein

Retinopathy of prematurity (ROP) is the major cause of blindness in premature babies, and in the developed world it is a disease of the most immature and unwell infants. Treatment is needed more often in extremely premature babies, taking place in 14% of those born before 26 weeks completed gestation.[1] Treatment of severe ROP was originally by cryotherapy, but is now more commonly undertaken with laser, either as transpupillary or trans-scleral diode photocoagulation.

C reactive protein (CRP) is an acute phase protein first discovered in the 1930s. It is a component of the innate immune system. Increased production is thought to be beneficial because of its ability to bind phosphocoline and thus recognise foreign pathogens.[2] Tissue damage including burns, trauma, and surgery is known to increase CRP.

Babies undergoing treatment for ROP often have regular CRP measurements to help identify the onset of sepsis. There is currently no evidence as to whether cryotherapy or laser photocoagulation cause a rise in CRP irrespective of sepsis.

To ascertain whether CRP is affected by treatment of ROP, a retrospective case note review of infants treated with laser photocoagulation was undertaken. The notes of 16 infants (11 female and five male) requiring treatment for ROP (mean gestational age 24 weeks and 6 days) were reviewed. Fifteen of the babies received laser photocoagulation by transpupillary diode laser, and one received trans-scleral diode treatment.

CRP concentration before surgery and the first measurement after surgery were obtained. CRP was measured using an automated discretionary discrete analyser (Olympus 600; Olympus Optical Equipment). Units are mg/l.

The time interval between the operation and CRP measurement was 12 hours to 12 days; the median time was three days. CRP concentration before surgery ranged from < 5 to 53 (median < 5). After surgery, the range was < 5–51 (median < 5). The data were non-parametric. A Wilcoxon signed rank test was used to determine whether the null hypothesis (lasering does not alter CRP concentration) was correct. This study did not find a significant difference in CRP concentration after surgery. (Sample size means this study has a 90% power to show significance (p < 0.05) if there were a difference in CRP concentration of 20.)

Our negative findings give some reassurance that if, after treatment for retinopathy, there is concern about infection, a raised CRP concentration is unlikely to be a result of the procedure and more likely to reflect sepsis. However, a prospective study of CRP concentrations after treatment for retinopathy will be necessary to confirm our findings.

J G Daniels
Homerton Neonatal Unit, Homerton Hospital, London E9 6SR, UK; justin.daniels@virgin.net

G G W Adams
Moorfields Eye Hospital, London EC1V 2PD, UK

References

1 Costeloe K, Hennessy E, Gibson AT, et al. The EPICure study: outcomes to discharge from hospital for infants born at the threshold of viability. Pediatrics 2001;106:659–71.

2 Gabay C, Kushner I. Mechanisms of disease: acute-phase proteins and other systemic responses to inflammation. N Engl J Med 1999;340:448–54.