Long line positioning in neonates: does computed radiography improve visibility?

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OBJECTIVE: To assess the use of soft copy reporting of computed radiography (CR) images in determining intravenous long line tip position in neonates and compare visibility rates with hard copy printed images.

METHOD: A retrospective study of all long lines inserted on the neonatal unit over a period of one year was performed. Forty five lines were inserted in 30 neonates over this time. Assessment of the CR images was made by three independent observers by reviewing the films on the viewing console and as hard copy printed films.

RESULTS: Accurate identification of the line tip could be made in 66.7% of cases ($\kappa = 0.9$) using hard copy images and 95.6% cases ($\kappa = 1.0$) using soft copy reporting (significant difference: $p = 0.002$). The difference in percentage visibility using the two techniques was 28.9% (95% confidence interval 10.2% to 36.7%).

Conclusion: The use of soft copy review of CR image improves the visibility of the line tip position compared with hard copy films and reduces the need for repeat radiographs with/without intravenous contrast.

RESULTS

All lines could be visualised using both techniques. With the hard copy reporting technique, the line tip could be accurately identified in 30/45 cases by both observer 1 and 3. There was discrepancy of opinion on two films, but overall there was excellent statistical agreement ($\kappa = 0.90$) with both observers confidently identifying the tip in 30 cases. With the soft copy reporting technique, the line tip could be accurately identified in 43/45 cases by both observer 2 and 3, with perfect agreement ($\kappa = 1.0$). The significance of the difference was assessed using McNemars test. All combinations of observers and methods were compared. All combinations revealed a significant difference in the visibility of the line tip using the two different reporting techniques ($p = 0.002$). Overall 66.7% of line tips were confidently identified on hard copy images and 95.6% using the soft copy reporting technique. The difference in the percentage of visible line tips between the two techniques was 28.9% (95% confidence interval 10.2% to 36.7%). Owing to the small numbers involved, no conclusion could be made in differentiating the two types of line long used.

DISCUSSION

Accurate positioning of intravenous long lines is important to avoid potential complications that may result from misplacement. Retrospective studies have suggested overall long line complication rates of 28–88%, mechanical complication rates of 13–53%, and perforation rates of 3–29%. Mortality resulting from perforation and cardiac tamponade has been estimated at 0.76–1%. After reports of complications associated with right atrial tip position, and subsequent Department of Health recommendations, there has been a move towards positioning the line tip within the distal superior vena cava for upper limb placement and distal inferior vena cava for lower limb placement. To allow for

Abbreviations: CR, computed radiography; PACS, picture archiving and storage systems
Long line positioning in neonates

migration and patient movement, it is recommended that the
line tip lie at least 0.5–1.0 cm outside the cardiac outline in
premature or small infants and 1.0–2.0 cm outside in larger
infants.1,2

The narrow calibre, poorly opaque lines used, however,
may be difficult to visualise using conventional radiography.
Reece et al.11 prospectively assessed line visibility on their
regional neonatal intensive care unit, and found that 50% (31/62)
of patients required a repeat radiograph, with the use
of intravenous contrast to clarify the position of the line and
tip which was not visible on the original film. They concluded
that “intravenous contrast should be routinely used in
the assessment of long line position in the neonate”. This policy
is currently the standard protocol for imaging neonatal long
lines in many centres nationally, and was adopted locally for
a short period until the introduction of CR and PACS within
the hospital.

The main advantage of CR and PACS over conventional
radiography lies in its superior contrast resolution and the
ability to allow alteration of image contrast and brightness
after processing. This can be used to compensate for
suboptimal exposure and improve overall image quality
without the need for a repeat radiograph. The major
limitation is a reduction in spatial resolution compared with
conventional images, although this difference is negligible
with the current high quality viewing hardware available.

At our centre a plain radiograph is performed after line
insertion using CR. Neonatal films are printed as hard copy
images and returned to the neonatal unit for review by
clinical staff. On occasion there has been doubt over line tip
position, and repeat films with contrast have been felt
necessary. In many of these cases, however, review of the
images using the viewing console, with the benefit of
contrast and brightness windowing and image inversion
has resulted in improved confidence in determining tip
position and avoided the need for repeat films, with its
associated radiation risk. Rarely, difficulties may arise out
of hours or when radiological review is not possible, and on
these occasions, a repeat film with intravenous contrast may
be performed.

Review of our hard copy films revealed that the line tip
could be accurately identified in 30/45 cases. Of the 15 lines
that were poorly visualised, it was felt that exact information
on line position was required in four cases, and repeat
imaging with intravenous contrast was recommended.
Visibility was significantly improved, however, when the
same films were viewed on the PACS console at the time of
reporting. The tip could be accurately identified in 43/45 cases
(95.5%) and in neither of the two poorly visualised cases was
it felt necessary to re-image, as exact determination of the tip
position was unlikely to influence clinical management.
Overall, 13 more lines (29%) could be seen using soft copy
rather than hard copy reporting, and repeat imaging could be
avoided in four cases (9%).

Although the overall numbers are small and there is need
for further controlled trials, these findings lead us to
conclude that the use of soft copy reporting of radiography
images significantly improves the accuracy in determining
neonatal long line position and tip, and in many cases may
obviate the need for further imaging or repeated films with
contrast.

This may have implications for the provision of CR/PACS
access on the neonatal unit, for review by clinical teams and
indeed has resulted in the installation of viewing consoles
with windowing and image inversion facilities on our
neonatal unit locally. Access is of particular importance out
of normal working hours and when immediate radiological
review may not be possible.

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Neonatologists are not always directly involved in the intensive care of neonates as surgical patients. In my own case this has led to a slightly blinkered approach. I am very familiar with perinatal stabilisation of problems such as chylothorax, subcutaneous stenosis, or necrotising enterocolitis and describe the authors’ perspective on management. There are numerous photographs, radiographs, and drawings in nice balance with the text. For matching drawings, intended to complement the “comprehensive description of operative techniques” left me wondering that such complicated operations could be taught as described. The authors are drawn from all over the world, but the book’s style remains uniformly European.

The book begins with a series of chapters dedicated to general and theoretical aspects of the care of these high risk infants. These areas of overlap with standard neonatal texts are very variable and, from my perspective, also very interesting. Some could have been more up to date. It was also interesting for example to see a chapter on neonatal transport written by two paediatric surgeons rather than by neonatologists.

Some overlap is inevitable in a book like this. However, I would have preferred, for example, that there was more embryology in each surgical chapter or a more comprehensive introductory chapter. A well written chapter on ethics, from a purely North American perspective, occupies eight pages, which is also the space given to perinatal nutrition. The five sides dedicated to respiratory management of the newborn emphasised to me the potential rewards to be reaped from closer integration of training and practice in neonatology and newborn surgery. The chapters on surgical problems are the book’s strongest area. We have found the book valuable in furthering our understanding of the problems we see on a day to day basis. Many of the lessons in question are relatively rare, which makes the superspecialist multiauthor approach most valuable. The inclusion of problems sometimes dealt with by neurosurgeons and plastic surgery specialists makes this an especially attractive volume. Only the occasional chapter seemed to focus too heavily on the authors’ own experience without consideration for the variety of techniques in use.

I’m glad to say that this book is the one to plug the gaps in my knowledge. I would therefore recommend this book to fellow paediatricians, much as I would encourage surgeons and neonatologists to further develop collaboration in practice and in training.

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Nestlé nutrition workshop series: pediatric program, Vol 52: micronutrient deficiencies in the first months of life

Micronutrient deficiencies in the first few months of life may not keep you awake at night if you are working in the UK, and this book may not grab your attention straight away, but you should give it some consideration whatever your branch or specialty in paediatrics. The book is a collection of 16 papers, written by an international panel of experts, which are the proceedings of a workshop held in Dubai in October 2002.

Most of us will be familiar with the problems of iron deficiency in early infancy and the debate on the role of neonatal vitamin K administration, and, if pushed, many of us would be able to say something about the public health implications of maternal folic acid supplementation and prevention of neural tube defects. This book presents papers that provide thorough state of the art reviews of these subjects. The practice of most UK based paediatricians won’t frequently encompass micronutrient deficiencies outside of these aforementioned areas, but this book reminds us that, from a global perspective, nutritional deficiency problems are extremely prevalent. Vitamin A deficiency probably affects over 40% of the world’s children, and iodine deficiency affects over 10%, with salt iodination theoretically simple, but practically complicated. Iron deficiency is a truly global problem which affects at least one in three children worldwide.

Many of us might be surprised to learn that over 50% of children in China and Tibet have features of rickets (which is also a growing (sic) problem among certain groups in the UK), and the latest evidence on the benefits of zinc supplementation in the prevention and treatment of diarrhoea, and in promotion of linear growth from field trials in developing countries, is truly compelling. Because the book is really a series of presented papers, it is genuinely more readable than a textbook on the subject. A paper on the relation between micronutrients in pregnancy and early infancy and mental and psychomotor development provides an especially interesting concern in premature infants were of particular interest to my personal practice. Discussions after the papers were presented have been included and often highlight areas of uncertainty or real practical importance.

Of course, in a book such as this there are going to be areas that don’t get covered, and, if you were looking for a comprehensive tome on this subject, then spending your money on a textbook might be better. But many of us purchase textbooks and then allow them to sit on the shelves collecting dust while we only “dip into” them occasionally. The good thing about this type of book is that you might actually end up reading some of it!

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LETTERS
Dehydration: the main cause of fever during the first week of life

We read with interest the findings of Maayan-Metzer et al on fever in healthy newborns during the first days of life.1 It is difficult to identify febrile neonates at low risk of serious bacterial infection.2 Although no consensus exists on the optimal approach to diagnosis and treatment, current guidelines recommend that febrile infants less than 28 days of age be admitted to hospital and given intravenous antibiotics for 48–72 hours. However, as mentioned in this report, dehydration is the primary cause of fever especially during the first days of life. We retrospectively reviewed the medical charts of patients admitted to our neonatal intensive care unit with fever between 1 May 1999 and 30 September 2003.

The inclusion criteria were gestational age >37 weeks, 1–7 days of postnatal age excluding the first day of life, axillary or rectal temperature >37.8°C on admission, and normal physical examination with well appearance, no signs of focal infection, and no history of illness or antibiotics. Overall, 46 febrile neonates were included in the study. Most (90–95%) were exclusively breast fed. Laboratory data included complete blood count, C reactive protein, serum urea and sodium concentrations, urinalysis, and blood, urine, and cerebrospinal fluid cultures. The mean (SD) age on admission was 3.4 (1.9) days. The mean (SD) duration of fever was 2.8 (2.4) hours. Twenty seven infants (59%) had lost 8–24.3% of their birth weights. In 34 of the babies, white blood cell counts were between 5000/mm³ and 15 000/mm³. Serum sodium concentrations were obtained in 35 patients: mean (SD) was 147 (6.7) mmol/l, and in 14 (40%) the levels were equal to or higher than 150 mmol/l. There was a positive correlation between weight loss and high serum sodium concentration (r = 0.002). Mean (SD) serum urea nitrogen concentration was 19.3 (11.1) mmol/l. In 22 (48%) babies, serum bilirubin concentration was equal to or greater than 220 µmol/l.

Culture were positive in seven babies. Coagulase negative staphylococci were recovered from five blood cultures and considered

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to be contaminated both clinically and in a negative repeated culture. In one infant, blood culture was positive for *Staphylococcus aureus*, and *Enterococcus* grew from culture of the urine in the other. Most admissions (83%) were between June and early October, which are the warmest months of the year in this area. In this low risk group of infants, only two patients had serious bacterial infection. Comparable with the findings of Maayan-Metzger et al., the results of our study support dehydration as the main cause of fever during the first week of life. As most of our cases occurred during summer and early autumn, environmental temperature may have an additive effect in this population.

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Increasing incidence of moderate neonatal hyperbilirubinaemia in *Wirral*

Severe neonatal jaundice and bilirubin encephalopathy have been reported with increasing frequency from North America and Europe. 

There are no published reports of similar trends in Britain. We therefore examined trends in moderate neonatal hyperbilirubinaemia in Wirral Hospital between 1991 and 2001. Neonates of >34 weeks gestation with a serum bilirubin of >340 μmol/L were identified from the laboratory database. Trends in hyperbilirubinaemia were analysed using the χ² test for trend.

A total of 184 infants were identified; 122 presented before initial discharge, and 62 were readmissions. Median (interquartile range) gestational age was 38 (37–39) weeks, and 69% of affected infants were breast fed. The incidence of moderate jaundice increased from 2.4/1000 live births in 1991 to 5.5/1000 in 2001 (p < 0.0001). Despite a progressive fall in annual births, readmissions for jaundice increased from seven in the first six years of study to 55 in the second five years (p < 0.0001). Five infants needed exchange transfusion; all had haemolytic disease. All were identified before initial discharge. No infants developed bilirubin encephalopathy, and none died.

Ours is the only report of recent trends in neonatal jaundice in Britain. Whether our experience is representative is not known, nor is the national incidence of bilirubin encephalopathy. These questions may be answered by this continuing study, supported by the British Perinatal Surveillance Unit, of severe neonatal jaundice.

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Use of abbreviations in daily progress notes

Errors in medication and documentation are reported. These errors, no matter how minor, could have grave consequences for the patient, especially in the paediatric population. Increasing incidence of moderate jaundice increased from seven in the first six years of live births in 1991 to 5.5/1000 in 2001. Neonates of moderate age was 38 (37–39) weeks, and 69% of presented before initial discharge, and 62 were identified from the laboratory database. Trends in moderate neonatal hyperbilirubinaemia were analysed using the χ² test for trend. A total of 184 infants were identified; 122 presented before initial discharge, and 62 were readmissions. Median (interquartile range) gestational age was 38 (37–39) weeks, and 69% of affected infants were breast fed. The incidence of moderate jaundice increased from 2.4/1000 live births in 1991 to 5.5/1000 in 2001 (p < 0.0001). Despite a progressive fall in annual births, readmissions for jaundice increased from seven in the first six years of study to 55 in the second five years (p < 0.0001). Five infants needed exchange transfusion; all had haemolytic disease. All were identified before initial discharge. No infants developed bilirubin encephalopathy, and none died.

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Use of nasal continuous positive airway pressure during neonatal transfer

Within neonatal intensive care units, nasal continuous positive airway pressure (nCPAP)
provides a means of respiratory support in a variety of acute and chronic clinical situations. We have used it as a means of respiratory support during neonatal transfer and describe our experience below.

nCPAP was provided by the Infant Flow Driver (Electro Medical Equipment Ltd, Brighton, Sussex, UK). This was clamped on to the vertical frame of the transport incubator, and a modified ventilation circuit, designed by the medical physics department of the Princess Royal Maternity, connected the Infant Flow Driver to the infant via short nasal prongs (Electro Medical Equipment Ltd). All infants were transferred by road in the West of Scotland Region dedicated neonatal ambulance. This ambulance provided an oxygen and air supply of 4000 litres each and AC power from a petrol generator.

Over a one year period from April 2002 until April 2003 there were seven nCPAP transfers involving six infants. The median gestational age at birth was 29 weeks (range 26–32) and the median age at transfer was 23 days (range 5 h to 91 d). These included infants with complex congenital abnormalities requiring specialist treatment and those returning to their base hospital. The median transfer time was 45 minutes (range 30–60). No major problems were encountered during transfer. All transfers using nCPAP were discussed in advance with a senior neonatologist experienced in neonatal transport.

We have shown in a small and carefully selected cohort of infants that transfer with nCPAP support is feasible and safe. Our infants, with one exception, had been stable on nCPAP for some time before transfer. Further studies are required to explore whether this form of respiratory support has a role in the transfer of neonates with acute respiratory failure.

Correct attachment of the nCPAP driver to the transport incubator system is vital. Further modifications are being engineered to our transport incubator system to comply with regulations ensuring safety in crash situations.

Even with our confidence in the use of nCPAP for selected clinical situations in transport, we would still strongly recommend that intubation remains the first choice for airway management during neonatal transfer.

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What is the normal range of blood glucose concentration in healthy term newborns?
The report by Dr Nicholl on “normal blood glucose concentrations in healthy term newborns” raises the interesting and important question of how normoglycaemia in newborns can be defined. In a comprehensive review of the literature in 1997, an expert panel of the World Health Organization concluded that there are numerous approaches to defining normoglycaemia, including the statistical approach (which was taken by Dr Nicholl), the metabolic approach (what is the concentration of blood glucose at which normal cell homoeostasis is maintained?), the neurophysiological approach (below what concentration of blood glucose does impairment of neurological functions occur?), and, perhaps most importantly, the neurodevelopmental approach (does a relation exist between neonatal blood glucose concentrations and the neurodevelopmental outcome of children years later?). These different approaches towards definition of normoglycaemia contribute to the controversy that surrounds this issue. Other factors that influence newborn blood glucose concentrations, even in healthy term newborns, are perinatal complications, mode of delivery, and feeding behaviour. It appears therefore that there is very little solid evidence on which judgment of neonatal blood glucose concentrations can be based. Follow up studies looking at neurodevelopmental outcome of neonatal “hypoglycaemia” (and its treatment) in healthy term infants of various delivery modes and birth weights are urgently needed.

References
Renal fungal ball

Preterm infants are prone to fungal infections because of immaturity of their host defence systems (immunology and skin). Other risk factors include multiple antibiotic therapy, prolonged use of umbilical or percutaneous catheters, total parenteral nutrition, colonisation and/or past mucocutaneous candidiasis, low birth weight, endotracheal tube placement, and congenital malformation.

Common sites for invasive candidiasis are the renal system, eyes, brain, and heart. Diagnostic tests should include blood and urine cultures, renal ultrasound, ophthalmological assessment, cardiac ultrasound, and examination of cerebrospinal fluid.

Candiduria may indicate colonisation, but the presence of other clinical signs increases the risk of invasive candidiasis. Fungal ball is the commonest presentation of renal fungal disease.

Clinical presentation may vary and can be obstructive, or non-obstructive, with renal failure.

A baby born at 28 weeks gestation was known to be colonised with *Candida* spp in the first weeks of life. The mother had declined routine antenatal care. The baby was ventilator dependent, with umbilical lines and received multiple broad spectrum antibiotics for possible bacterial sepsis.

After one month the baby developed thrombocytopenia and renal impairment. A renal ultrasound confirmed the presence of a solitary kidney with an echogenic mass.

Limited postmortem examination revealed multiple abscesses in the renal parenchyma, which grew *Candida albicans* only.

Invasive fungal infections in very low birthweight babies are currently the subject of a BPSU study (http://bpsu.inopsu.com/current.htm#Invasive).

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