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

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**OBJECTIVES:** 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 long line 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.

**Abbreviations:** CR, computed radiography; PACS, picture archiving and storage systems
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.1-3

The narrow calibre, poorly opaque lines used, however, may be difficult to visualise using conventional radiography. Reece et al11 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. 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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Newborn surgery, second edition

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 meconium aspiration, with the intensive care of infants with diaphragmatic hernias, and with the referral of infants with less acute problems. However, perioperative management, particularly of uncomplicated cases, and the mysteries of operative techniques have been beyond my reach. A book, with neonatologists within its scope, ideally with strong emphasis on presentation, embryology, and associations as well as description of surgical techniques, would plug a significant gap in my knowledge.

With 97 chapters, typically under 10 pages each, this book certainly has breadth of coverage. Chapters typically deal with a problem 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, which is also the space given to the North American perspective, occupies eight pages, which is also the space given to the North American perspective.

The book begins with a series of chapters dedicated to general and theoretical aspects of the care of these high risk infants. One area of overlap with standard neonatal texts are 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 the North American perspective.

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 lesions in question are relatively rare, which makes the superspecialist list multiauthor approach most valuable. The inclusion of problems sometimes dealt with by neurosurgeons and plastic surgery specialists might make it 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 am 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 training.

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Nestle 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 possible, and many will 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 a 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 illustrates the special micronutrient concerns 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 Maayyan-Metzger 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) duration of fever was 3.4 (1.9) days. The mean (SD) duration of fever was 2.8 (2.4) hours. Twenty seven infants (59%) had lost 8–24.4% of their birth weights. In 34 of the babies, white blood cell counts were between 5000 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 (p = 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.

Cultures were positive in seven babies. Coagulase negative staphylococci were recovered from five blood cultures and considered
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 dehy-
dration 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 ence-
phalopathy have been reported with increas-
ing frequency from North America and Europe. There are no published reports of similar trends in Britain. We therefore exam-
ined trends in moderate neonatal hyperbilir-
ubinemia 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 hyperbilirubinemia were analysed using the χ² test for trend. A total of 184 infants were identified; 122 presented before initial discharge, and 62 were readmitted. Median (interquartile range) gesta-
tional 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 5.3/1000 in 2001 (p < 0.0001). Despite a progressive fall in annual births, readmissions for jaundice increase from seven in the first six years of study to 33 in the second five years (p < 0.0001). Five infants needed exchange transfusion; all had haemolytic diseases. All were identified before initial discharge. No infants developed bilirubin encephalopathy, and none died.

Our 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 Paediatric Surveillance Unit, of severe neonatal jaundice.

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References

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. One can imagine the potential threat to small neonates. Recently, Carroll et al described problems in residents’ progress notes in a neonatal intensive care unit. Being the busiest centre in the country, managing the great majority of seriously sick neonates, we are at a very high risk of these errors. In view of this and as a screening audit, we looked at a few progress notes written on our inpatient neonates. One example of a progress note, written by a junior doctor, stated “Prem 32 WOG, F&G: Problems: RDS, IVH II, S/P SVT, Stable on RA, TPR normal, PU, BO. Chest, CVS & abdomen: NAD”. This excessive and inappropriate use of abbreviations is alarming and disturbing. The abbrevia-
tions used denoted the following (in order of citation): weeks of gestation, feeder and grower, respiratory distress syndrome, intra-
ventricular grade 2 haemorrhage, status supraventricular tachycardia, room air, tem-
perature pulse respiration, passed urine, bowel open, cardiovascular system, and no abnormality detected. This prompted us to look further into the inappropriate use of abbreviations in the daily progress notes in our neonatal unit.

A cross section survey was carried out at the Special Care Baby Unit (SCBU), Royal Hospital, Muscat, on 7 October 2003. Thirty consecutive charts were reviewed. The pro-
gress notes written by seven different doctors (three registrars and four resident medical of the staff were used to them. However, this does not indicate that it is all right to use abbreviations. Standard abbreviations, such as VSD (ventricular septal defect) and PDA (patent ductus arteriosus), are acceptable, whereas others are not.

Documentation errors have been reported to be an increasing problem in day to day care of patients. A recent report described the same negligence in documentation by resi-
dents. Carroll et al found discrepancies in the daily progress notes written by a resident doctor in the neonatal intensive care unit. They also found that notes often contained inaccurate information and lacked pertinent information. We looked further into the situation and found extensive use of abbrevia-
tions in progress notes.

Our observation is not unique and requires rectification. The solution could be to stan-
dardise or eliminate the use of abbreviations in the unit. Total elimination would be difficult, as many of the abbreviations are acceptable. Thus, the use of unacceptable abbreviations should be discouraged. New medical officers should be given brief instruc-
tion on the writing of appropriate progress notes. An alternative is to use the electronic information system for all medical transcription and progress notes, as described elsewhere. In conclusion, care of neonates requires good documentation of day to day progress. The use of unacceptable abbreviations should be discouraged. A follow up audit is war-
ranted to look further into the effect and success of our recommendations.

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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 hours to 91 days). 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.

It has been 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 distress syndrome who are stable on nCPAP, and who would currently be intubated only because of the need for transfer.

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 homeostasis 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.

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Gastrectomy and transillumination
We read with interest the article of Farrugia and colleagues’ about neonatal gastrointestinal perforation. However, there was no mention of:
- Isolated gastrectomy as a cause of neonatal gut perforation, or
- Transillumination as a simple diagnostic tool of pneumoperitoneum.

We highlight these two points relating to a recent case. A 29 week gestation baby girl was born by vaginal delivery. She initially required conventional ventilation for her lung disease. An umbilical arterial catheter was inserted but removed after a few hours due to diskiness of the toes. On day 2 she was extubated and nCPAP was tried. After a few hours, her condition deteriorated and she returned to conventional ventilation. On day 4, she was started on enteral feeding, using small volumes of breast milk, but had mild abdominal distension and some aspires. Feeding was stopped. Her abdomen deteriorated and she had persistent metabolic acidosis. Transillumination of her abdomen was positive (fig 1) for pneumoperitoneum and was confirmed by abdominal x ray examination (fig 2). At laparotomy, two small gastric perforations were identified with local areas of infarction. These were oversewn, with excellent results.

Neonatal gastric perforation is unusual but serious. Various causative factors, including prematurity and nCPAP, have been suggested. Both of these were present in our case. It is also possible that emboli from the umbilical catheter led to small areas of infarction of the stomach wall. Transillumination is a quick and easy technique for diagnosing pneumoperitoneum, and obviates the need for frequent radiographs.

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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).

REFERENCE


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Figure 1 Solitary kidney with echodensities.

Figure 2 Gross pathology, showing multiple fungal abscesses.