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

A Evans, J Natarajan, C J Davies

METHOD

A retrospective study was performed over the year between January 2001 and January 2002. All neonates on the neonatal unit at our district general hospital who required a percutaneously inserted intravenous long line were included in the study. Long lines were inserted by paediatric clinicians using their standard procedure. Two standard types of lines were used: Premicath 27G (Vygon, Cirencester, UK) and Epicutanoe-cava Katheter 24G (Vygon). After insertion, a plain radiograph was taken, using the CR system, to ascertain the line position. The viewing system used is Kodak Direct View PACS version 4.2. Soft copy images are viewed on 2K portrait monitors, and hard copy films are printed at true size.

Both hard and soft copy (console) images were assessed by three independent observers. The hard copy films were reviewed by observers 1 and 3, and soft copy images by observers 2 and 3. Assessment was made as to whether the line tip position could be confidently identified or not.

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 (κ = 0.9) 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 (κ = 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 percentage visibility using the two techniques was 28.9% (95% confidence interval 10.2% to 36.7%).

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%,1 2 mechanical complication rates of 13–53%,2 and perforation rates of 3–29%.4 5 Mortality resulting from perforation and cardiac tamponade has been estimated at 0.76–1%.4 6 After reports of complications associated with right atrial tip position, and subsequent Department of Health recommendations,10 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.1 11 To allow for...
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. 1,3

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, which is also the space given to the North American perspective, occupies eight pages, which is also the space given to this. However, I would have preferred, for a textbook might be better. But many of us 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, as well as 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 and technical details, 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 with the text.

Dehydration: the main cause of fever during the first week of life
We read with interest the findings of Maayan-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 antibiotic use. Overall, 46 febrile neonates were included in this 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 8–24.3% 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 concentrations (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. Cerebrospinal fluid 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 Entrococcus 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. Com-
parable with the findings of Maayan-Metzger
et al., the results of our study deph-
hydration 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 hyperbilirubinemia in Wirral

Severe neonatal jaundice and bilirubin ence-
phalopathy have been reported with increasing
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
prevented 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 increased from seven in the first six years of study to 35 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 Paediatric 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 where
the nurse has 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
found 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 abbrevia-
tions 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, birth asphyxia,
temperature 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 daily progress notes were reviewed.
The progress notes written by seven different doctors (three registrars and four resident medical
officers) were analysed for use of abbreviations. The commonly used ones were: CP (crystalline penicillin), RR (respiratory rate),
HR (heart rate), BP (blood pressure), PA (per
abdomen), O/E (on examination), NGT (nasogastric tube), UEI (urica and electrolyte
1), BGA (blood gas analysis), BBA (born
before arrival), TPN (total parenteral nutri-
tion), SLS (standard lipid solution), STS (standard TPN solution), D/w (discussed with), SBR (serum bilirubin), CTG (cardio-
tocograph), IUGR (intrauterine growth restriction), RP (right to left shunt), Blalock-Taussig
shunt), TAT (trans-anastomotic tube), IVF
(intravenous fluid or in vitro fertilisation),
POD (postoperative day), ASD (atrial septum
defect), VSD (ventricular septum defect),
PDA (patent ductus arteriosus), TR (tricuspid regurgitation), I-R shunt (left to right shunt), TOF (tetralogy of Fallot), CRT (capil-
lar refill time). One interesting note that
needs separate mention was “Plan is to start
ABs after ABC’” (ABs, antibiotics; ABC,
aerobic blood culture).

We noted a high frequency of the use of abbreviations in our neonatal unit. This was a single day observation; we would expect much more variability in a normal study. Fortunately, none of the abbreviations had resulted in erroneous interpretation, as most
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 abbreviations 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, including 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)
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 gestational age at birth were stable on 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 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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References

What is the normal range of blood glucose concentration in healthy term newborns?

We read with interest the article of Farrugia and colleagues’ about neonatal gastrointestinal perforation. However, there was no mention of:
- Isolated gastric perforation 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 akinsness 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 aspirates. 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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Gastric perforation and transillumination

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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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