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SEPTEMBER 2012 VOLUME 8, ISSUE 5

infant

for neonatal and paediatric healthcare professionals

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Volume 8 Issue 5 September 2012

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infant

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Infant is an independent, peer-reviewed bimonthly journal for the multidisciplinary team that cares for sick or premature babies in their first year of life. The journal contains authoritative articles written by experts in their field, covering a wide range of subjects that reflects the varied roles of the professionals working in this area. Practically and clinically based, *Infant* supports neonatal and infant paediatric nursing and medical practice and develops professional education and health promotion skills. All opinions expressed in the articles published in *Infant* are those of the authors and not necessarily those of the publishers.

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Editorial and business enquiries should be addressed to: Lisa Leonard, Infant Editorial Office, 134 South Street, Bishop's Stortford, Herts CM23 3BQ. Tel: 01279 714508. Email: lisa@infantgrapevine.co.uk

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Printed by Stones The Printers, Banbury

ISSN 1745-1205

Infant is indexed in the British Nursing Index (BNI), the Cumulative Index to Allied Health Literature (CINAHL) and EMCare.

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Volume 8 Issue 5 September 2012

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Date of preparation: February 2011

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Learning from a Pseudomonas outbreak in a tertiary neonatal unit

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Neonatal infection is an important cause of morbidity and mortality[1]. A large UK neonatal study showed that the incidence of late onset sepsis (LOS; >48 hr of age) was 3/1000 live births and 29/1000 neonatal admissions[2].

Pseudomonas aeruginosa (PA) is a gram negative rod which accounts for 5% of neonatal LOS[2]. It is commonly found in wet and humid environments. It can produce a biofilm which creates a protective layer when it grows in a water system. Pseudomonas is particularly likely to grow on plastic or rubber components within the system rather than copper piping. PA has been a known cause of outbreaks in neonatal care settings for over 50 years[3].

In November 2011, a Turkish neonatal intensive care unit published details of an outbreak affecting 12 babies. The host was thought to be contamination of electronic sensor taps[4]. Investigations of outbreaks have linked causes to different factors including contaminated equipment[5] and contaminated feeding bottles[6].

The current neonatal intensive care unit in Belfast was opened in 1993. The building itself dates back to the 1930s. There are 31 cots, with 16 intensive care and high dependency, about 550 admissions and 120 very low birthweight infants per year. It functions as the regional centre. Four other neonatal units offer intensive care in Northern Ireland without a formal managed network. Between August 2011 and October 2011 the main NICU room was refurbished including installation of new wash sinks and sensor taps.

The Belfast unit benchmarks its outcomes through the Vermont Oxford Network. As a result of this benchmarking a quality improvement initiative called CSI (clearing serious infection) commenced in January 2011. In addition the neonatal unit runs monthly multidisciplinary risk meetings held in the unit to review all incident reporting. On 11 January 2012 a "neonatal review" was held attended by neonatal staff and service managers. At this meeting relevant issues were reviewed including data on occupancy and nosocomial infection.

In early December 2011 a known case of PA was transferred to the regional unit in Belfast from a large district general hospital. Later in December 2011 that district general hospital declared an outbreak of PA. Full details of the sequence of events across a number of hospitals are available in the interim and final reports by the Regulation and Quality Improvement Authority (RQIA). The reports concluded that the different hospitals had separate outbreaks or clusters.

On 17 January 2012 the Belfast Trust declared an outbreak based on two identical strains of PA. These isolates had occurred 31 days apart. Case 1 was from early December (but distinct from the strain transferred in from the district general hospital) and case 2 from early January.

A further case (case 3) was identified eight days after the second but was later confirmed to be a separate PA strain associated with a third hospital. Case 4 developed symptoms two days after the third. Cases 2, 3 and 4 died. Cases 1, 2 and 4 were caused by identical strains of PA.

At the meeting at which the outbreak was declared the plan included:

- Restriction of admissions with plans to transfer patients *in utero* out of region to access regional services as necessary. Total numbers of inpatients were reduced over the next four days to allow the main intensive care room to undergo vaporised hydrogen peroxide treatment.
- Environmental screening.
- Design of information leaflets for parents about PA.
- Parents were informed verbally that their baby was being screened by skin swabbing for Pseudomonas. Patients with positive results were then co-located with dedicated staff. Initially twice weekly skin swabs continued, later relaxed to weekly.
- Routine practice was to use tap water for nappy changing but sterile water for face care. Subsequently sterile water only was used for nappy changing.
- Unit practice had also been to defrost frozen breast milk with tepid tap water. This was stopped.
- Hand alcohol gel was in routine use after hand washing. Its use was re-enforced.

Subsequent case findings across Northern Ireland detected several babies who had been cared for in the Belfast Unit in November 2011 and found to be colonised with PA *after* transfers to other units. In December an infant cared for in Belfast developed a PA bacteraemia with the "Belfast" strain in late December *after* transfer to another unit. There was no formal arrangement in place to ensure this information was shared between relevant neonatal units.

It became clear that three neonatal units in Northern Ireland hospitals had had unlinked problems with PA within about six weeks of each other. Two hospitals found a tap or taps to be the host of a relevant strain. A single case in two of these hospitals was caused by a strain which originated from another hospital.

The Belfast Trust arranged a 'root cause analysis' and the Northern Ireland Health Minister ordered an independent review by the RQIA. Both came to very similar conclusions and recommendations. The root cause in Belfast was identified to be five out of six sensor taps in the main intensive care room. The taps were most heavily contaminated at the tip, ie the flow straightening rosette. How the taps first became contaminated is unknown. All taps and sinks in the intensive care room were replaced and regular water testing commenced.

The root cause analysis concluded that the most likely method of spread to the babies was through use of tap water for nappy changes. The use of tap water to defrost breast milk previously frozen for storage may also have contributed. It was recommended that PA is identified as an alert organism for neonatal intensive care and high dependency units.

Previous to the Pseudomonas outbreak The British Institute of Cleaning Sciences (BICS) instructed staff to clean sinks from the bottom, cleaning the taps last. Interim guidance on cleaning sinks now recommends starting at the taps and cleaning down.

Prior to release of a press statement on 19 January 2011 the bereaved parents were all contacted by consultant staff either by telephone or in face to face meetings and informed of the fact that their baby had died in the context of an outbreak which was likely to feature in the press.

The following week parents of inpatients were invited to a parents' meeting on 24 January. This was very well attended by parents, managerial and clinical staff. Bereaved parents were offered separate private meetings. At the meeting the sequence of events was explained by clinical staff and estate staff also talked about the investigation of the unit. Maintaining confidentiality was challenging. Parents expressed concern that staff had not informed them of the deaths before the details appeared in the press. Psychology staff attended the meeting and their support was offered. A second update meeting was arranged eight days later.

Water safety has largely developed around experience of Legionella. Sources of Legionella can exist within a water system, eg in blind-ended pipes, however Pseudomonas appeared with heavy contamination at the end of the tap suggesting contamination from outside. Sensor taps can contain internal components on which Pseudomonas can form a biofilm. Current Belfast practice still includes the use of sensor taps, which now contain a UV chamber. These taps are auto-clavable and do not contain a flow straightening rosette. After the refurbishment in August 2011 the sensors were positioned at the end of the tap beside the rosette. They are now adjacent to but not part of the taps themselves. Water sampling in neonatal intensive care continues on a weekly basis. If a sample is positive for PA the sink will be decommissioned, the tap and sink analysed and the tap autoclaved or replaced.

Learning points

- It was not the sensor taps but the internal component, ie the flow straightening rosette which became the host. (http://www.dhsspsni.gov.uk/tapstudyreport290512.pdf)
- It is not appropriate to assume a single case of PA is sporadic. A single case of PA should prompt testing of all sinks in rooms in which the patient has been nursed in any unit from birth requiring reporting of results to previous units. This could identify a sink/tap which is the host leading to the case OR importantly identify a sink/tap which has become contaminated and is a future risk.
- The lack of an agreed surveillance system for PA led to delays in sharing information. In retrospect the first signs of an outbreak began in November 2011 but in early January 2012 this information was not available.
- A meeting for parents just before the initial press release on the evening of 19 January would have allowed parents to hear about the deaths from Trust staff rather than the press.
- A major infection outbreak such as this will lead to scrutiny of governance procedures within any unit. Evidence was readily available of international benchmarking, multidisciplinary quality improvement initiatives related to infection and to work around risk and incident reporting.
- The outbreak was contained by identification of the host and stopping long standing practices involving patient contact with tap water.
- Infection control practices within the Belfast unit meant that cross infection was not an issue.

The RQIA made 32 recommendations including a formal established neonatal network and suggested that a new regional intensive care unit should be expedited. Plans for these projects are underway.

Acknowledgements

The authors would like to acknowledge advice on this article from Dr Tony Stevens, Medical Director, Belfast HSC Trust and Mr George McCracken, Head of Estates Risk & Environment.

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Innovating for Life Awards 2013

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Innovation in neonatal care has been a key to many of the improvements in the quality of care and outcome over the years. These have included major innovations such as high frequency oscillation and cooling therapy to small, simple, cheap but effective developments such as the use of a simple plastic bag to wrap a newborn preterm infant during the early minutes after birth to prevent hypothermia. Innovations are not limited to technical equipment but include developments in nutrition, improvements in parent communication using new technologies, the ability to obtain rapid opinions on complex cases across a network or the development of training programmes designed to optimise the care of infants with complex disease.

In the autumn of 2011 the Innovating for Life Awards 2012 were opened to entries from neonatal and midwifery care. There was a strong field of applicants and the neonatal category was won by a team led by Dr Richard Mupanemunda from the neonatal intensive care unit at Heartlands Hospital, Heart of England NHS Foundation Trust, Birmingham. The team submitted an innovative training programme for the management of infants with complex airway problems using a Storz DCI video laryngoscope to both train and improve the capability to intubate babies with difficult airways within a network. This has been described in detail in *Infant*[1]. A highly commended award was given to a team from Salford Royal Foundation Trust, led by Dr Ula El-Kafrawy, who developed a technique for the accurate weighing of ventilated babies within an incubator. The midwifery category was won by a team lead by Dr Sian Warriner from Oxford University Hospitals NHS Trust, for their mindfulness-based childbirth and parenting project.

Infant journal, in partnership with Cow & Gate, are delighted to announce that the 2013 Innovating for Life Awards will be open to entries from September 2012. As last year, the awards are designed to promote innovation in neonatal and midwifery practice, especially where the innovation might be implemented in a wide range of neonatal and midwifery units in the future. Innovative ideas can come from all areas of neonatal and midwifery care and from individuals or teams including neonatologists, paediatricians, neonatal nurses, midwives, neonatal dietitians and pharmacists, speech and language therapists and neonatal physiotherapists. Cow & Gate fully endorse the Unicef Baby Friendly Initiative (BFI) which includes informed support for all mothers and infants whatever their choice of feeding method. Submitting an application for this award from a Trust with BFI accreditation should not be perceived as a conflict of interest and as many Trusts are now BFI accredited we welcome any innovation that improves the quality or delivery of care for mothers and their infants.

To apply for an award you will need to describe your innovation in no more than 1000 words, including the rationale for the innovation, how you propose to deliver the initiative and how it will improve the delivery or quality of care. You should include details of how the award will be used and what measures you will employ to monitor your success. Your proposed innovation will be judged on its potential impact on neonatal or midwifery care, rigour of process/evidence and whether it can be rolled out to other neonatal and midwifery units.

Sometimes the smallest of ideas can make a significant change so don't hold back and submit your ideas. Details of the application process can be found at www.InnovatingforLife.co.uk or on pages 148 and 149. The closing date for applications is 31st December 2012. The neonatal award winner will be invited to write up their innovation for publication in *Infant* journal.

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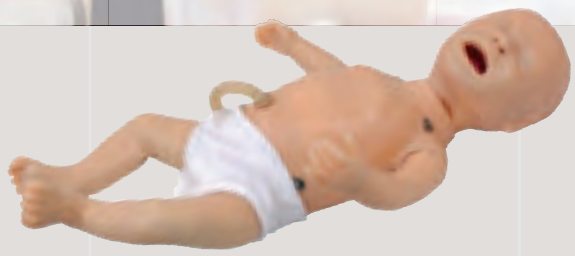

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Home from home in Ronald McDonald Houses

FOCUS ON A UNIT

Anu Ohrling, Consultant in Paediatrics and Trustee of Ronald McDonald House Charities

In 1989 a global charity providing free 'home away from home' accommodation for the families of hospitalised children opened its first House in the UK. Today, Ronald McDonald House Charities has a network of 15 Houses and 25 sets of family rooms in the UK, located within or near to hospitals with specialist paediatric and neonatal wards.

The importance and impact of parental proximity on the wellbeing of hospitalised children has been recognised for many years. The increased level of stress experienced by parents of sick children has also been well documented, especially in the case of neonates.

Anne Roberts, Head of Operations and Development for Ronald McDonald House Charities, agrees: "From birth through to teenage years children need to have their family close to them when they are in hospital because it can be a frightening experience. For newborn babies it is extremely important to establish an early bond with parents.

"Sometimes to access the best medical treatment families need to travel long distances and this can be an immense source of stress, both emotional and financial. We recognise that by offering families a free, supportive and comfortable place to live for the duration of their child's hospital stay we are helping to alleviate some of that stress. Little things also make a big difference, such as every one of our rooms having a direct telephone line to their child's ward. Parents go to bed knowing that they will be contacted immediately if their child runs into difficulties and that they are only minutes away."

Natasha and Steve Paul with daughter Grace.

To access a Ronald McDonald House a family is typically referred to the House Manager by either a member of the nursing staff, the ward clerk or receptionist. House Manager at Ronald McDonald House Tooting, in London, Jeanette Hill explains: "St George's is a large London hospital and there are a number of specialist paediatric wards and services. Throughout the week I visit the wards and talk with the sister or the team psychologist about families who might benefit from staying in one of our eight bedrooms. As a former nurse, I have a useful insight into how the medical teams operate but also as a parent myself I understand it from the family's perspective.

Jeanette Hill, centre, with the paediatric nursing team from St George's Hospital in Tooting.

"A fairly recent change on the neonatal ward was the introduction of two Family Care Co-ordinators (FCC). The FCC is a dedicated post to support neonatal parents and it seems to be working really well. The nursing and medical teams are often extremely busy delivering the best care for baby, whereas the FCC is there to support the family emotionally."

With such clear demand for family accommodation, it is not surprising to find that most Ronald McDonald Houses attract long waiting lists. Looking to the future it seems that demand for 'home away from home' accommodation is likely to increase given the government's current proposal for focusing medical treatment at centres of excellence, which will mean the closure of some existing facilities and therefore greater distances to travel.

Commenting on the most recent government announcement around the provision of children's cardiac treatment in the UK, Anne Roberts says: "The recent move to close some children's heart surgery units can only mean an increase in demand for parental accommodation. We hope that independent charities like ours can continue to support the potential increase in the numbers of children and families who will need our help."

The thousands of families who have stayed in a Ronald McDonald House are the charity's biggest advocates. They also highlight the important role that the House Manager has in welcoming the families into the home and offering emotional and practical support.

The Paul family, who stayed at Ronald McDonald House Tooting are representative of how many parents feel after coming into contact with the charity. Steve Paul says: "Words can't express how we feel about Ronald McDonald House Charities but what I can say is that they helped us find strength in a time that was hellish. Before we found out about the charity we had planned to take out a loan to pay for a local hotel. Staying at the House gave us the opportunity to bond with Max for his short seven weeks of life. We will never forget the House Manager Jeanette and her team for the kindness and support they showed us in our time of need."

To find out more about Ronald McDonald House Charities visit www.rmhc.org.uk

What's new in neonatal jaundice?

This article reviews current issues in the risk management of neonatal jaundice. These include discussion of challenging aspects of the recent National Institute for Clinical Excellence (NICE) guideline, an account of an evidence update for this guideline and consideration of possible future developments, including screening for bilirubin encephalopathy, audit of current practice and surveillance for severe hyperbilirubinaemia.

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Keywords

bilirubin encephalopathy; bilirubinometry; exchange transfusion; jaundice; kernicterus; screening

Key points

Manning D., Ives N.K. What's new in neonatal jaundice? *Infant* 2012;8(5): 137-141.

1. Controversial and challenging features of the NICE neonatal jaundice guideline (2010) include the recommendation to measure bilirubin in all visibly jaundiced neonates, risk assessment of neonates for jaundice and the recommended treatment thresholds.
2. The use of bilirubin nomograms has not been shown to reduce the incidence of bilirubin encephalopathy.
3. A recent Jaundice Evidence Update found no new evidence to suggest changes to NICE guidance.
4. There is insufficient evidence currently to support screening of neonates for hyperbilirubinaemia.

There have recently been several important developments in the understanding of neonatal jaundice, and refinements in monitoring and treatment. This paper reviews some of these developments and makes suggestions for further initiatives to help improve practice in neonatal jaundice in the hope of reducing the incidence of the rare but devastating sequelae of bilirubin encephalopathy and kernicterus.

Here, the term 'bilirubin encephalopathy' is used to refer to acute neurological dysfunction associated with hyperbilirubinaemia. While 'kernicterus' is strictly speaking a pathological term, it is often used to refer to the long-term neurodevelopmental effects of bilirubin encephalopathy, and it is in this latter sense that the term is used in this paper.

Neonatal jaundice has been the subject of much interest in the past 15 years following reports, initially from North America[1] and later from Europe[2], of the apparent re-emergence of bilirubin encephalopathy and kernicterus in term and near term infants. While there is some dispute as to whether this problem had ever disappeared[3], these reports generated concern among neonatologists. This was related in part to concern that control of rhesus disease had led to a complacent approach to the recognition, investigation and management of neonatal jaundice. For example, the UK surveillance study of severe hyperbilirubinaemia, supported by the British Paediatric Surveillance Unit (BPSU), reported 108 babies in two years with severe hyperbilirubinaemia (unconjugated serum bilirubin (SBR) ≥510μmol/L)[4]. Fewer than half of these babies underwent exchange transfusion despite some showing symptoms consistent with bilirubin encephalopathy, and 14 showed clinical features, brain MRI changes, post-mortem findings or sequelae clearly consistent with bilirubin encephalopathy/kernicterus. Other national surveillance studies have reported similar findings, both clinical and demographic – many babies with severe jaundice are readmitted to hospital following 'early' neonatal discharge, many are near term and babies from ethnic minorities are represented disproportionately[5-7]. Perhaps a surprising proportion of affected babies, including some who developed bilirubin encephalopathy, were still in hospital when severe jaundice was eventually recognised. The vast majority of affected babies have been breastfed, some showing clinical and biochemical evidence of lactation failure.

These observations have given rise to concern about risk management of neonatal jaundice, for example:

- Are babies who are at particular risk being identified and monitored appropriately?
- Regardless of risk, is jaundice in neonates identified in a timely manner?
- When jaundice is identified, is treatment timely and effective?
- Is sufficient support offered to lactating mothers and their babies before and after discharge?

Concern about these questions was heightened by the findings of a survey of UK treatment of neonatal jaundice[8]. The survey showed wide variation in practice, with almost as many treatment schemes as units surveyed. Some regimes appeared lax, with high SBR thresholds for phototherapy and exchange transfusion, and some made no allowance for differential treatment of preterm babies. Some of this wide

variation in practice probably reflected variation in risk perception and tolerance among clinicians and, more importantly, the relative paucity of evidence to inform treatment of neonatal jaundice.

In light of these concerning findings and such variation in practice, the National Institute for Health and Clinical Excellence (NICE) commissioned a Guideline Development Group (GDG) for neonatal jaundice in 2007. The group comprised clinicians with experience and expertise in jaundice, clinical and academic midwives, a health visitor, a biochemist, a general practitioner and lay members. The brief was to consider jaundice in the first month of life, to give recommendations on recognition, investigation and treatment and to provide written information for patients and carers.

The group met over a period of two years to review evidence and prepare its guidance. Following a draft publication and feedback from stakeholders, the full guidance was published in 2010. The full and abridged versions are available on the NICE website[9], and comprehensive summaries and reviews of the guidance have been published recently[10-12]. This article will list the main components of the NICE guideline, consider some aspects that may offer the greatest challenge to health professionals, discuss developments since the publication of the guideline, and recommend further developments in risk management of neonatal jaundice.

- Provision of a pathway for the approach to jaundice in all neonates.
- Advice for greater vigilance (and early review) of neonates with the following factors:
  - gestation <38 weeks
  - previous sibling with jaundice requiring phototherapy
  - mother's intention to breastfeed exclusively
  - visible jaundice in the first 24 hours
- Recommendation that bilirubin must be measured in all babies with visible jaundice.
- Endorsement of transcutaneous bilirubinometry in clearly specified circumstances.
- Generation of pathways for phototherapy and exchange transfusion, reinforced by gestation-specific, consensus-based, treatment thresholds.
- Practical advice for managing standard and intensified phototherapy.
- Production of an information leaflet for parents and carers.

TABLE 1 Important aspects of the NICE guideline on neonatal jaundice.

Summary of the NICE guidance

The most important aspects of the NICE guideline[9] are shown in **TABLE 1**.

Challenging and controversial aspects of the NICE guidance

Measuring bilirubin in visibly jaundiced babies

One of the most significant recommendations is the advice to measure bilirubin in all visibly jaundiced babies. This was based on a review of the evidence concerning visual assessment of jaundice. This indicated clearly that, while the absence of visible jaundice had good negative predictive value, even experienced health professionals are inaccurate in their visual estimation of hyperbilirubinaemia in jaundiced babies.

This recommendation has substantial implications for relevant health professionals, particularly a midwife working in the community. When a midwife encounters a jaundiced baby, according to the guideline, the bilirubin should be measured. If a transcutaneous bilirubinometer is available this can be used if the baby is mature and more than 24 hours old. If not, or there is no access to a bilirubinometer, or the bilirubinometer reading exceeds 250μmol/L, arrangements should be made for laboratory SBR measurement. Ideally this should be measured as soon as possible, so taking a blood sample and taking it back to the laboratory at the end of rounds is inappropriate. However, returning immediately to the hospital with the sample will inevitably, and repeatedly, disrupt the midwife's rounds.

Some of these problems can be allayed by providing bilirubinometers to midwives, particularly those who work in the community. This carries substantial resource and training implications – bilirubinometers are not cheap. Should they be provided to all community midwives, or should the training and resource be concentrated on a smaller group? Different arrangements may be appropriate in different districts. In one of the authors' districts (DM), the latter approach has been adopted, with three 'locality' community midwives who have had training in routine neonatal examination being trained in the use of, and provided with, bilirubinometers. This may work in a geographically small or defined district, but there are problems when the locality midwife is not available, and the arrangement carries the risk of de-skilling the other midwives. Yet, to provide all midwives with bilirubinometers, and to train them in their use, may be prohibitively expensive. While the health economic analysis accompanying the NICE guideline suggested that preventing one to two cases of kernicterus per year would pay for the rollout of transcutaneous bilirubinometry, nonetheless for individual units the required investment is substantial.

Enhanced surveillance of neonates at greater than average risk for jaundice

Risk assessment, to offer enhanced monitoring of babies at greater than average risk for neonatal jaundice, is also controversial and challenging. In the days before early discharge of mothers and babies this was not an issue, since most remained in hospital long enough for jaundice to present itself. Now, however, most mothers and babies are discharged before jaundice has appeared and this may well be a factor in the apparent resurgence of severe hyperbilirubinaemia. A universal system of community surveillance in which neonates received daily review in the first week of life could accommodate this challenge, particularly if informed by the need to measure bilirubin in all jaundiced babies.

Unfortunately, constraints on resources, particularly numbers of midwives, render this ideal system unattainable, and midwives increasingly have to prioritise their work. This entails offering enhanced input, with earlier and more frequent visits to mothers of babies at greater than average risk for hyperbilirubinaemia. Community midwives, of course have responsibilities other than dealing with neonatal jaundice. The guideline advice on risk assessment is intended to assist hospital and community midwives in providing enhanced input to babies at greater than average risk. It is, however, not without problems and controversy. It has been criticised as being too broad to be useful, for example one of the risk factors – mother's intention to exclusively breastfeed – may apply to up to 70% of mothers of newborn babies. How can this help

midwives to prioritise their work?

Systematic attempts have been made to assign risk for later hyperbilirubinaemia before discharge of newborn babies. These attempts have included plotting pre-discharge bilirubin on a nomogram, since high pre-discharge bilirubin measurements may 'track' for later hyperbilirubinaemia. The best-known example, the Bhutani nomogram, was devised from bilirubin measurements in a population of neonates in Philadelphia and excluded babies with known haemolysis[13]. Bilirubin nomograms have shown moderate predictive value, particularly when pre-discharge bilirubin is combined with clinical risk factors similar to those in the NICE guideline. They have not been shown, however, to convincingly reduce the incidence of important outcomes such as extreme hyperbilirubinaemia or bilirubin encephalopathy[14]. This is perhaps not surprising since these are still relatively infrequent adverse outcomes and they are often unpredictable, being associated, for example, with sepsis, lactation failure and glucose-6-phosphate dehydrogenase (G6PD) deficiency as well as hyperbilirubinaemia.

The main value of highlighting risk factors is to raise awareness among health professionals (and parents) and to encourage particular vigilance about jaundice when the factors are present.

Treatment thresholds for phototherapy and exchange transfusion

The treatment thresholds in the guideline have been another area of controversy. Some stakeholder feedback during the consultation period before final publication expressed concern that the thresholds were too aggressive and might lead to overtreatment of neonatal jaundice. The GDG was well aware of the lack of evidence to inform these thresholds and that previous guidelines included consensus, not firmly evidence-based, thresholds. In the 2004 American Academy of Paediatrics guideline, for example, the treatment graphs for phototherapy and exchange transfusion were accompanied by a qualification that the advice was indeed a consensus and that there was not universal agreement about them among their expert group[15]. The NICE GDG recommended treatment thresholds that were intended to offer a reasonable balance between thresholds acceptable both to 'hawks' and 'doves' and there was substantial unanimity about the thresholds debated and agreed. Also, there was a conscious attempt to produce advice that was practical and attainable, particularly when designing the early slope of SBR thresholds. Treatment advice has been produced as a series of charts, one for full term babies (gestation ≥ 38 weeks) (**FIGURE 1**), and one for each week of gestation down to 23 weeks. These charts are readily available, and can be downloaded for clinical use, from the NICE website.

Undue emphasis should not be placed just on SBR levels when making treatment decisions about neonatal jaundice. Other important variables include the baby's age and maturity (accommodated by the graphs), co-morbidity such as haemolytic disease, sepsis, dehydration and acidosis, the mode of feeding and the success of establishing lactation. One of the main potential benefits of the treatment advice is to encourage consistency in treatment, which must be an improvement on the pre-guideline situation. Since, at least in term babies, bilirubin encephalopathy typically occurs at SBR levels well above the treatment thresholds[16] their use, in association with timely recognition and assessment of neonatal jaundice, may help to reduce the incidence of this potentially preventable disaster. This may not reassure the 'doves', who fear that compliance with the guideline will result in overtreatment of neonatal jaundice. In the absence of evidence for or against this, since phototherapy used according to the guideline is safe and effective and may help prevent the disaster of bilirubin encephalopathy, perhaps the burden of proof, to show that higher treatment thresholds are safe, rests with the doves.

Evidence update

In January 2012, NICE commissioned an Evidence Update Advisory Group to review evidence published since the production of the guideline and to consider whether any such evidence justified change in the guidance. A professor in neonatal medicine chaired the group; it included the three consultants in the original GDG and another consultant neonatologist. It

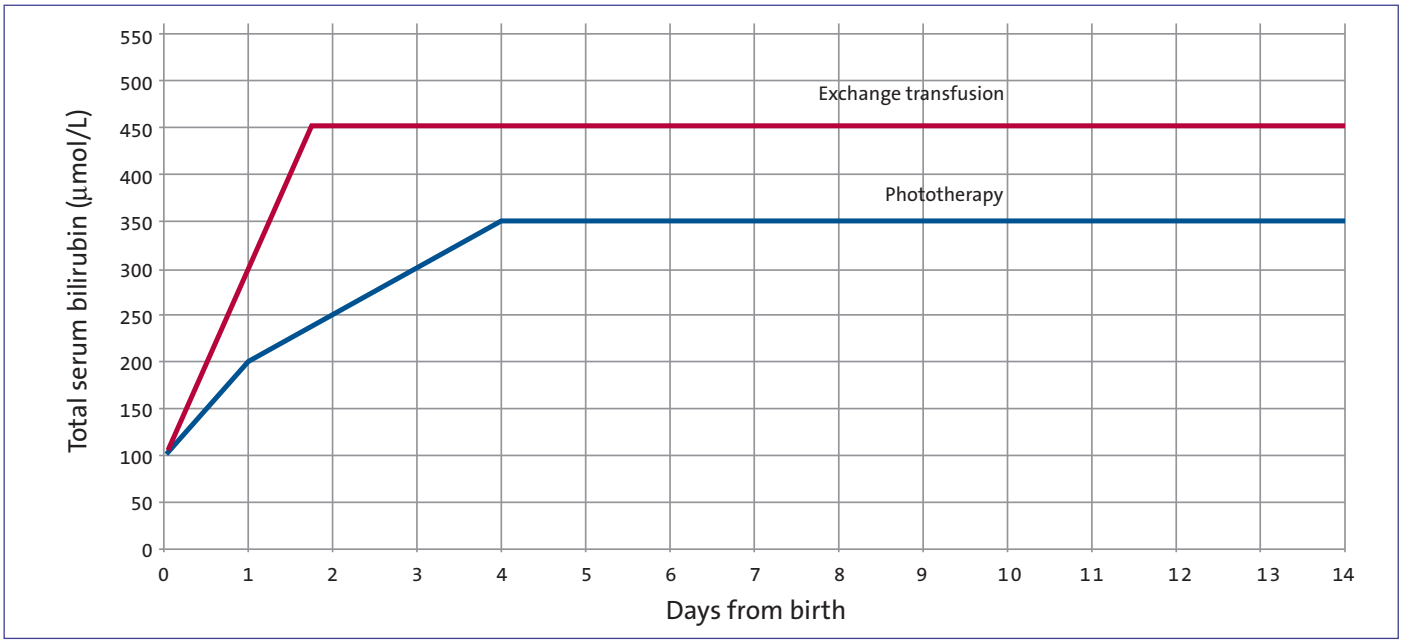

FIGURE 1 Treatment threshold graph for baby with neonatal jaundice, born at or greater than 38 weeks' gestation. Adapted from the NICE guideline[9].

received evidence appraisal and editorial support from a NHS Evidence project team.

The NHS Evidence project team conducted searches for relevant studies from June 2009 (the end of the search period for the full guideline) to November 2011. Databases searched included CINAHL, the Cochrane Database of Systematic Reviews, Embase, Medline and the Database of Abstracts of Effects. The main, but not the exclusive, focus of the search was management of jaundice. In all, 131 studies were identified and after sifting, eight studies were considered in the published update[17].

In short, most of the studies reviewed provided no substantive evidence to suggest that the full guideline recommendations need to be changed. Transcutaneous bilirubinometry was accompanied by the need for fewer blood tests for jaundiced babies than visual assessment[18]. Prone positioning provided no advantage during phototherapy compared to supine positioning[19]. LED for providing blue light was no more effective than fluorescent tubes[20]. Triple was no more effective than double phototherapy[21], and in a small study the mean decrease in SBR after 24 hours was non-significantly greater in babies randomised to double compared to single phototherapy[22]. In a larger study this difference may have reached statistical significance. White curtains, as noted in the original NICE guidance, offer no advantages[23] over phototherapy alone (**FIGURE 2**).

Two studies reported findings that might in future lead to changes in the guidance. A pilot study was conducted to determine whether phototherapy could safely be stopped at a higher SBR level (17μmol/L less than the treatment threshold compared to 51μmol/L below the threshold as recommended in the current guidance). The duration of phototherapy was significantly shorter in the 'high threshold' group, and length of hospital stay was significantly reduced[24]. There was no significant difference in the need for further phototherapy between the groups. Thus, using the higher stopping threshold appeared to be safe and to reduce the duration of intervention. The authors stated their intention to complete a definitive study based on the findings of this pilot study. Should their findings be replicated in a larger study, guidance might need to be changed to accommodate the clinical and health economic attractions of shorter treatment duration and hospitalisation, with no compromise of safety.

FIGURE 2 Phototherapy: the mainstay of treatment for significant jaundice.

The second study offering promise was a randomised controlled trial of albumin infusion before exchange transfusion compared to exchange transfusion alone in babies with non-haemolytic jaundice[25]. Babies randomised to albumin received 1mg/kg albumin one hour before exchange transfusion. Compared to controls, their SBR levels were significantly and substantially lower both six and 12 hours after the intervention. No babies in the albumin group needed a second exchange transfusion, whereas four babies in the control group did. These findings may lend support to the intuition of some clinicians that albumin priming is beneficial in hyperbilirubinaemia at or approaching exchange transfusion levels. It was not recommended in the original guidance because of lack of evidence for such benefit. If further studies replicated these findings, this might inform a change in guidance.

Screening for bilirubin encephalopathy/kernicterus

Is there a case for screening for bilirubin encephalopathy/kernicterus? In 2007, the National Screening Committee (NSC) judged that, according to its criteria, such a case had not been made[26], and in 2009 the United States Preventive Services Task Force concluded that there was insufficient evidence at the time to recommend screening of neonates for hyperbilirubinaemia[27]. While the condition is of undoubted clinical and public health importance, there is no threshold of SBR above which the risk of kernicterus is clearly defined. As discussed above, pre-discharge screening, even when combined with clinical risk scores, has not convincingly been shown to reduce morbidity or mortality from bilirubin encephalopathy, and some cases present rapidly and unpredictably in the absence of definable risk factors. The NSC is currently reviewing its advice, taking account of new research. It is likely that further research on the natural history of bilirubin encephalopathy, the relationship between SBR and bilirubin encephalopathy and the utility of pre-discharge screening will be needed before a substantial change to universal screening in the UK occurs.

Future developments in neonatal jaundice

What of other developments in neonatal jaundice? One of the recommendations of the NICE GDG was to establish a national kernicterus registry, which would help in monitoring national trends and could facilitate sharing the findings of root cause analyses of individual cases. There are practical challenges to establishing and maintaining disease registries. The BPSU, while supporting surveillance of rare disease, does not consider establishing registries to fall within its remit. Reporting cases would be the primary responsibility of individual clinicians or neonatal units.

Hopefully, this would be a rare experience for such individuals and many cases may have medico-legal implications and be the subject of litigation. Individual clinicians or units may, therefore, be reluctant to report cases or share the findings of local root cause analyses. Reporting could, however, be triangulated and other sources could include medico-legal proceedings and even parents of affected babies. For a registry to be successful, clinicians and the public need to be persuaded of the anticipated benefits, and challenging issues relating to consent and confidentiality would have to be addressed.

Other measures could be taken to evaluate developments in neonatal jaundice. First, compliance with the NICE guideline could be determined. Clinicians are expected to audit their compliance with relevant NICE guidelines and NICE provide audit tools to facilitate this. It would be very interesting to survey national compliance with the jaundice recommendations, particularly with regard to the challenging issues discussed above, such as uptake of transcutaneous bilirubinometry and appropriate post-discharge follow-up of babies with 'risk factors'.

Second, the national surveillance study should be repeated to determine the current incidence of severe hyperbilirubinaemia and bilirubin encephalopathy. A reduction in these would not necessarily be causally associated with the implementation of the NICE guideline – other relevant factors could include heightened awareness and risk perception of jaundice. Nonetheless, for rare problems such as severe hyperbilirubinaemia and bilirubin encephalopathy, national surveillance can provide an invaluable snapshot of trends and associations.

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Nursing care and surgical correction of neonatal myelomeningocele

Neural tube defects are a major cause of fetal, neonatal and childhood death. They are also responsible for significant life-long disabilities. In some cases, they can be prevented, and in others surgery can improve life expectancy and quality. Factors relating to these concepts are discussed, alongside suggestions for improvement in care.

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Keywords

neural tube defect; myelomengingocele; folic acid; neonatal neurological assessment; surgical nursing care

Key points

Jensen A. Nursing care and surgical correction of neonatal myelomeningocele. *Infant* 2012; 8(5): 142-146.

1. Periconceptional folic acid supplementation is known to reduce neural tube defect incidence but the impact on incidence within the general population appears negligible.
2. Surgical correction of spina bifida – myelomeningocele – is improving, reducing mortality and morbidity.
3. Neonatal surgical care utilises basic but important actions, improving immediate and long-term outcomes.
4. National guidelines on neonatal neurological assessment are lacking.

Congenital abnormalities are described as anomalies involving structure, metabolic or endocrine processes, or genetic coding that is present in the newborn at the end of the pregnancy[1]. Neural tube defects are the most common abnormality of the central nervous system, probably second only to cardiac defects when considering major congenital anomalies[2]. Representing a major public health concern, neural tube defects have a dramatic impact on all social levels by virtue of their mortality, morbidity, social cost and human suffering[2].

Embryology

Neural tube defects arise from abnormalities in the formation of the embryonic neural tube, the forerunner of the central nervous system and most of the peripheral nervous system. By day 28 of embryonic life, before most mothers are aware of their pregnancy, the neural tube has formed from the neural crest, through a complex and highly regulated morphogenetic process[3]. Approximately 132 genes have been implicated in the control of this process, with neural tube defects arising from a rostral or caudal failure of neural tube closure[4]. While the precise process of neural tube closure is not known, two models have been proposed. The first suggests a zip-like closure of the neural tube; the second proposes multiple closure sites along the developing neural tube[5]. Some defects may arise from secondary reopening of the tube or from a post-neurulation defect[6].

Types of neural tube defects

The clinical spectrum of neural tube defects spans five forms, namely, craniorachischisis, iniencephaly, anencephaly, encephalocele and spina bifida. Craniorachischisis is rare, with an incidence ranging from 0.1-10.7 in 10,000. It results in fetal or early neonatal death, and the huge variation in incidence is strongly linked to increasing levels of poverty[7]. Iniencephaly is also rare, with an incidence of 0.1-10 in 10,000, and similar outcomes[8]. The USA records the incidence of anencephaly, encephalocele and spina bifida as 1.4, 5.5, and 3.7 in 10,000 live births, respectively[5]. By comparison, and for reasons unknown, Wales has the highest recorded incidence of these three neural tube defects in Europe, with rates as high as 17 in 10,000[9]. Anencephaly will usually result in fetal or early neonatal death[3]. Encephalocele mortality is largely determined by the site and size of the lesion while early childhood survival of spina bifida can be near 100%[6].

Despite perceived negative outcomes, progress in medical treatment has improved the outcome for children with the survivable neural tube defects of encephalocele and spina bifida. Surgical correction of encephalocele can be straightforward, with a favourable prognosis, dependent on the site and extent of the lesion[6]. Substantial improvements in the surgical correction of spina bifida are also described, with mortality falling from 37% in the first year of life in 1972, to a mean survival of 30 years[6]. Of the three main forms of spina bifida (see **FIGURE 1**), literally 'split spine', only spina bifida occulta does not require surgery to correct the defect.

Spina bifida occulta is described as arising from flawed closure of the vertebral laminae, though the spinal cord and neural tissue are usually normal[10]. Although it is suggested that this is present in approximately 5% of the USA population, the symptoms experienced by the affected

individuals are usually so mild they are unaware of the defect. In contrast the two forms of spine bifida cystica – meningocele and myelomeningocele – both require surgical intervention[10]. In both forms, the meninges protrude through the malformed spinal column. In myelomeningocele, the most common form and that which is usually referred to as spina bifida, this is further complicated by the presence of neural tissue. After corrective surgery for myelomeningocele (see **FIGURE 2**), there is always neural insufficiency to regions below the defect, which may manifest in conditions such as paraparesis and neurogenic bladder and bowel[10]. However, there is usually little or no neural damage and disability after surgery to correct meningocele.

While such physical disabilities and their life-long implications are important to remember, anomalous brain development causes its own concerns. Hydrocephalus, with its associated functional and neural abnormalities, occurs alongside myelomeningocele in up to 90% of cases, with up to 80% historically requiring surgical intervention for this condition[11]. Current trends indicate that this figure is now nearing 50%[12]. Differing degrees of Chiari II malformations, with significant impact on the hindbrain and brainstem, occur in virtually all cases of myelomeningocele and can give rise to diverse symptoms including apnoea, headaches and bradycardia[13].

Folic acid and the prevention of neural tube defects

Precise causative agents for neural tube defects are largely unknown[14], though many factors have been implicated. These have included socioeconomic status, maternal age, birth order, parental occupation, maternal medication and caffeine use, and even hypothermia in early pregnancy[4]. Furthermore, there is a 50-fold increased risk for recurrence of neural tube defects in subsequent pregnancies[15]. Nonetheless, the complex aetiology of neural tube defects appears to be substantially influenced by maternal diet[3]. Seminal work by Smithells et al[16] and Laurence et al[17] provided two of the first studies demonstrating conclusive links between poor maternal diet, specifically a deficiency of vitamin B9 (folic acid), and an increased neural tube defect incidence. Studies such as these, culminating in the randomised double-blind prevention trial of the Medical Research Council Vitamin Study Group[18], prompted government advice on the periconceptional use of folic acid[19]. Women of childbearing age were advised to take 400µg/day before and during early pregnancy; those with a family history of neural tube defects, 4mg/day.

Despite the common perception of folic acid being the panacea of neural tube defects and contemporary literature citing its undoubted benefits[3], others state that periconceptional use does not appear to have fulfilled its perceived potential. Decreasing neural tube defect incidence in England and Wales has been noted since the early 1970s, and folic acid supplementation has had no discernible impact on this downward trend[20]. A similar situation is described in both the USA and many, mainly western, European countries[2] although it may be possible to attribute these findings to nearly 50% of pregnancies being unplanned and lack of knowledge about the use of folic acid supplementation[2,20]. These findings led to universal fortification of the diet with folic acid in the USA, with some fall in neural tube defect incidence[2]. However, this measure was rejected in the UK over fears that it would mask vitamin B12 deficiency in the elderly[9]. Inborn maternal[3] and fetal[21] errors of folate metabolism have also acted to reduce the efficacy of folic acid supplementation.

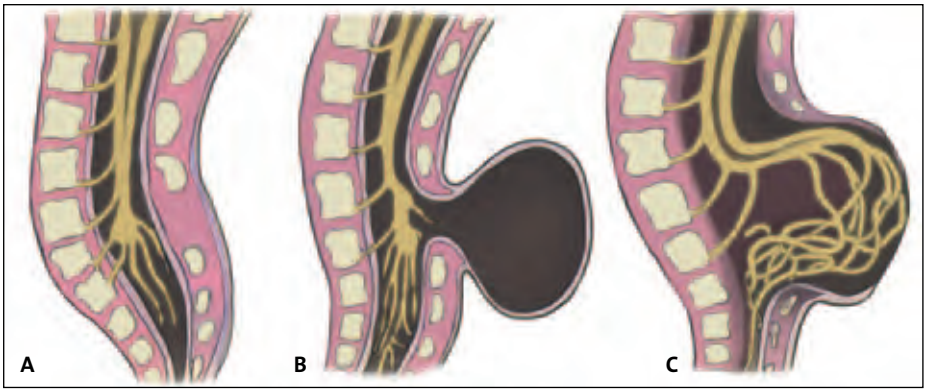

FIGURE 1 Three types of spina bifida. A) Spina bifida occulta; B) Meningocele; C) Myelomeningocele.

Antenatal screening

Concurrently, antenatal screening in the UK has improved dramatically, moving from reliance on low-quality ultrasonography and blood serum tests to indicate the possibility of neural tube defects with a wide regional variation in screening protocols[22], to high-quality cost-effective ultrasonography wielded by highly experienced health professionals[23]. A review of ultrasonography use in the UK reports a near 100% detection rate of anencephaly by week 14, and 66% detection rate for spina bifida in the same time scale[23]. Similar success rates have been reported in Wales[9]. In the USA, such improvement in antenatal screening over the past 30 years has also increased the prevalence of selective termination of affected pregnancies, further increasing the difficulty in determining the effectiveness of folate supplementation, as incidence is usually determined by the number of live births[2]. By comparison, studies found that between 1998-2009, while the incidence of spina bifida in Wales fell, determined by antenatal diagnosis, the number of affected live births rose, indicating an active choice to continue with affected pregnancies[24].

Impact on families

While antenatal screening for neural tube defects has significantly improved, there is a lack of input from those directly affected by such advances – the parents[25]. An Australian study explored the feelings and emotions experienced after antenatal diagnosis of a neural tube defect or hydrocephalus[25]. Portraying recognised patterns of grief and bereavement, these parents at once feel helplessness, disorientation and shock[26]. It was found that, despite determination to continue with the pregnancy, such feelings could persist for the duration of the pregnancy[25]. While admission to a neonatal unit is expected, the experience is stressful[27], and such feelings are only heightened in the milieu of the neonatal unit[28]. Consistent, empathetic support by neonatal staff can begin to provide appropriate support for these parents[29]. Alongside these initial stressors, parents must now also consider the implications of providing life-long care for a child who may have severe physical

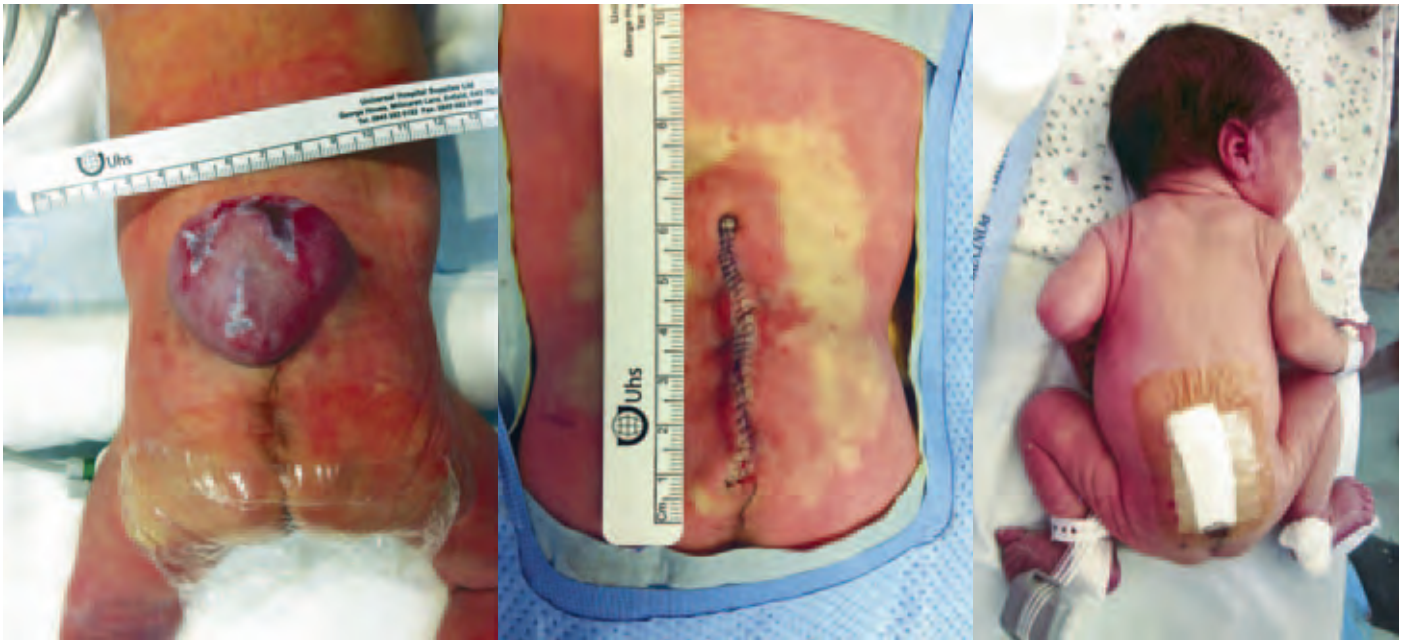

FIGURE 2 Corrective surgery for myelomeningocele.

and mental disabilities. Stressors on such families can lead to global psychological distress, including stress and depression, in both parents. Siblings suffer in a similar manner, also reporting great concern for the isolation of the affected child, and sadness that their sibling is not able to engage in physical activities. In contrast, affected families can also demonstrate great resilience and develop much stronger family bonds through this experience[30]. Formation of good therapeutic relationships with neonatal staff can pave the way for future health professionals, enabling them to improve the support of the family[31].

Perinatal management of neural tube defects

While the optimal mode of birth in antenatally diagnosed myelomeningocele is debatable[6,32], it was thought that myelomeningocele repair should occur soon after birth[33]. Such prompt intervention was thought to help reduce infection risks and preserve neural function. Once considered a surgical emergency requiring immediate attention, there is little evidence to support this viewpoint[6]. Stabilisation of the infant is more important and clinically this entails achieving stable and appropriate vital signs, ensuring adequate respiration, pulse rate and temperature, and usually including mean blood pressure[34]. While the infant is stabilised, it is vital that the lesion is examined, noting location and possible leakage of cerebrospinal fluid[32]. A thorough neurological examination is also useful, noting aspects such as spontaneous activity, extent of muscle weakness/paralysis, orthopaedic deformities – limbs or spinal, and the presence of hydrocephalus or Chiari II malformation[32]. A concurrent assessment for associated congenital anomalies, including cardiac and renal irregularities[32] will also improve subsequent care. Early proactive management of these anomalies can significantly improve future quality of life[35,36].

Nursing care and surgical correction of myelomeningocele

The main surgical goals in the repair of myeolomeningocele are the formation of the neural tube and skin closure[32]. There may also be attempts to repair the vertebral defect. In the preoperative period, there are four basic principles of nursing care to consider for affected neonates[33]. The first of these is the use of sterile techniques when caring for the defect, which is an open track for pathogens to the central nervous system. Second, is the prevention of hypothermia. While all neonates are at risk of hypothermia[37], the open defect may make thermal homeostasis more difficult to maintain. This difficulty arises because the skin covering of most myelomeningoceles is incomplete[38]. As such, unprotected internal structures are exposed to the environment, increasing radiant heat loss. Also, leaking cerebrospinal fluid will increase evaporative heat loss. Both of these factors will tend to cool the neonate, and may necessitate active management to maintain appropriate body temperature. The use of plastic wrap may reduce the impact of these routes on thermoregulation[32]. The third principle is to nurse the neonate prone, with the defect covered in saline moistened dressings. The exposed neural tissue is potentially functional, and so must be preserved[31]. These actions seek to preserve potential neural function by avoiding mechanical damage and desiccation of the exposed neural tissue[33]; plastic wrap can also improve the efficacy of the saline dressings[31].

Finally, avoiding the use of latex as these neonates are at increased risk of developing latex sensitivity[33]. Latex allergy incidence in these children can be as high as 25-65%, compared to 0.7% in unaffected children. It is direct latex contact with the meninges and mucosal membranes in early, frequent surgeries and procedures which is key to this prevalence[39]. Altered neuroimmune interactions may also predispose this population to latex sensitivity[38]. Hence, latex-free environments reduce sensitisation episodes and the subsequent risks of anaphylactic reactions. The use of broad-spectrum prophylactic antibiotics appears to be supported by a reduction in postoperative infection[32].

Building on antenatal counselling, parents should be prepared for imminent surgery. The possibility of immediate, intermediate and long-term complications should be discussed. These may include hydrocephalus[11], complications related to cerebrospinal fluid shunt placement[40],

neurogenic bladder[35], developmental delay[41] and orthopaedic difficulties that may include paraplegia or paraparesis[36].

A pioneering surgical option being explored to correct myelomeningocele is prenatal surgery[32,42]. Performed at around 26 weeks' gestational age, reports currently suggest some long-term benefits for the child. These include reduced need for cerebral spinal fluid diversion, reduced incidence of Chiari II malformation and improved motor outcome. However, the oldest patients are currently only 30 months old. Clinical experience suggests that similar results are seen in patients in receipt of postnatal repair, whose neurological function then deteriorates with age. It has yet to be seen if this occurs in prenatal surgical patients. Furthermore, it is highlighted that the procedure also carries significant risks for both the mother and fetus, including extreme preterm delivery, uterine dehiscence at delivery, and placental abruption. While this work is promising, it is acknowledged that further study is required to develop this into a viable treatment option.

Postsurgical care

Following postnatal myelomeningocele repair, many infants will develop some degree of ventriculomegaly[32]. This arises from imperfect cerebrospinal fluid circulation attempting to follow conduits that have not been established *in utero*[38], causing head circumference to increase at a rate greater than normal[32]. Assessment of ventriculomegaly and associated hydrocephalus can be made by serial ultrasound scans[32]. Combined clinical and radiographic assessment, including head circumference measurements, can be used to determine the need for cerebrospinal fluid diversion by means of a shunt[32]. Prompt action avoids issues of mortality and morbidity associated with long-term hydrocephalus[11]. However, infants with stable neurological status and stable or slowly increasing ventricular size, need only clinical assessment, with regular head circumference measurements and imaging studies[32]. This practice reduces the frequency of shunt placement and avoids its associated long-term complications[40].

Benchmarking with a number of UK level 3 neonatal units highlights a range of methods utilised for clinical neurological evaluation after myelomeningocele repair. These methods vary from the full Glasgow Coma Scale[43] to simple observations recorded in narrative form that may or may not include pupil reaction. In clinical experience, while the observations made can be useful, the impetus for recording postoperative neurological observations appears to arise more from routine practice rather than the needs of the neonate. A similar situation is described in an Australian study into drivers for postoperative observations[34]. While acknowledging the need for postoperative observations, it is emphasised that these need to be driven by the needs of the patient, using an evidence-based format[34].

It is necessary, therefore, to have an evidence-based assessment tool with which to make such clinical judgements. The use of a standardised assessment tool not only improves reliability of nursing records, but also increases the accuracy of notes that are traditionally written in narrative form[44]. Accurate and standardised evaluation is vital in the assessment of neonatal neurologic status, which must take into account not only the maturity of this rapidly developing system but also potential pathological changes[45]. However, national guidance on this issue is lacking. The National Institute for Health and Clinical Excellence (NICE)[46] only has guidelines for neurological assessment of infants and children who have suffered head trauma, but none for these age groups relating to neurological evaluation following neurosurgery. Furthermore, while tools for evaluating neurologic status in newborns exist, they tend to be detailed examinations requiring the baby to be held and moved, and so are more suited to discharge checks and prognosis of future neurological condition[45,47]. Additionally, while recognising neurological evaluation is important, the needs of the neonate as a whole must not be forgotten. Care delivery models can improve holistic nursing, including wound care[48]. This supports the observation that standardised tools improve the reliability and accuracy of nursing notes[44].

It is recognised that the life-long implications of neural tube defects are significant, both for surviving children and families. It appears that significant improvement can be made in public health arenas regarding the periconceptional use of folic acid. Increased public compliance with folic acid supplementation may reduce the incidence of neural tube defects still further. However, it is conceded that not all neural tube defects can be prevented in this manner. Hence, in partnership with improvements in postnatal surgical repair of myelomeningocele, it is suggested that developments are also encouraged in postoperative nursing care. The mainstay of this would be a standardised evidence-based tool that would support effective holistic evaluation of the neonate. With such care, it is hoped that the quality of life for affected children will be improved.

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Introducing the Innovating for Life Awards

Rewarding innovation and creativity within maternity and neonatal teams to improve the care of infants

Innovation lies at the heart of maternity and neonatal care.

Maternity and neonatal teams rely on research and evidence based creative thinking to advance care. Development of state-of-the-art equipment, pioneering techniques and progressive working practices help to improve care on a daily basis.

"It's great to see so many examples of innovation within the NHS."

Dr. Lynne Maher, Director for Innovation and Design, NHS Institute for Innovation and Improvement.

Who is eligible to enter the awards?

The *Innovating for Life Awards* are aimed at:

- Midwives and their full teams
- Neonatologists and their full teams including dietitians and paediatricians

Teams with both midwifery and neonatal roles should apply for the award that is most appropriate to their innovation and profession.

The winners will be contacted and displayed on the *Innovating for Life* website early next year.

Grants worth £20,000

The winner of each award will be presented with £10,000, to be used to develop a new initiative or to expand an existing innovation within their hospital practice.

Innovation in action

Innovation plays a huge role in maternity and neonatal care. We received some excellent entries to the first *Innovating for Life Awards* and were delighted to be able to announce the winners at a ceremony on 2nd March 2012 at the Royal Society, London.

Here are a few examples where creative thinking and practical applications can help to improve standards of maternity and neonatal care.

- Educating mothers about nutrition, sleep and hygiene needs of their babies through easy-to read factsheets, leaflets and interactive software
- New approaches to professional training
- Improving access for expectant mothers
- Educational tools
- Communication networks
- Working practices

If you have an idea or an existing programme that could be added to this list, the *Innovating for Life Awards* could help you take your project forward.

Last year's winner: Midwifery category
Mindfulness-Based Childbirth and Parenting Project
Lead applicant: Dr. Sian Warriner, Consultant Midwife, Midwifery Team, John Radcliffe Hospital, Oxford University Hospitals NHS Trust
The Mindfulness-Based Childbirth and Parenting (MBCP) project promotes mindfulness meditation during pregnancy, childbirth and the parenting relationship; and parenting education, family health and supportive peer relationships; to help address fear, pain, stress and depression. The aim is to equip expectant parents with specific skills to negotiate the transition to parenthood and decrease anxiety and depression during pregnancy and beyond.

Last year's winner: Neonatal category
Improving Neonatal Airway Management
Lead applicant: Dr. Richard Mupanemunda, Consultant Neonatologist, Birmingham Heartlands Hospital Neonatal Intensive Care Unit
A 4-step intervention project aimed at improving the management of infants with difficult neonatal airways. This will be through the development of an algorithm, an equipment kit, improved training and a neonatal clinical pathway.

"The Innovating for Life Award has provided us with the opportunity to extend our collaboration with Oxford University's Mindfulness Centre. Jointly we have now completed two Mindfulness-Based Childbirth and Parenting (MBCP) courses which the award helped to fund. These are the first MBCP classes to run in the UK and their evaluation will contribute to the evidence base for this intervention. We hope to demonstrate its benefit to pregnant women and their families."

Dr. Sian Warriner, Consultant Midwife at Oxford University Hospitals NHS Trust and winner of the Midwifery category of the 2012 Innovating for Life Awards

"Thank you for making our project a reality and giving us such a handsome amount to get the project off the ground! We are excited to be taking our airway project forward and look forward to the anticipated success of the project."

Dr. Richard Mupanemunda, Consultant Neonatologist at Birmingham Heartlands Hospital and winner of the Neonatal category of the 2012 Innovating for Life Awards

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Innovating for Life Awards

In association with inpractice Practical advice for healthcare professionals from Cow & Gate and infant

Judging panel

Entries to the *Innovating for Life Awards* will be judged by an expert panel of practicing midwifery, neonatal nursing and medical staff alongside representatives from editorial boards and medical affairs.

To enter the award online, find out more information and get the full terms and conditions visit www.innovatingforlife.co.uk

Terms and Conditions of Entry

1. Entries are open to professionals working in maternity and neonatal care individually or as members of a team.
2. Both awards are open to individuals and / or teams in the UK.
3. Entries should be made either by the individual or the team.
4. Each entry should be supported by a statement of no more than 1000 words, to include the following:
   - Background to the need for intervention and rationale
   - Proposed change / innovation / intervention
   - Methodology of implementation
   - Desired outcomes
   - Assessment and measurement of progress and success
   - Cost and resources
   - An explanation of how the individual / group would utilise the grant
5. For each entry, there should also be a supporting statement of no more than 300 words signed by the Head of Midwifery or Clinical Director verifying that the entrant has indeed achieved or shared the idea that is described in their submission. Applications should be supported by the unit and an academic institution where relevant.
6. Each submission will be judged by up to six judges.
7. Each category will have one winner.
8. Entries from teams/individuals closely associated with Infant journal or Cow & Gate, be that employee, spouse, close relative or regular contributor or columnist are welcome but please declare any conflict of interest.
9. **The closing date for entries in all categories is 31st December 2012.**
10. The decision of the judges is final and no correspondence can be entered into.
11. The same piece of work cannot be submitted into both categories.
12. The organisers reserve the right to reject an entry, if in their opinion it fails to comply with the rules and conditions.
13. The judging panel reserves the right to consult an independent expert if it needs to when deciding on winners.
14. No submitted entry material can be returned, including images, DVDs etc.
15. If an entry is received after the official closing date without prior approval, the organisers reserve the right to refuse the entry.
16. The organisers accept no responsibility for lost or damaged entries.
17. The organisers cannot guarantee that a winner will be awarded for every category. It will be at the discretion of the judging panel and dependent on the quality of submission.

How to enter

You can enter the *Innovating for Life Awards* using this application form or by visiting www.innovatingforlife.co.uk. The deadline for entries is the 31st December 2012 and winners will be announced on the website early next year.

If you have any questions please call 020 8971 6416.

Individual and / or all team members' names and job titles

_____

_____

_____

_____

_____

Please specify which award category you are entering: ☐ Neonatal care ☐ Maternity care

Contact Name _____ Contact Number _____

Contact Address _____

Email _____ Postcode _____

Your innovation please describe this on a separate page in no more than 1,000 words, including the following:

- Background on the need for intervention and rationale
- Proposed change/innovation/initiative/ intervention
- Methodology of implementation
- Outcome(s)/desired outcome(s)
- Assessment and measurement of progress and success
- Cost and resources
- An explanation of how you would use the £10,000 grant

The criteria by which the submissions will be judged include:

- The potential impact/value of your innovation
- Rigour of process/evidence
- Feasibility for adoption as a standard practice

Please include a supporting statement from your team Head of Midwifery or Clinical Director as evidence of your innovation or sharing of the idea described in your submission.

Additional evidence is optional. If you would like to include items, such as audit data, photos, DVDs, please send them with your entry.

Shortlisted entries may be asked to provide additional information if requested by the judging panel.

Please send your entry to the following address:
Innovating for Life Awards Say Communications, The Courtyard, 7 Francis Grove, London SW19 4DW

We would like to publish and share the best practice elements of winning and shortlisted entries. Please tick here if you agree to:

☐ Give us permission to use/share elements of your entry

☐ Write or present a case study at best practice meetings

Innovating for Life.

Measures to reduce infection in the neonatal intensive care unit

An increasing incidence of *Staphylococcus aureus* bacteraemia was identified by Stirling Royal Infirmary neonatal intensive care unit (NICU). In order to work towards the Scottish Patient Safety Programme (SPSP) targets, current policies regarding obtaining blood cultures or siting intravenous catheters were reviewed and changes implemented. Hand hygiene for staff and parents was further promoted. This culminated in the NICU reaching the SPSP targets with on-going success.

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Keywords

healthcare acquired infections; *Staphylococcus aureus*; skin decontamination; care bundles

Key points

Vallance A., Brown C. Measures to reduce infection in the neonatal intensive care unit. *Infant* 2012; 8(5): 150-154.

1. Current practice was reviewed against available evidence and changes initiated.
2. Education of staff and parents regarding infection control was paramount.
3. Care bundles were implemented to ensure compliance to new practices.
4. Auditing demonstrated a successful reduction in *Staphylococcus aureus* bacteraemia.

Healthcare-acquired infections (HAIs) are preventable and unacceptable. They contribute to significant patient morbidity and mortality, which prolongs hospital stay, increases antimicrobial use, and can be potentially fatal[1]. The neonatal intensive care unit (NICU) environment, with unplanned admissions of sick and or preterm infants, unpredictable workload and high incidence of invasive therapies, highlights the difficulties facing staff to ensure safe care. Nursing practice requires extreme vigilance and a structured approach[2,3]. Neonates are particularly vulnerable due to low birthweight, physiological immaturity and limited compensatory abilities[4]. Giving birth to a preterm or sick neonate is an extremely anxious time for parents. Their expectation is that their baby will have the best possible care in a safe healthcare environment. They have a right to expect that evidence-based guidelines are implemented and adhered to by all healthcare staff[5], consequently infection control policies in the NICU must be continually reviewed to encompass emerging robust evidence.

National objectives

The Scottish Patient Safety Programme (SPSP), co-ordinated by Health Improvement Scotland (HIS), set targets that all *Staphylococcus aureus* bacteraemia (SABs) should be reduced by 30% by 2010 with a further 15% reduction by 2011[6]. A specific target was to ensure a minimum of 300 days between episodes of SABs. As part of the Health Protection Scotland Healthcare Associated Infection surveillance programme, NHS boards were requested to produce 'triggers' for individual hospital wards – warning signs prompting investigation – to identify the problem of *Staphylococcus aureus* bloodstream infections at a local level, providing a clear understanding of the scale of any identified problem.

The authors were also keen to reduce the rate of coagulase negative Staphylococcus, a contaminant that can also cause bacteraemia.

Methods

To establish the current infection rate within the NICU, evidence was collected and distributed by the Forth Valley Infection Control Department. The hospital's laboratory staff determined frequency, percentage and identity of organisms isolated in blood cultures. The number of positive blood cultures was then compared with results from previous years. It became apparent that there was an increasing rate of SABs within the unit, increasing from 1.9% in 2008-2009 to 3% in 2009-2010.

The unit's aim

- Review the actual performance against agreed standards of practice.
- Raise awareness of infection control and improve practice.
- Reduce the SAB rate and achieve the 300-day target set by the SPSP.
- Secure and maintain any improvements made.
- Audit practice and outcomes regularly to ensure quality indicators are being met.

Essential steps for achieving goals

- Good planning.

- Teamwork and communication.
- Commitment from staff to work together to create a positive culture that promotes safety by instigating zero tolerance to unsafe practices.
- Utilisation of the experience and different strengths of staff, to draw on their knowledge and skills.
- Empowerment of staff to challenge poor practice. Adaptive decision-making and dynamic capabilities are considered important drivers of performance[7].
- Identification and management of patient-related risks; learning from these and implementing solutions to remove or minimise that risk.
- Dissemination of results to reinforce improved practice.

Any changes had to be sustainable, realistic and cost-effective. This involved consulting with management, clinicians, laboratory staff and the infection control department.

Reviewing performance

To ensure clinical services are of the highest possible quality, one of the National Health Service Quality Improvement Strategy's key priorities being taken forward by HIS is the support of clinical governance[8]. Unintended consequences of care – risks such as adverse incidents, clinical errors or near misses – can be reduced by the analysis and tackling of the root cause to prevent or minimise recurrence[9].

The working environment

A meeting was arranged between the nursing staff, unit management, the infection control department and the microbiologist. The resulting action plan included looking at the working environment. This involved taking 106 swabs from equipment, hand washing facilities and horizontal surfaces within the NICU. A variety of organisms colonise the environment and the hands of staff working in the NICU and in the course of working may be transmitted to and between infants and staff[10,11]. The environmental swabs did not identify a source of *Staphylococcus aureus*. The weekly routine surveillance of neonates within the NICU for meticillin resistant *Staphylococcus aureus* (MRSA) was extended to include meticillin sensitive *Staphylococcus aureus* (MSSA). Positive swabs initiated a paper trail to identify potential cross infection of incubators, but no pattern emerged to suggest this was an issue.

FIGURE 1 Using a light box and UV disclosing lotion to reveal areas of unwashed skin.

Equipment cleaning schedules

Equipment brought in to the unit from other areas (eg ECG machine) was cleaned with detergent wipes (Clinitex) before entering a nursery and maintained on the cleaning schedule of the visiting department. X-ray plates were inserted into disposable polythene bags before being placed under the baby. The cleaning schedules were reviewed for all ward equipment, eg IV pumps, procedure trolleys, computer keyboards etc[12].

Staff education

The orientation and development programme for new staff, deployed staff and bank staff was updated. The ward infection control link nurse and the microbiologist arranged for teaching sessions on *Staphylococcus aureus* infection to ensure a greater understanding of the problem. Over the past five years 50% of the staff from sisters to healthcare assistants had received training from the Cleanliness Champion programme[13]. Staff who had completed the Cleanliness Champion programme engaged in surveillance of available literature and commenced a peer review of hand washing technique. A core number of staff underwent further training to become hand wash trainers. From this, staff and parental education sessions were commenced for hand hygiene through demonstration of hand washing using the light box (**FIGURE 1**). This was received well by both staff and parents.

Hand hygiene

Effective hand hygiene is paramount in the control of infection. Hand-mediated, cross-transmission is a major contributing factor in the current infection threat to hospital in-patients. Serious life-threatening infections can arise when organisms are cross-transmitted onto susceptible sites, such as: intravascular cannulation sites, endotracheal tubes during pulmonary ventilation and enteral feeding systems. Cross-transmission to non-vulnerable sites can still leave a patient colonised with more pathogenic and resistant hospital organisms[12]. Effective hand decontamination results in significant reductions in the carriage of potential pathogens[14,15]. The neonatal unit has taken an active part in promoting good hand hygiene in staff, visitors and parents alike.

Procedures performed on patients

Any invasive procedure, which bypasses the baby's natural defences, provides a means of potential contamination, as in the case of IV therapy. It is estimated that approximately 89% of all hospital admissions receive some type of IV therapy as part of their treatment regimen. Infection is one of the highest reported problems. An aseptic technique should be adhered to throughout all IV procedures[16].

The current procedure for obtaining blood cultures was reviewed, which highlighted the need for a change in practice. Blood cultures were obtained using a clean procedure with aqueous chlorhexidine 0.05% (Hibisol) as the skin decontamination product; research identified this as an ineffective solution[17]. All of the infection control policies were reviewed.

Advanced neonatal nurse practitioners (ANNPs) reviewed policies for the insertion of peripheral venous cannulae and peripherally inserted long lines (PICC). Nursing staff assessed the preparation and administration of IV drugs.

Improvements in practice

The potential consequences of catheter-related infections are so serious, eg septic arthritis, osteomyelitis, endocarditis, deep seated abscess; that enhanced efforts are required to reduce the risk of infection to the absolute minimum[18]. Quality improvement initiatives suggest that 'bundles of care' result in significant and sustained decreases in catheter-related bloodstream infections[19].

A care bundle is a number of clinical interventions that every neonate should receive collectively during one clinical episode of care. Work commenced on developing a peripheral vascular care (PVC) bundle for use with neonates by adapting the adult PVC bundle (**FIGURE 2**). Cannulae are noted if *in situ* >72hr, but not removed.

Skin decontamination policy review

The Rapid Review Panel (RRP) makes recommendations to provide a prompt assessment on new and novel equipment, materials and other products that may be of value to the NHS in improving hospital infection control and reducing HAIs. In 2007 the RRP awarded its highest recommendation (Recommendation 1) for use of ChloraPrep (2% chlorhexidine and 70% alcohol), a sterile, single-patient-use, skin antiseptic that works through a dual mode of action, both denaturing microbial proteins and disrupting cell membranes. It has an immediate onset of bacterial action and prolonged antimicrobial efficacy. It is recommended for skin decontamination and complies with the infection control guidelines of many organisations[20-23].

The literature on the skin effects of chlorhexidine in neonates is very limited. The premature infant has a poor epidermal barrier with few cornified layers and is at risk of increased permeability to exogenous materials, additional skin compromise, delayed barrier maturation and infection. The dermis is deficient in structural proteins and the skin is easily torn. Alcohol-based preparations, including chlorhexidine in 70% isopropanol, have been reported to cause burns in infants of 24-26 weeks' gestation[24]. The Center for Disease Control and Prevention (CDC) guideline recommends skin disinfection with 2% chlorhexidine gluconate, tincture of iodine, an iodophor or 70% alcohol for adults and older paediatric patients, but states that no recommendation can be made for infants less than two months of age because of limited evidence or lack of consensus[18]. Skin effects of chlorhexidine were examined in parallel groups of 715 NICU patients with central venous catheters. The application of 2% chlorhexidine in 70% isopropanol to the PICC site did not visibly increase erythema, suggesting the absence of an immediate inflammatory response[25,26]. Great Ormond Street has used ChloraPrep since December 2010 for skin preparation in all neonates[27]. The Cincinnati Children's Hospital Medical Centre (Regional Centre for Newborn Intensive Care) implemented the use of chlorhexidine in place of povidone-iodine in the NICU in 2004 and found a significant reduction in bloodstream infections from 3.6 to 0.7 per 1000 catheter days[26].

PVC Cannula insertion bundle Completed after insertion	
Date inserted	
Inserted by	
Size/colour	
Level 2 hand wash	
Sterile gloves worn	
Skin cleansed with ChloraPrep	
Venflon secured	
Tegaderm dressing	

PVC Maintenance bundle Completed daily	
Dressing intact	Yes/No
Inflammation or extravasations	Yes/No
In situ <72 hours	Yes/No
Cannula still in use	Yes/No
Cannula: removed	Yes/No

FIGURE 2 PVC for use with neonates.

Colonisation of catheter hubs

Colonisation is recognised as a risk factor contributing to the increasing infection rate associated with central venous catheter use[28]. Limiting catheter access and manipulations may decrease catheter related bloodstream infections (CRBSI) as evidence suggests that frequent manipulations increase the risk for microbial contamination[12,29,30]. Micro-organisms colonising catheter hubs and the skin surrounding the insertion sites of vascular devices then migrate intraluminally and reach the distal tip in the bloodstream[1,17,28]. The organism produces a "slime layer" that acts as glue adhering it to plastic devices and also causes resistance to phagocytes and some antibiotics. Impaired diffusion of antibiotics makes it difficult to effectively clear this type of infection. The most common treatment for these infections is to remove or replace the IV catheter[1,17]. Methods to reduce possible contamination and colonisation of indwelling catheters and access ports were reviewed. Clinell wipes, containing chlorhexidine gluconate BP 2% and isopropyl alcohol 70%, were developed as a response to the recommendations in the Epic 2 and Saving Lives guidelines[28,29,30]. A fall in bloodstream infections followed a change to 2% chlorhexidine and 70% alcohol wipes for catheter connections in a haemopoietic stem cell transplant ward[33]. Prolonged contact with the wipe and the use of friction was found to be effective in disinfecting needle-free devices[34]. Needle-free devices themselves reduce possible contamination and colonisation of indwelling catheters and access ports. These devices work on the principle that providing closure to the catheter hub reduces the risk of infection[35].

- Uptake of the hospital Cleanliness Champion programme which led to a core group of staff becoming hand wash trainers for staff, parents and visitors.
- Introducing teaching sessions for staff on *Staphylococcus aureus*.
- PVC bundles implemented.
- ChloraPrep for skin decontamination. For extreme preterm neonates residue is rinsed off with sterile water.
- Clinell wipes for cleansing of indwelling catheter access ports.
- Use of needleless devices.
- Improvement in line securement with the use of DuoDERM; the line is then enclosed using a Tegaderm dressing.
- Improved ward equipment cleaning schedules.
- Supplemental cleaning schedules by visiting staff on out-of-departmental equipment.

TABLE 1 Summary of implemented changes.

Central line securement

In a six-year study looking at limiting catheter complications, DuoDERM was used as a base layer for the catheter dressing. This provided a protective barrier between delicate skin and the catheter, reducing potential irritation by providing a stable surface to secure the catheter and preventing catheter movement. A catheter that is mobile can slide in and out of the insertion site; drawing organisms that colonise the skin into the catheter tract and eventually toward the catheter tip[29]. Catheter contact with the skin surface increases the chance of organisms migrating to the bloodstream along the catheter tract. Placing a sterile barrier between the infant's skin and the exposed catheter potentially decreases the chance of catheter-related sepsis due to skin flora[29]. For a summary of implemented changes see **TABLE 1.**

Period	Number of positive blood cultures	Percentage of positive blood cultures
Coagulase negative Staphylococcus		
2008-2009	14	5.2
2009-2010	14	5.1
2010-2011	6	2.1
2011-2012	5	**1.9**
***Staphylococcus aureus* bacteraemia**		
2008-2009	5	1.9
2009-2010	8	3
2010-2011	2	0.7
2011-2012	0	**0**

TABLE 2 Organisms isolated in positive blood cultures.

Results

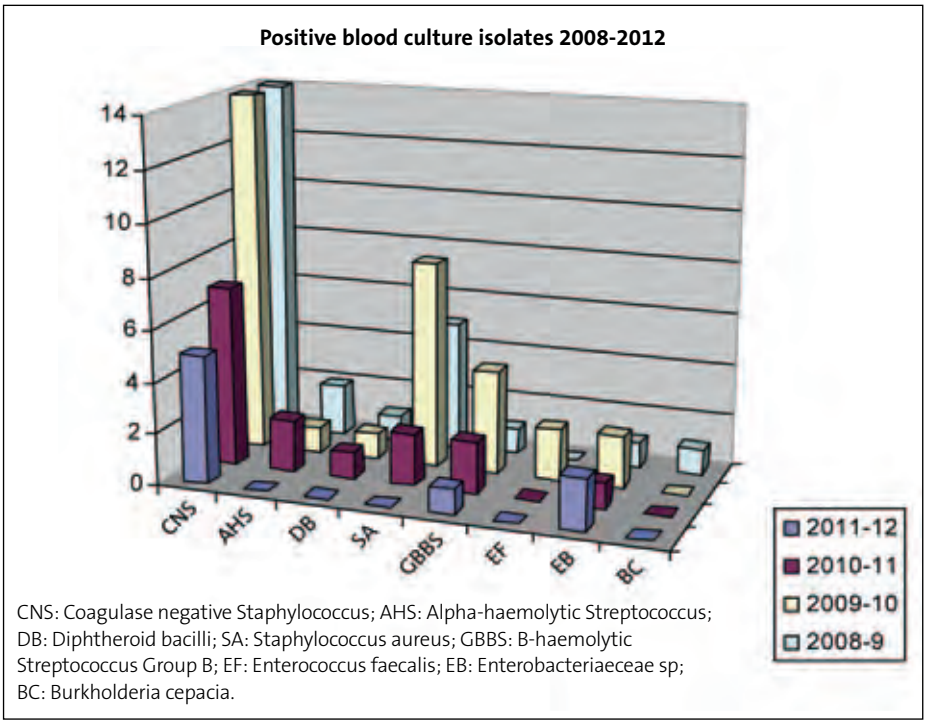
It is important to point out that the NICU moved from Stirling Royal Infirmary to the newly built Forth Valley Royal Hospital on 12th July 2011 and by that date had achieved 408 SAB-free days. At the time of writing (23rd March 2012) there had been no SAB in the NICU for 734 days (**TABLE 2**). The numbers of different bacteria colonised in blood cultures is displayed in **FIGURE 3** and the total number of positive blood cultures is demonstrated in **FIGURE 4**.

Conclusions

Premature and ill infants have an increased susceptibility to sepsis and subtle non-specific initial presentations. They therefore require extreme vigilance so that sepsis can be effectively identified and treated. To provide this there needs to be appropriate training to maintain key skills and competencies and to maintain standards. This enables staff to provide an environment dedicated to patient safety by maximising the team's effectiveness and function; encouraging a culture where quality and safety in the delivery of care can flourish and promote best practice.

HAIs are unacceptable. Looking at positive blood cultures identified infection rates within the neonatal unit. Current practice within the unit needed to be reviewed in order to improve infection control. Teaching programmes on SAB and hand washing were launched.

After reviewing the results of available research, it was decided in May 2010 that the unit would change to ChloraPrep for use in skin decontamination. Since using the neonatal unit's policy for ChloraPrep



CNS: Coagulase negative Staphylococcus; AHS: Alpha-haemolytic Streptococcus; DB: Diphtheroid bacilli; SA: Staphylococcus aureus; GBBS: B-haemolytic Streptococcus Group B; EF: Enterococcus faecalis; EB: Enterobacteriaceae sp; BC: Burkholderia cepacia.

FIGURE 3 Organisms isolated in blood cultures over four years, 2008-2012.

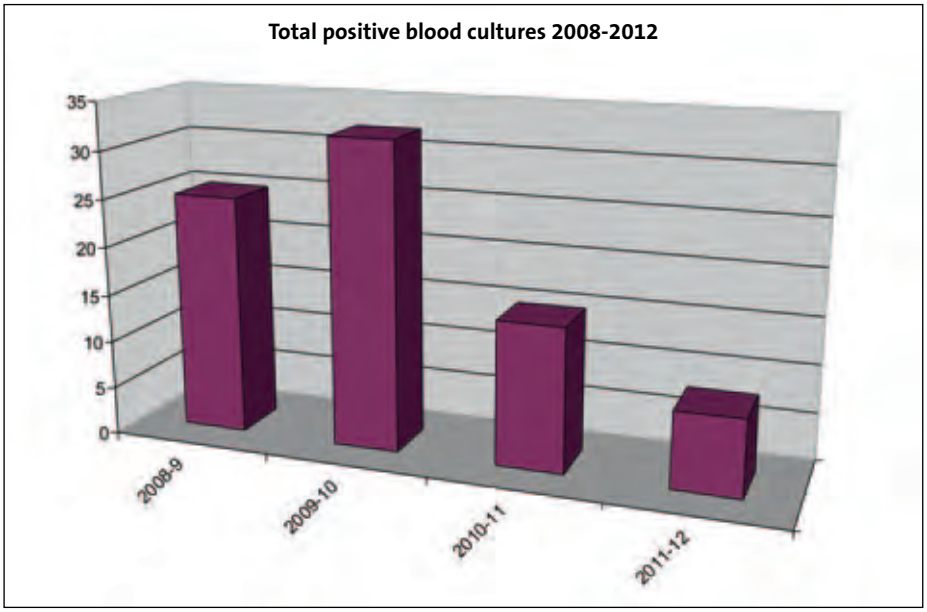


FIGURE 4 Total number of positive blood cultures over four years, 2008-2012.

application there have been no skin problems on any of the neonates. The use of Clinell wipes was introduced as a means of decontamination of access ports before every interruption to all indwelling catheters and the decontamination of all drug and/or fluid vials. The implementation of DuoDERM as a base layer for PICC catheter dressings to reduce possible movement of the catheter was introduced.

PVC bundle and hand hygiene audits reassure that practice continues at the expected level.

There must be continual monitoring of the quality of the service in order to safeguard high standards of care, through clinical governance and risk management to provide measurable improvements in the aspects of quality of care. The hospital infection control department continues to use the triggers throughout the hospital and provides wards with details of infection identified.

Through the simple application of changes to current practice, there has been significant benefit to the babies within NICU and this has been rewarding for all concerned. The unit has achieved a direct and positive impact on infection control. The aim to achieve a 30% reduction in

SAB and a minimum of 300 days between episodes has been achieved. Surveillance of the literature should continue to inform revisions of policies encompassing the continually evolving evidence base. The NICU staff at Forth Valley Royal Hospital will continue their commitment to patient safety and the avoidance of infection. This provision of high quality care will be achieved and maintained by effective use of evidenced-based practice, delivered in a safe environment where infection control is paramount.

Acknowledgements

The authors would like to thank Linda Hannah, Lesley Menczykowski, Carol Scott and Wendy Moncrieff and the Infection Control team for their data and advice, in particular Sara Jamdar and Mike Williamson.

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Implementation of standard concentration medication infusions for preterm infants

Medication safety remains a challenge in the neonatal intensive care unit (NICU). The use of standard concentration medication solutions aims to reduce the risk associated with delivering 24-hour continuous IV infusions to this vulnerable population. This paper describes a quality improvement project to implement and measure the reliability of using standard concentration 24-hour medication protocols for dopamine and dobutamine undertaken in an Australian NICU.

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Keywords

infant; infusions; intravenous; medication safety; patient safety; performance improvement; quality improvement

Key points

Christie-Taylor S.A., Tait P.A.
Implementation of standard concentration medication infusions for preterm infants.
Infant 2012; 8(5): 155-159.

1. Standard concentration 24-hour medication infusions allow a fixed number of concentrations for each medication, making the checking process easier, reducing the risk of error and providing the potential for pre-mixed solutions.
2. Three standard concentration solutions for each medication provide for the diverse weight range, medication dose and fluid requirements of infants, improving the compliance with medication protocols.
3. Multidisciplinary collaboration and feedback enhanced acceptance of change to standard concentration solutions.

In the NICU, many high-risk medications – those that have a heightened risk of causing significant harm when used in error[1], such as dopamine and dobutamine – are delivered by 24-hour continuous IV infusions. The process of prescribing, preparing and administering medications to infants offers many opportunities for error[2]. Mistakes in the delivery of medications are potentially life-threatening to the infant, costly to the health system and take a personal toll on all staff[3-5]. Errors relating to 24-hour medication infusions are three times more likely in the paediatric and neonatal populations than in adults, as both prescribing and administering are more complex[6,7].

Existing practice in the authors' NICU used an infant's weight to determine the amount of medication to be added to each medication syringe, when preparing 24-hour medication infusions. Preparing each infant's medication syringe as a unique concentration resulted in the initial infusion rate being equal for all infants, regardless of their weight. This method is known as the rule-of-six[8,9] and is calculated as follows:

6 x patient weight (kg) equals the amount of medication that should be diluted in 100mL of compatible fluid. The infusion volume in millilitres per hour (mL/hour) will then equal the dose (µg/kg/minute) ordered.

Designed for the emergency setting, the rule-of-six enables staff to quickly prepare 24-hour medication infusions. When prepared according to the protocol, the starting infusion rate is linked with a specific dose (µg/kg/min), regardless of the infant's weight.

A number of safety measures were included within each medication protocol to supplement the mandatory double check procedure required by staff. This included a table within each protocol that described the corresponding volume of medication to be added to the syringe for a selection of infant weights within a range for the corresponding starting dose. This guided staff through the process of prescribing, preparing and administering medications by acting as a reference point when checking their own calculations.

Background

A significant incident involving the delivery of a 24-hour medication infusion in the NICU triggered a review of the infusion process. A retrospective audit of 24-hour medication infusions delivered to 40 infants (weight range 0.41-4.11kg) was conducted. It demonstrated that while all infants received the correct dose, only 4.2% (five out of 117) of the syringe concentrations prescribed matched the concentration recommended within the ward protocol. This poor compliance between the prescriptions and the protocol clearly showed that the existing protocol (using the rule-of-six method) was not meeting the needs of the infants.

Discussions with the nursing staff revealed that they were not comfortable with the extra level of calculation required to ensure that the dose they were preparing and administering was correct. A number of the nurses in the NICU grappled with the checking process as the tables within each protocol, designed to support the checking procedure, were no longer relevant for the infant within their care, due to the departure from the ward prescribing protocol.

Identifying the need for change

A multidisciplinary team (MDT) of nurses, midwives, neonatologists and a pharmacist was formed to review this multifaceted process. The team initially mapped out each step in the delivery of a 24-hour medication infusion as a flow diagram (**FIGURE 1**). From here, the team listed the factors contributing to variability in practice for each step when using the rule-of-six method. These contributing factors were then prioritised to 10 key issues (**TABLE 1**). Half (five out of 10) of these contributing factors were related to the existing neonatal medication protocol. It was clear that, while many of the initial medication orders complied with the protocol, commonly encountered issues such as fluid restriction and the need for dose escalation meant that the concentration of medication within each syringe was often different to that recommended.

The MDT acknowledged that while some variation from protocol should be expected, this should be the exception rather than the rule. A review was undertaken to investigate the method by which 24-hour medication solutions were prepared.

In reviewing the literature on safety and quality, the use of standard concentration medication infusions was flagged as an alternate model in the delivery of these high-risk medications in the paediatric population. The Australian Medication Safety Self Assessment (MSSA) recommends the use of standard concentration medication solutions where possible[10]. In addition, the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) in the USA has mandated the elimination of the rule-of-six method and promoted the use of standardised medication concentrations for all paediatric patients[11-13].

While it was clear that the use of the rule-of-six method was not meeting the needs of this patient population, there was uncertainty from both medical and nursing groups in changing from such a firmly entrenched process.

The MDT agreed to review the process of delivering two commonly used 24-hour medication infusions (dopamine and dobutamine) as a direct observation quality improvement project. These medications were chosen for the project, as they were the most commonly prescribed 24-hour infusions within the unit. This also meant that results of the change in practice would be immediately evident. The intention was to incorporate standard concentration protocols for each of these medications and measure the compliance. Any problems could then be dealt with prior to the implementation of standard concentrations for all 24-hour medication infusions prescribed for infants in the NICU. This stepwise approach would also give all staff confidence in the process before it was rolled out to the range of protocols used within the NICU.

Taking into account the diverse weight range of this population (0.4-4kg) and the restricted rates of infusion (between 0.2mL/hr and 1mL/hr), two standard concentrations were selected by the MDT for each medication. The two concentrations selected for dopamine were 0.8mg/mL and 3.2mg/mL. This involved adding 0.5mL and 2mL respectively from a 40mg/mL dopamine solution, to make a total volume of 25mL, using the appropriate compatible fluid.

The two standard concentrations selected for dobutamine were 1mg/mL and 3mg/mL. This involved adding 2mL and 6mL respectively from the 12.5mg/mL dobutamine solution, to make a total volume of 25mL, using the appropriate compatible fluid.

The total infusion volume of 25mL was selected to ensure that, even at maximum infusion rate, the syringe did not require changing within 24 hours. Ideally identical concentrations for each medication would have been used but this would have required drawing impractical volumes of medication from the ampoule to prepare each of the standard concentration solutions.

Once two standard concentrations were selected, the pharmacist, in collaboration with medical and nursing staff, developed new protocols. The new protocols incorporated:

- A visual matrix for each concentration to assist medical and nursing staff determine the appropriate concentration for various weight ranges.
- Specific instructions to medical staff on how to write each prescription in a

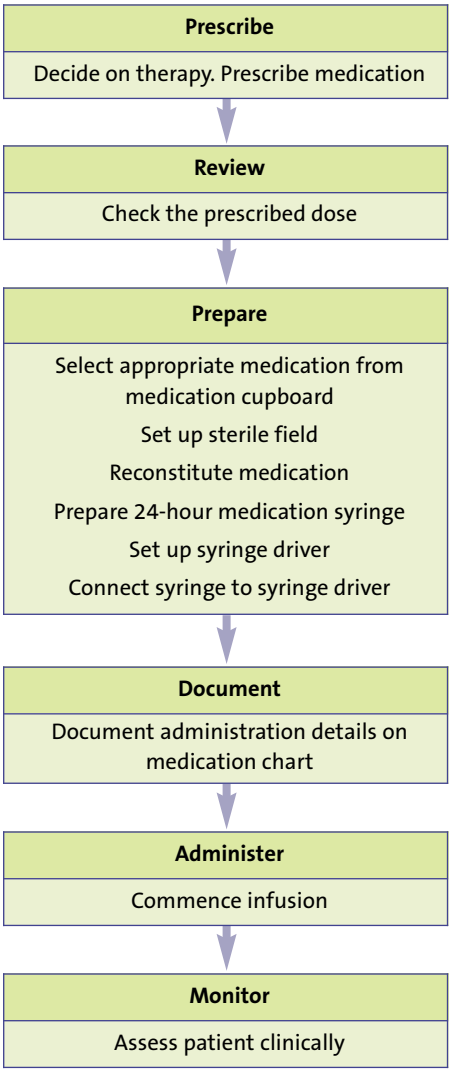

FIGURE 1 Flow diagram: steps to deliver 24-hour medication infusions.

1. Each patient has an individualised concentration medication syringe.*
2. Difficulty in finding a second person with the appropriate skill level to check calculations.
3. Necessity to search through multiple areas for the appropriate equipment.
4. Medication ordered in different styles and with different levels of legibility.
5. Many distractions in a busy ward environment.
6. Double dilutions are required for some medications.*
7. Final syringe volume varies with different medicines.*
8. Need to change medication order regularly due to both fluid restrictions and the delivery of high doses.*
9. Adjustment of infusion rates to keep within daily fluid allowance.*
10. Varying experience in checking medication doses.

TABLE 1 Top 10 factors contributing to variability in practice for the prescribing, preparing and administration of 24-hour medication infusions. **Factors associated with medication protocol.*

standardised format.
- Specific instructions for nurses on how to prepare each concentration from the original ampoule.
- Formulae to support staff in calculating both the rate of fluid to be administered to deliver a desired dose, and the dose administered when the infusion is run at a known rate.
- Internationally recognised Tall Man lettering (see below).

Aim of the project

The aim was to safely implement standard concentration medication solutions within the NICU and support staff through the change process.

Methods

Design

This was a quality improvement project using the Plan-Do-Study-Act (PDSA) methodology[14]. It involved undertaking small rapid cycles of quality improvement using the PDSA model, utilising data to measure change and effect and responding in real time to any problems that the MDT team observed.

Setting

All observations were made in the NICU of a large 308-bed teaching hospital. The NICU is a level 3 unit, providing 24-hour care to approximately 260 patients a year with a maximum capacity of 14 intensive care cots.

Data collection

Details of all prescriptions were recorded daily including: the infant's weight, medication name, infusion concentration and rate of infusion delivery. Data collection for the first four weeks was based on using the rule-of-six protocols for both medications (pre-implementation). Data collection from weeks 5 to 12 weeks was based on the standard concentration 24-hour medication protocols (post-implementation). These data were used to demonstrate change in compliance rates with the change in protocol to all ward staff from week 5 (see below).

Medication protocols

From week 5, the new standard concentration protocols for each medication were published on the hospital intranet. Copies of the protocol were printed for all infants currently receiving either medication. All infants on either medication had new prescriptions written to match the updated protocol and a reference sheet was provided for each cot space. This reference sheet (**FIGURE 2**) described the two standard concentrations available, instructions on how to prepare them and formulae to calculate the dose they were providing.

Education campaign

The education campaign for medical, nursing, midwifery and pharmacy staff also involved regular in-services and update posters. This continued throughout the study period and provided opportunities for all staff to see the progress, as well as opportunities to offer feedback on the new process.

Data analysis

Each observation was transcribed and entered into a spread sheet. The number of syringes prepared for both medications was recorded. Each medication infusion was assessed against the current protocol. Compliance with the protocol was calculated using the number of times one of the two standard concentrations, as advised by the protocol, was used over the number of prescribed orders for each medication. The data were graphed on a weekly basis for each medication and displayed on the ward for all staff to see, as part of the ongoing education campaign. The compliance results for the pre-implementation and post-implementation periods were compared using the chi-square test.

Adjustments to protocol

As part of the PDSA methodology, at the end of each week, a nurse, neonatologist and pharmacist would review the compliance against each medication protocol and adjust the relevant protocol as necessary. Data continued to be recorded and reported for 12 consecutive weeks. This information was regularly fed back to the staff through the ongoing education programme.

Results

A total of 58, 24-hour infusions were prepared for both medications throughout the study period: an average of 4.8 (±2.7) medication infusions prepared per week.

Seventeen infusions were made during the pre-implementation period (using the

DOBUTamine	1mg/mL strength (1000μg/mL) Suits neonates ≤2kg
Add 2mL of DOBUTamine 12.5mg/mL to 23mL of compatible fluid = Total 25 mL	
Start at 5μg/kg/min	
DOBUTamine	3mg/mL strength (3000μg/mL) Suits neonates >2kg
Add 6mL of DOBUTamine 12.5mg/mL to 19mL of compatible fluid = Total 25 mL	
Start at 5μg/kg/min	
DOPamine	0.8mg/mL strength (800μg/mL) Suits neonates ≤2kg
Add 0.5mL of DOPamine 40mg/mL to 24.5mL of compatible fluid = Total 25mL	
Start at 5μg/kg/min	
DOPamine	3.2mg/mL strength (3200μg/mL) Suits neonates >2kg
Add 2mL of DOPamine 40mg/mL to 23mL of compatible fluid = Total 25mL	
Start at 5μg/kg/min	
To calculate infusion rate (mL/hr): $\text{Rate (mL/hr)} = \frac{60 \times \text{dose (μg/kg/min)} \times \text{weight (kg)}}{\text{Strength (μg/mL)}}$	To calculate the dose (μg/kg/min): $\text{Dose (μg/kg/min)} = \frac{\text{Rate (mL/hr)} \times \text{strength (μg/mL)}}{60 \times \text{weight (kg)}}$

FIGURE 2 Reference sheet used in the first iteration of PDSA cycle.

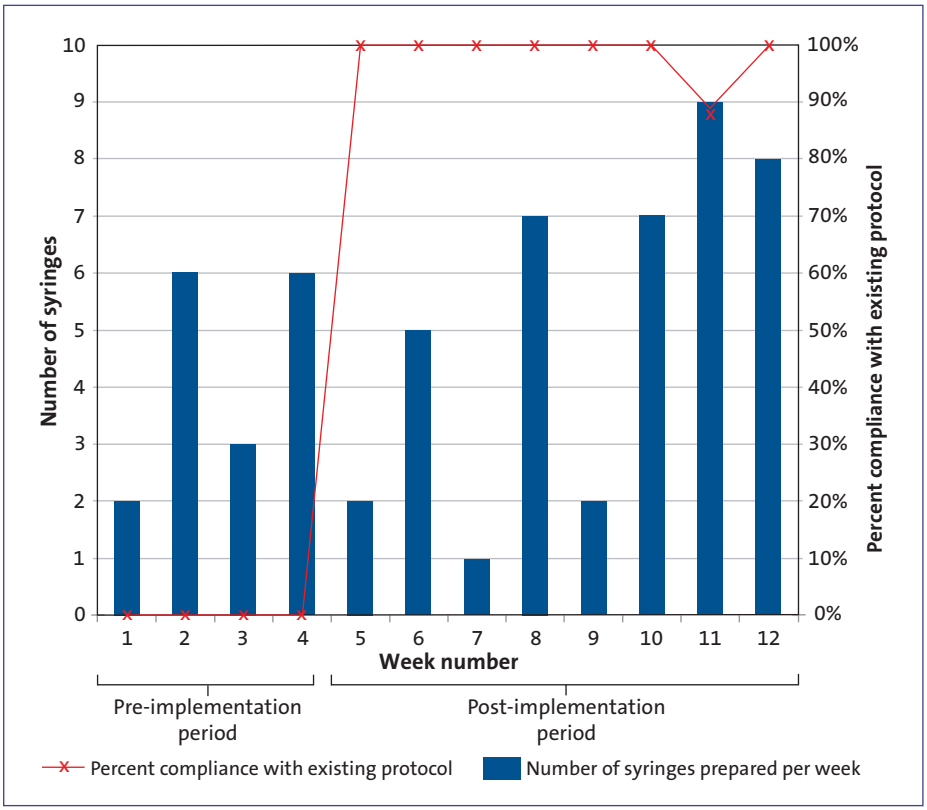

FIGURE 3 Percent compliance with existing protocol.

rule-of-six method). None of these infusions was compliant for both medications (**FIGURE 3**).

Forty-one 24-hour infusions were prepared during the post-implementation period using the standard concentration protocols for both medications. During the post-implementation period, all dopamine and dobutamine 24-hour medication infusions were compliant with the standard concentration protocol from weeks 5-10. At week 11, a dopamine syringe was prepared at a non-standard strength. This was for a term infant with gross fluid restriction. The MDT reviewing the standard concentration solution protocols concluded that a third solution was required for each medication. This was to accommodate for critically ill term infants. This was in accordance with the PDSA model that was used.

New concentrations were selected for each medication. The three concentrations selected for dopamine were 0.8mg/mL, 1.6mg/mL and 3.2mg/mL and the new standard concentrations for dobutamine were 1mg/mL, 2mg/mL and 4mg/mL. The on-line protocols were updated (including the reference sheet) and implemented immediately, while communicating the changes to all ward staff.

At week 12, the compliance with the standard strength protocol returned to 100%.

Comparing the compliance results between the pre-implementation (zero out of 17) and post-implementation (40 out of 41) periods, there was a statistically significant improvement with the introduction of standard concentration 24-hour solutions from week 5 ($p<0.05$).

Discussion

The change process was based on Clinical Practice Improvement (CPI) methodology[15], which provides a framework with which to put published evidence into clinical practice. It recognises that research does not translate identically across different healthcare institutions. Through CPI methodology, evidence of a problem was gathered, the individual steps that contributed to the medication use process were identified and factors contributing to variability in practice were discussed and prioritised. In focussing on the contributing factors, the team concentrated on the system rather than apportioning blame to any individual or professional group. The PDSA cycle[10] ensured that all changes to the system were carefully and safely monitored and reported throughout the process, to further enhance the intervention and ensure that all staff could observe the reasons for change.

The success of this change in practice relied on a multidisciplinary approach. Through teamwork, a range of risks inherent in the existing process was identified from a number of points of view. Using a quantitative approach to prioritise these risks, interdisciplinary engagement was promoted in the change process.

Some resistance to change had to be overcome. The existing practice had been in place for many years. The reported rate of incidents with the existing process was low, which resulted in, what has been described as, an illusion of safety[16]. Ongoing education, incorporating discussion and feedback, encouraged a sense of ownership, enabling the improvements in practice; it was paramount to the success of this practice change.

Mapping out the process of delivering 24-hour medication infusions to infants, highlighted the number of steps required as well as the dependencies each had on the previous step.

It is suggested that a complex system (such as the delivery of 24-hour medication infusions) is protected from error by a series of safety nets[17]. These safety nets may be physical, functional, symbolic or incorporeal[18]. The medication protocols are an example of a safety net in place to support staff through a process. It was clear from this review that the existing protocol did not meet the needs of this vulnerable population.

In measuring the compliance with the protocol, the MDT learnt that in all cases where the rule-of-six was used, the prescriber departed from the clinical protocol at the *prescribe* step (**FIGURE 1**). In order to deliver the appropriate dose in less fluid, the medication syringes were prescribed in greater concentrations than recommended by the protocol. This left the steps that followed prescribing, including review, prepare, document and administer, to be carried out independently from the protocol, thus removing an important safety net. While there were many options to how this problem could be addressed, the use of standard concentration solutions has improved compliance with the protocol. This has resulted in all staff being able to reliably check directly against the medication protocol at all steps of the process (from prescribe to administer).

The significant difference between the old and the new method is that, when the dose of medication is increased, the prescriber may either increase the infusion rate or make a decision to use an alternate infusion concentration using one of the

three options available, thus providing all staff performing the steps that follow with standard written guidance.

The development of the new medication protocols provided an opportunity to incorporate Tall Man lettering to distinguish medications with similar names. Integrated within the medication name, Tall Man lettering uses uppercase letters to highlight the differences between two similarly spelt medications, for example DOBUTamine and DOPamine. Studies have shown that fewer mistakes are made, in both medication dispensing and administration, when Tall Man lettering is used[19]. The Australian Commission on Safety and Quality in Health Care[20] as well as the Institute for Safe Medication Practices[21] have published a list of recommendations for the use of Tall Man lettering.

The success of this project has supported expansion of standard concentration solutions to other medication protocols including fentanyl, insulin and alprostadil. It has also encouraged dialogue with other neonatal units across the state (including neonatal retrieval services) to develop regional medication protocols, in the support of safer medication management for infants retrieved from regional centres.

When using the rule-of-six method, multiple concentrations of each medication were required to meet the needs of all infants within the nursery. Therefore nurses had to prepare all syringes for 24-hour medication infusions in the ward environment, immediately before use. The development of three standard concentrations for each medication has opened the opportunity for the pharmacy department to prepare standard concentration syringes in batch quantities, in advance, for storage on the NICU. This will facilitate more timely administration of medications to an infant.

Conclusion

The literature on safety and quality, has flagged the use of standard concentration medication infusions as one model for the safe delivery of medications in paediatrics. This project has demonstrated that, with sensible selection of standard concentration medication solutions, this model can be integrated within the NICU. In doing so, the protocol is more reliably used at all points of the process, improving the safety net to support staff in the safe delivery of high-risk medications within the NICU.

Standard concentration solutions have streamlined the whole process of delivering high-risk medications, making it easier for medical, nursing and pharmacy staff in the NICU, thus contributing to a safer system.

This experience in changing to standard concentration solutions can be used in any area that uses medication infusions for the stabilisation or treatment of critically ill infants or children, including other paediatric intensive care units and retrieval services.

Acknowledgements

The authors are particularly grateful to Dr Andrew McPhee for his encouragement and collaboration.

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Need to improve communication with mothers of critically ill infants

Research from the Johns Hopkins Children's Center, published in the *Journal of Perinatology*, studying communication between mothers of critically ill newborns and the clinicians caring for them, found that miscommunication was common. The most serious breakdown in communication occurred when mothers and clinicians discussed the severity of the baby's condition.

The consequences of a communication breakdown, the researchers say, can be serious, hampering critical short-term and long-term treatment decisions and aggravating already high levels of parental stress, a situation often compounded by the new mother's own fragile medical state. The survey of 101 clinician-mother pairs showed that most clinicians (89%) and mothers (92%) described their conversations as productive, but when the investigators looked at the actual survey results they noticed a notable gap between maternal and clinician perceptions about the severity of a baby's disease.

Nearly all mothers could name at least one of their child's diagnoses and treatments, yet nearly half of the mothers disagreed with the clinicians' assessment of the severity of their baby's illness. Of these, 63% believed the child was less sick than the clinician had indicated. Even mothers of children with serious or life-threatening conditions such as sepsis, extreme prematurity or bladder exstrophy minimised the severity of the disease and described their babies as "not sick," "somewhat sick" or "pretty healthy". The investigators recommend that NICU doctors and nurses take the following steps to ensure effective communication:

- Talk with parents as often as possible and regularly update them on any treatments their baby needs and why.
- Be direct and unequivocal about the baby's condition, treatments and prognosis.
- Eliminate medical jargon, complex terminology and doctor speak.
- Be specific and define even the simplest terms and diagnoses.
- Be sympathetic and warm.
- Test maternal understanding by asking follow-up questions.
- Ask the mother to summarise what she took away from the conversation.

Imaging technique to improve diagnosis of seizures in babies

Researchers at The Rosie Hospital, Cambridge, led by Dr Topun Austin and funded by Action Medical Research, are investigating a new technique combining brain imaging and monitoring of electrical activity to improve early diagnosis and treatment of babies who suffer seizures.

In the UK over 2,000 newborn babies suffer seizures each year. Early diagnosis and treatment is vital, as seizures may cause lasting brain damage. However, they sometimes go unnoticed, as babies can have no obvious symptoms.

Around two or three babies in every 1,000 born alive also suffer from seizures within a month of birth. Babies born very prematurely are especially vulnerable, as are babies who suffer from a lack of oxygen during birth.

Babies who are suspected of suffering from seizures are normally referred for an electroencephalogram (EEG).

"When babies have a seizure, there is a large amount of electrical activity in the brain, which we are measuring with EEG. But EEG has limitations, as it can only detect seizures occurring near the surface of the brain. It cannot detect abnormalities deeper within the brain," explains Dr Austin.

"The amount of oxygen in the brain also changes, which we measure with the new optical system. This system works by shining near-infrared light into the brain, which is harmless and non-invasive."

Dr Austin hopes the new combined technique will boost understanding of what's happening inside the brain during seizures: "The ultimate aim is to develop the new system for routine use at the cot-side."

Support World Prematurity Day 2012

This year 15 million babies will be born prematurely around the world, 60,000 right here in the UK.

On 17 November, World Prematurity Day, Bliss will join with other organisations around the globe to raise awareness of this very serious issue. As part of our commitment we are pleased to announce that we are the first UK charity to join the global alliance of charities that are concerned about premature birth. The aim of the group, which was set up and is overseen by the March of Dimes, USA, is to raise awareness of prematurity around the world and the issues faced by babies born too soon and their families.

Bliss, is asking everyone around the UK to get involved. Take part in some activity in the week leading up to 17 November and share with us on Facebook and twitter.

The international colour for World Prematurity Day is purple so you could light a purple candle or dress in purple to show your support. You could decorate your unit with purple balloons and streamers and take some photos and share with us on facebook. We'd love to see as many of you take part as possible and show your support!

For more information visit www.bliss.org.uk or email kellies@bliss.org.uk

Research priorities for preterm birth

The Social Science Research Unit (SSRU) at the Institute of Education, University of London, in collaboration with the James Lind Alliance (JLA), is conducting a survey to identify uncertainties about causes, prevention and care of premature babies. The Preterm Birth Priority Setting Partnership (PSP) will then prioritise the uncertainties for future research.

Health professionals and parents of preterm infants are invited to suggest topics that could be considered for future research into preterm birth care; this feedback will help to improve quality of care and outcomes at very preterm birth.

Seilin Uhm, who is coordinating the project, says: "So far we have gathered almost 400 uncertainties about preterm birth and caring for premature babies across the UK and Ireland." As the majority of responses have come from white, middle-class and well-educated populations, Seilin is particularly keen to get feedback from families from lower socio-economic or ethnic minority groups.

Healthcare professionals are invited to complete the survey online at www.surveymonkey.com/s/prembabies before 16 September 2012 and asked to encourage the parents of premature babies to participate in the survey.

For further details or to get involved, contact Seilin Uhm, s.uhm@ioe.ac.uk

Small Wonders National Change programme

In June, the child health charity Best Beginnings, working in collaboration with staff in more than 150 neonatal units, launched the Small Wonders National Change programme in England. Small Wonders is a major new initiative to drive and support cultural shift across the UK towards more family-centered care in ways designed to improve health outcomes and well-being of children born prematurely or sick.

At the heart of the change programme is the Small Wonders DVD which follows 14 families on their journey over the course of a year as they gain confidence in caring for their babies in hospital and at home. The DVD is divided into 12 films each covering a different aspect of caring for a premature and sick baby including 'Birth', 'Holding your baby' 'Expressing breastmilk', 'Preparing for home' and 'Bereavement'. Over 300 neonatal staff from across the UK have watched and given feedback on 'rough cuts' of the DVD and have been involved in piloting the DVD prior to its June launch. The final DVD is supported by 23 organisations including the NNA and BAPM.

Best Beginnings has secured charitable funding to enable free copies of the DVD to be distributed to all parents and staff in neonatal units across the UK for a year. The charity is committed to ensuring this valuable resource is being used as effectively as possible as part of a local change programme with multi-disciplinary staff engagement and a proper plan for dissemination to parents. For this reason, the DVDs are only being sent to a hospital if the neonatal unit has at least one Small Wonders Champion and has returned a planning form signed by the unit's clinical lead.

Images© Best Beginnings with thanks to Lyanne Wylde Photography.

To date, 68,330 free copies of the DVD have been disseminated to 130 of the 171 hospitals in England and as more planning forms are received more DVDs are being sent out. Plans are now underway to launch Small Wonders in Scotland, Northern Ireland and Wales.

Across the UK there are currently 412 Small Wonders Champions.

If your hospital does not yet have copies of the Small Wonders DVD, you are interested in becoming a Small Wonders Champion and/or you are interested in finding out more about the Change Programme or NUCAT, please contact: smallwonders@bestbeginnings.org.uk

Be part of a landmark accreditation scheme for neonatal units

Following the recent launch of the Bliss Baby Charter Audit Tool, Bliss is enlisting the support of health professionals to help develop the audit tool into a new accreditation scheme for neonatal units.

Bliss is keen to involve neonatal staff and parents right from the very start of this pioneering initiative to help develop it into a world-class scheme. Key to the success of the accreditation scheme is ensuring that those who will participate in their own unit's accreditation are involved in how the scheme is set up.

Bliss values the range of skills and knowledge on units across the UK and is keen to ensure that those involved in the project represent different aspects of care, unit levels and geographic areas. The charity wants to hear from neonatal staff from all disciplines, whether that be clinical, management, psychosocial or developmental – the more diverse the better. Support could include reviewing the scheme proposal, trialling part of the scheme on a unit, gathering colleagues' views on principles of the scheme or attending focus group meetings. The most important qualifications to be part of this initiative are knowledge of a neonatal unit, a passion for family-centred care and enthusiasm for contributing to this project – you do not have to have been involved in similar projects.

If you would like to find out more about what is involved in this project and how you might be able to help please get in touch with morvenm@bliss.org.uk

THROUGHOUT 12

Baby Friendly Initiative Training Courses

Breastfeeding Management
5-7 September
Cost: £390

Breastfeeding and Lactation Management for Neonatal Staff
27-28 September
Cost: £390

Train the Trainer
3-5 October
Cost: £690

Project Management
18-19 October
Cost: £405

Venue: London

Further information on each course and how to book: http://unicefbfi.force.com/signup/EventsHome

THROUGHOUT 12

Understanding Newborn Behaviour and Supporting Early Parent-Infant Relationships

Training courses organised by The Brazelton Centre

Neonatal Behavioural Assessment Scale (NBAS)
17-18 September

Newborn Behavioural Observations (NBO)
3-4 December

Venue: Addenbrooke's Hospital, Cambridge

Contact: info@brazelton.co.uk
Tel: 01223 245791
London, WC1X 8SH
www.brazelton.co.uk

THROUGHOUT 12

Child Bereavement Charity Training Courses

The Neonatal Experience – Loss and Grief Without a Bereavement
1 October
Cost: £99
Venue: Saunderton, Buckinghamshire

Stress Management for the Caregiver
16 October
Cost: £99
Venue: Saunderton, Buckinghamshire

Pregnancy Loss and Death of a Baby – Supporting Parents
26 November
Cost: £99
Venue: Manchester

When a Child Dies – Supporting Parents and Family Members
29 November
Cost: £99
Venue: Saunderton, Buckinghamshire

Contact: Training Team
Child Bereavement Charity
Saunderton
Buckinghamshire
HP14 4BF
Tel: 01494 568908
training@childbereavement.org.uk
www.childbereavement.org.uk

20 SEPTEMBER 12

Advancing Neonatal Practice: a Celebration of the First 20 Years

An invitation to join colleagues in Southampton to celebrate the development of the first Advanced Neonatal Nurse Practitioner (ANNP) programme in the UK.

Professor Jessica Corner will open the day, which will feature an international neonatal faculty. The conference topics include:

- Antibiotics for neonatal infection
- Nutrition
- Developmental outcomes
- Online postgraduate education
- Probiotics
- Respiratory management

As well as celebrating the success of the introduction of ANNPs into the neonatal workforce, this is an exciting opportunity to participate in stimulating discussions about the future provision of neonatal education.

Venue: University of Southampton
Cost: £95
Contact: Tim Lees
t.lees@soton.ac.uk

20 SEPTEMBER 12

Uncertainty and Loss in Maternity and Neonatal Care

A joint one-day conference organised by Sands, Bliss and the Royal College of Midwives aimed at improving the knowledge of health professionals faced with critical illness, loss and bereavement in the delivery of maternity and neonatal care.

This year's programme includes parents talking about their experiences and information from a wide range of practitioners.

Cost: £75-150
Venue: Brunei Gallery, London
Contact: Profile Productions Ltd
Tel: 0208 832 7311
info@profileproductions.co.uk
www.profileproductions.co.uk

27-29 SEPTEMBER 12

First International Symposium on Perinatal Hemodynamics

Key topics include:

- Ultrasound workshops
- Ultrasound assessment of perinatal hemodynamics
- Ultrasound in hostile perinatal environment
- Hostile perinatal environment: long term effects
- Future perspective

Venue: Lausanne, Switzerland
Contact: contact@isph2012.org
www.isph2012.org

5-9 OCTOBER 12

The 4th Congress of the European Academy of Paediatric Societies (EAPS)

Join fellow leading paediatric clinicians, researchers and nurses for the EAPS 2012 Paediatric Congress organised by Europe's paediatric subspecialty societies, ESPNIC, ESPR and EAP. The congress aims to advance the quality of paediatric care and training worldwide by providing professionals from different specialties with a comprehensive scientific programme presented by a leading international faculty.

Venue: Istanbul, Turkey
Contact: Kenes International
1-3 Rue de Chantepoulet
PO Box 1726, CH-1211
Geneva 1, Switzerland
Tel: +41 22 908 0488
Fax: +41 22 906 9140
paediatrics@kenes.com
www2.kenes.com/paediatrics

25 OCTOBER 12

St George's Basic Ventilation Workshop

This workshop organised by Chiesi Connect is aimed at neonatal nurses, midwives and junior doctors. Key topics include:

- Early extubation and nasal cannula oxygen
- Physiology of ventilation
- Volume ventilation
- Ventilation of surgical neonate
- Vapotherm
- High frequency ventilation
- Volume ventilation
- Adapting ventilation to blood gases
- Management of baby with PPHN
- Oxygen and resuscitation

Venue: St George's Hospital, London
Cost: £70

Contact: Rob Bullen
CFS Events Ltd
Unit E, Mindenhall Court
17 High Street
Stevenage SG1 3UN
Tel: 0800 9177 405
rob@cfsevents.co.uk

20-21 NOVEMBER 12

Trouble Up North 2012

The annual North Trent and Yorkshire Neonatal Network conference, sponsored by Chiesi Ltd, will cover the following topics this year:

- Feeding issues
- Death/dying
- Substance misuse and the neonate
- Current topics

Come and network with colleagues – all welcome.

Venue: The Waterton Park Hotel, Wakefield, South Yorkshire

Cost: Doctors £270, £135 single day
Nurses £195, £98 single day

Contact: Wendy Wombwell
wendy@cfsevents.co.uk
Registration online:
www.cfsevents.co.uk

15 NOVEMBER 12

Infant Development in Neonatal Intensive Care-Ireland (IDNIC-I)

This year's IDNIC conference is hosted by the Coombe Women and Infants University Hospital and offers an innovative, topical and multidisciplinary programme:

- Sensory experience and preterm brain development
- Cerebral blood flow and caregiving
- Neuroimaging
- Six good reasons for observing babies
- Newborn behavioural observation
- Bayley scales
- The parents' journey
- Assessing the quality of care: the NEO-ACQUA study
- Evaluating pain management interventions: the EVIN scale
- Hot topics in developmental care
- Changing the NICU environment
- Parents as a force for change

Venue: Ashling Hotel, Dublin 8

Cost: €80

Contact: Mary O'Connor
Friends of the Coombe
Coombe Women & Infants Hospital
Cork, Dublin 8
Tel: 00353 876811755
maoconnor@coombe.ie
www.friendsofthecoombe.ie

28 NOVEMBER-1 DECEMBER 12

Excellence in Paediatrics

The annual Excellence in Paediatrics (EIP) conference is a vibrant meeting that will explore, discuss and share the latest developments in general paediatrics. It aims to inform international paediatric health care professionals of the latest scientific developments and improve care delivery. Last year's conference attracted over 1,200 delegates from 77 countries.

Venue: Madrid, Spain

Contact: EI Congresses & Communications UK Ltd
Tel: +44 (0) 20 8326 5710
eip@2eic.com
www.excellence-in-paediatrics.org/content/68/conference

3-7 DECEMBER 12

Neonatal Update 2012: The Science of Newborn Care

The annual five-day international meeting organised by Imperial College London is the longest running, neonatal and infant medicine meeting in Europe. The meeting regularly attracts a capacity international audience of senior neonatologists and paediatricians.

Venue: BMA House, London

Cost: £630-750

Contact: The Symposium Office
Tel: +44 (0) 20 7594 2150
sympreg@imperial.ac.uk
www.symposia.org.uk

5-6 DECEMBER 12

2012 Baby Friendly Initiative Annual Conference

Organised by UNICEF UK, the BFI conference is the UK's highest-profile event covering infant feeding issues.

Venue: Motorpoint Arena Cardiff

Information:
www.unicef.org.uk/BabyFriendly/Health-Professionals/Conferences/This-years-conference/

11-13 FEBRUARY 13

Neonatal Cranial Ultrasound

Date for the diary.
Organised by The Symposium Office on behalf of Imperial College London,

Venue: BMA House, London

Contact: The Symposium Office
Tel: +44 (0)20 7594 2150
sympreg@imperial.ac.uk
www.symposia.org.uk

5-8 JUNE 13

6th Europaediatrics jointly held with the RCPCH Annual Conference

Date for the diary.
For the first time ever, Europaediatrics, the biennial conference of the European Paediatric Association, will be held jointly with the RCPCH's Annual Conference.
Venue: Glasgow, Scotland

Register your interest at:
http://www.rcpch.ac.uk/events/annual-conference

12-15 JUNE 13

24th Annual Meeting of the European Society of Paediatric and Neonatal Intensive Care (ESPNIC)

ESPNIC 2013 aims to enhance the welfare of children by advancing latest research and developments. The multidisciplinary setting offers doctors and nurses from around the world the opportunity to influence their specialty by exchanging ideas and expertise with colleagues, hearing presentations by internationally acclaimed experts and participating in a highly innovative scientific programme. The conference is an ideal opportunity to develop new professional contacts.

Abstract submission deadline: 16 January 2013.

Venue: Rotterdam, Netherlands

Contact: Kenes International
Tel: +41 22 908 0488
espnic@kenes.com
http://espnic2013.kenes.com/

5-8 SEPTEMBER 13

8th International Neonatal Nursing Conference

Organised by The Council of International Neonatal Nurses (COINN), the international conference focuses on neonatal nursing and aims to translate latest findings into clinical practice. The programme suits specialist and general nurses.

Abstract submission opens 5 November 2012.

Venue: Belfast, Northeren Ireland

Information:
http://coinn2013.com/

Contact: Kenes UK Ltd
Tel: +44 (0) 207 383 8037
coinn@kenes.com
www.kenes.com/uk

Closed circuit suctioning and surfactant delivery

The Kimberly-Clark Health Care *Kim*Vent range contains a selection of user-friendly, plasticiser (DEHP)-free neonatal and paediatric airway care systems specialising in closed circuit suctioning and surfactant delivery.

The success of surfactant replacement therapy relies on effective liquid delivery and distribution to targeted regions of the lung. The *Kim*Vent MAC (Multi-Access Catheter) is a 5 Fr. in-line endotracheal catheter designed for accessing the neonatal airway, supporting optimal administration of surfactant without disconnection from the ventilator. There are several benefits over a conventional catheter for instilling surfactant; these include better distribution, easy depth measuring and importantly – continued ventilation during the procedure.

The *Kim*Vent range also offers closed suction catheters designed to offer significant benefits to both patients and their caregivers alike. All are available with either elbow or Y-connectors, easy-to-view numbered and coloured depth measurement markings and a full range of French sizes from 5 to 12.

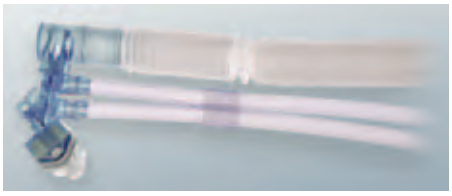
For more information visit the Kimberly-Clark Health Care website: www.vap.kchealthcare.com/uk or contact Kimberly-Clark on 01732 594333.

Needle-free surfactant kit

A new needle-free surfactant kit is now available from Medicina. The kit contains a needle-free access device for surfactant vials, 5mL syringe and a specially designed delivery tube. All are colour coded blue to avoid confusion with purple (enteral) and orange (spinal and epidural) equipment. The kit also has a unique connector that cannot be attached to other IV, enteral or intrathecal devices making it safer in the critical care area.

For more information please contact Medicina on 01204 695050 or info@medicina.co.uk

New nCPAP generator



Designed from proven technology, the new SLE1000 nasal CPAP generator can help facilitate early extubation or prevent re-intubation and reduce the work of breathing. When used with the SLE1000 machine the SLE1000 generator gives a very stable CPAP that compensates for leaks and movement by the baby.

The SLE1000 generator is available as a complete system containing the circuit, masks, prongs and simple to apply bonnets, which are available in 12 sizes. Every generator is 100% flow tested.

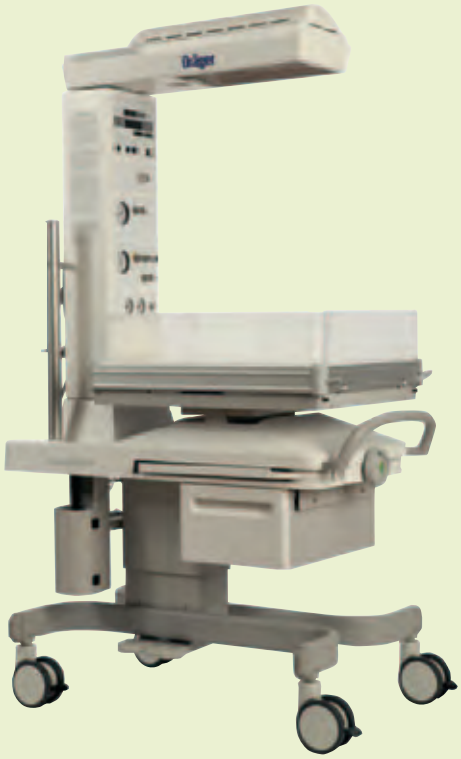
Marketing Manager Chris Worrell comments: "Nasal CPAP had developed a great deal in the past 20 years with many devices now available. The SLE1000 nCPAP generator builds on the experience of the past to provide caregivers with a cost-effective solution for supporting premature and sick babies." Samples are available for demonstration.

For more information contact Chris Worrell, 0751 766 0608, 020 8681 4530, cworrell@sle.co.uk, www.sle.co.uk

Re-invention of a tried and tested format

After many years of Dräger's commitment to newborn life support, the trusted RW82 Resuscitaire has recently evolved to improve clinical practice and patient outcome.

Clinical application and resuscitation delivery remains the same, ensuring consistency in user training and compatibility with the existing Dräger resuscitation devices.



Other features of the Resuscitaire evolution include:

- Improved suction positioning
  Moved from the front to the back/side
- 38mm pole either side
  Suitable for mounting SPO_2 monitors and accessories
- Dual instrument tray
  Better access to accessories during treatment
- Variable height adjustment pedals on either side
  Improved height positioning
- Autobreath mode optional
  Automatic resuscitation delivery
- New dual 5-inch steering castors and locking castors
  Improved manoeuvrability
- Resuscitation functionality remains the same
  Reducing clinical training risk

For more information visit www.draeger.co.uk or contact on 01442 213542 or via email at med-marketing.uk@draeger.com

Peyona®

caffeine citrate

IV

ORAL

- Licensed for IV and Oral administration
- Preservative free
- High strength, single use, age appropriate formulation
- A trusted partner in neonatology

Peyona caffeine citrate 20 mg/ml.
Solution for infusion and oral solution

Peyona®

caffeine citrate

Treatment of primary apnoea of premature newborns

Peyona® 20 mg/ml solution for infusion and oral solution (caffeine citrate). Please refer to Summary of Product Characteristics (SmPC) before prescribing
Prescribing Information. Presentation Peyona® is a clear, colourless, aqueous solution at pH=4.7. Each 1 ml ampoule contains 20 mg of caffeine citrate (20 mg of caffeine citrate is equivalent to 10 mg caffeine). **Indications** Treatment of primary apnoea of premature newborns. **Dosage and Administration** The recommended dose regimen in previously untreated infants is a loading dose of 20 mg caffeine citrate per kg body weight administered by slow intravenous infusion over 30 minutes, **using a syringe infusion pump** or other metered infusion device. After an interval of 24 hrs, maintenance doses of 5 mg/kg body weight may be administered by slow intravenous infusion over 10 minutes every 24 hrs. Alternatively, maintenance doses of 5 mg/kg body weight may be administered by oral administration, such as through a nasogastric tube every 24 hrs. The dose expressed as caffeine base is one-half the dose when expressed as caffeine citrate (20 mg caffeine citrate are equivalent to 10 mg caffeine base). In preterm infants with insufficient clinical response to the recommended loading dose, a second loading dose of 10-20 mg/kg maximum may be given after 24 hrs. Higher maintenance doses of 10 mg/kg body weight could be considered in cases of insufficient response. Where clinically indicated, caffeine plasma levels should be monitored. The diagnosis of apnoea of prematurity may need to be reconsidered if patients do not respond adequately to a second loading dose or maintenance dose of 10 mg/kg/day. When given IV, caffeine citrate should be administered by controlled IV infusion. Caffeine citrate can be either used without dilution or diluted in sterile solutions for infusion such as glucose 50 mg/ml (5%), or sodium chloride 9 mg/ml (0.9%) or calcium gluconate 100 mg/ml (10%) immediately after withdrawal from the ampoule. Caffeine citrate can be administered by intravenous infusion and by the oral route. The product must not be administered by intramuscular, subcutaneous, intrathecal or intraperitoneal injection. *Duration of treatment:* The optimal duration of treatment has not been established. Treatment is usually continued until the infant has reached a post-menstrual age of 37 weeks, by which time apnoea of prematurity usually resolves spontaneously. Caffeine citrate administration should be stopped when the patient has 5-7 days without a significant apnoeic attack. If the patient has recurrent apnoea, caffeine citrate administration can be restarted with either a maintenance dose or a half loading dose, depending upon the time interval from stopping caffeine citrate to recurrence of apnoea. Because of the slow elimination of caffeine in this patient population, there is no requirement for dose tapering on cessation of treatment. As there is a risk for recurrence of apnoeas after cessation of caffeine citrate treatment monitoring of the patient should be continued for approximately one week. **Contraindications** Hypersensitivity to active substance or excipients. **Special Warnings and Precautions** Other causes of apnoea should be ruled out or properly treated prior to initiation of treatment with caffeine citrate (see SmPC for full details). Baseline plasma concentrations should be measured in neonates born to mothers who consumed large quantities of caffeine prior to delivery or newborns previously treated with theophylline. Extreme caution in newborns with seizure disorder. Caffeine has been shown to increase heart rate, left ventricular output, and stroke volume therefore caution should be exercised in newborns with known cardiovascular disease. Caution in newborns with impaired renal or hepatic function or suffering gastro-oesophageal reflux. Careful monitoring for development of necrotising enterocolitis. Caffeine citrate causes a generalised increase in metabolism, which may result in higher energy and nutrition requirements during therapy. The diuresis and electrolyte loss induced by caffeine citrate may necessitate correction of fluid and electrolyte disturbances. **Interactions** Inter-conversion between caffeine and theophylline occurs in preterm neonates; these active substances should not be used concurrently. Caffeine has the potential to interact with active substances that are substrates for CYP1A2, inhibit CYP1A2, or induce CYP1A2. However, caffeine metabolism in preterm neonates is limited due to their immature hepatic enzyme systems (see SmPC for full details). **Pregnancy and Lactation** Caffeine in animal studies, at high doses, was shown to be embryotoxic and teratogenic. These effects are not relevant with regard to short term administration in the preterm infant population. Caffeine is excreted into breast milk and readily crosses the placenta into the foetal circulation. Breast-feeding mothers of neonates treated with caffeine citrate should not ingest caffeine-containing foods, beverages or medicinal products containing caffeine (see SmPC for full details). **Undesirable effects** The known pharmacology and toxicology of caffeine and other methylxanthines predict the likely adverse reactions to caffeine citrate. Effects described include central nervous system (CNS) stimulation such as irritability, restlessness and jitteriness, and cardiac effects such as tachycardia, hypertension and increased stroke volume. These effects are dose related and may necessitate measurement of plasma levels and dose reduction. The adverse reactions described in short and long term published literature are: *Common*: infusion site phlebitis, infusion site inflammation; *Rare*: hypersensitivity reaction; *Not known*: sepsis, hypoglycaemia, hyperglycaemia, failure to thrive, feeding intolerance, irritability, jitteriness, restlessness, brain injury*, convulsion*, deafness* (*more frequent in placebo group), tachycardia, also associated with increased left ventricular output and increased stroke volume, regurgitation, increased gastric aspirate, necrotising enterocolitis (see SmPC for full details), urine output increased, urine sodium and calcium increased, haemoglobin decreased, thyroxine decreased. Caffeine may suppress erythropoietin synthesis and hence reduce haemoglobin concentration with prolonged treatment. Transient falls in thyroxine (**T4**) have been recorded in infants at the start of therapy but these are not sustained with maintained therapy. **Pharmaceutical Precautions** None. After opening the ampoule, the product should be used immediately. For storage conditions of the diluted medicinal product see SmPC. **Special precautions for disposal and other handling** Aseptic technique must be strictly observed throughout handling of the medicinal product since no preservative is present. For single use only. Discard any unused portion left in the ampoule. Do not save unused portions for later administration. No special requirements for disposal. **Legal category** POM. **Packs and Prices** Basic NHS price of £172.50 per pack of 10 x 1 ml ampoules. **Marketing Authorisation Number** EU/1/09/528/002. Full prescribing information is available from the **Marketing Authorisation Holder** Chiesi Limited, Cheadle Royal Business Park, Highfield, Cheadle, SK8 3GY. **Date of Preparation** April 2012.

Adverse events should be reported. Reporting forms and information can be found at www.mhra.gov.uk/yellowcard. Adverse events should also be reported to Chiesi Limited. (address as above) Tel: 0161 488 5555

Chiesi
In neonatology for life

Date of preparation: June 2012 Code CHPEY20120643