

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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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 fatal¹. 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 abilities⁴. 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 staff⁵, 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 2011⁶. 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.

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.

- 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 performance⁷.
- 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 governance⁸. 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 recurrence⁹.

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 etc¹².

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 programme¹³. 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 organisms¹². 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 procedures¹⁶.

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 solution¹⁷. 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 minimum¹⁸. Quality improvement initiatives suggest that 'bundles of care' result in significant and sustained decreases in catheter-related bloodstream infections¹⁹.

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 organisations²⁰⁻²³.

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' gestation²⁴. 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 consensus¹⁸. 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 neonates²⁷. 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 days²⁶.

Colonisation of catheter hubs

Colonisation is recognised as a risk factor contributing to the increasing infection rate associated with central venous catheter use²⁸. 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

- 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.

stem cell transplant ward³³. Prolonged contact with the wipe and the use of friction was found to be effective in disinfecting needle-free devices³⁴. 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 infection³⁵.

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 tip²⁹. 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 flora²⁹. For a summary of implemented changes see **TABLE 1**.

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.

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
<i>Staphylococcus aureus</i> 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

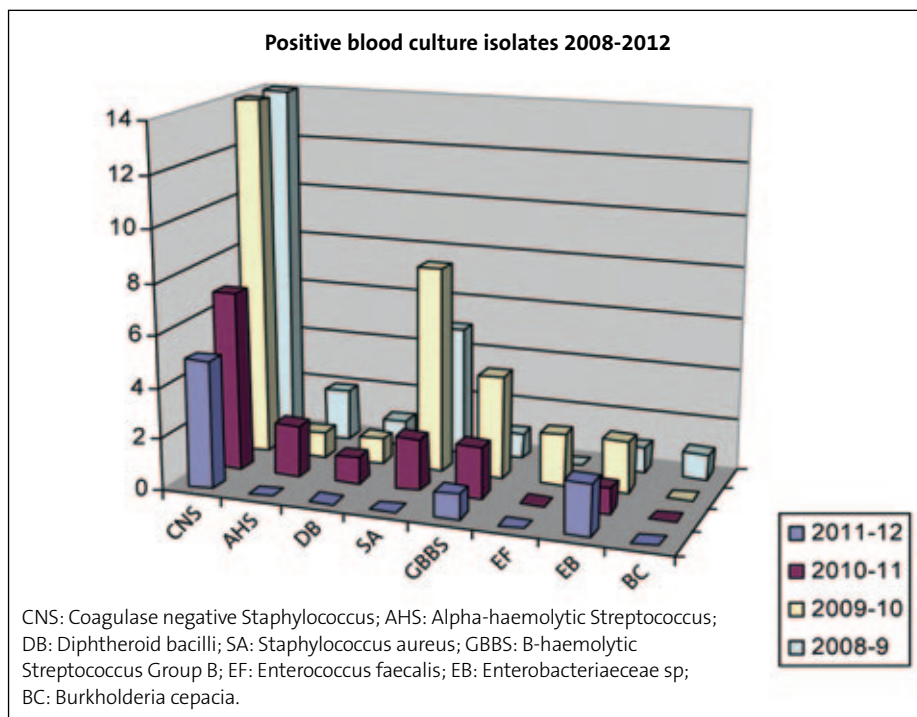


FIGURE 3 Organisms isolated in blood cultures over four years, 2008-2012.

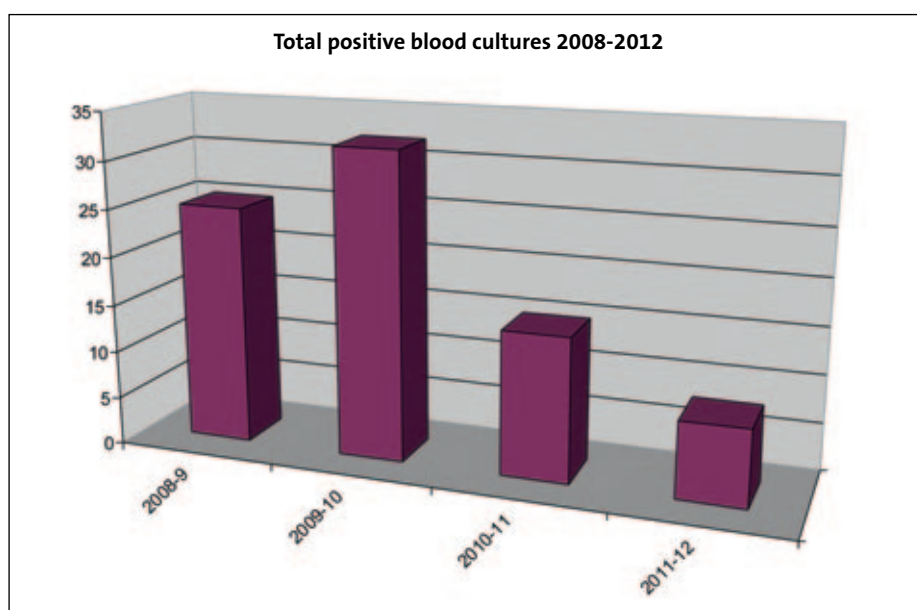


FIGURE 4 Total number of positive blood cultures over four years, 2008-2012.

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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