Title: Managing and preventing outbreaks of Gram-negative infections in UK neonatal units.

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Summary
Gram-negative infection outbreaks on neonatal units reflect breakdown in infection prevention measures. Poor hand hygiene, overcrowding, inadequate spacing between cots, low nurse:patient ratios, environmental colonisation (especially of water systems), inadequate cleaning of common-use equipment, injudicious use of antibiotics, particularly broad spectrum and prolonged courses, and delaying the introduction of maternal breast milk, all contribute to the emergence of outbreaks. This guidance has been produced through the English Department of Health by the Neonatal Gram-Negative Infection sub-group of the Antimicrobial Resistance and Healthcare Associated Infection (ARHAI) committee, and is aimed at neonatologists and infection control teams interfacing with NNUs. It represents an amalgamation of joint expert opinion and consultation with UK neonatal and infection prevention societies, and where available is supported by relevant neonatal literature. Although produced through the Department of Health in England, the recommendations should be applicable to all of the UK.

Introduction
Late-onset neonatal sepsis (infection occurring >48 hours after birth) in the UK affects 2-3/1000 babies [1], and the incidence in the most vulnerable, those born prematurely or with surgical conditions, is much higher [2]. Gram-negative bacteria (GNB) cause approximately 20-40% of all late-onset sepsis, with Klebsiella responsible for most neonatal outbreaks, followed by Serratia, Enterobacter, Pseudomonas, Escherichia coli, and Acinetobacter. GNB infections in babies are frequently fatal, for instance within the NeonIN surveillance network the case fatality rate is 27% [1]. Survivors have longer intensive care stays compared with premature
babies without infection, and more neurodevelopmental sequelae, with their associated lifetime social care costs. GNB outbreaks also impede the effective functioning of neonatal clinical networks. Approximately 15% of UK NNUs have been investigated for a ‘recent’ infection prevention and control issue, and 12% per year temporarily close for this reason [3](w1).

GNB outbreaks reflect a degree of breakdown in infection prevention measures. Poor hand hygiene, overcrowding, inadequate spacing between cots, low nurse:patient ratios, environmental colonisation (especially of water systems), inadequate cleaning of common-use equipment, injudicious use of antibiotics, particularly broad spectrum and prolonged courses, and delaying the introduction of maternal breast milk, all contribute to preterm and sick babies becoming colonised or infected with GNB (w2)[4, 5]. Additionally, colonised infants frequently have very long lengths of stay on NNUs, and long-stay colonised patients pose a greater risk of transmission than shorter-stay patients as in other intensive care settings. UK tertiary NNUs have a background rate of 1-2 GNB blood stream infections (BSIs) per month, and occasional outbreaks [1, 6]. Spread of GNB around NNUs is thought to occur predominantly on the hands of healthcare workers [5], with a contribution from environmental contamination, such as colonisation of hand basin taps, especially for pseudomonad infections (w2, w3). Preterm babies have immature immune systems and develop small intestine (a normally sterile site) colonisation with GNB species - both factors render preterm babies at risk of Gram-negative BSIs.

This guidance has been produced through the English Department of Health by the Neonatal Gram-Negative Infection sub-group of the Antimicrobial Resistance and
Healthcare Associated Infection (ARHAI) committee, in response to the general experience of UK neonatal units (NNUs) of Gram-negative blood stream infections and antimicrobial resistance. The review, aimed at neonatologists and infection prevention and control teams interfacing with NNUs, represents an amalgamation of joint expert opinion and consultation with UK neonatal and infection prevention societies, and where available the relevant neonatal literature. Although produced through the Department of Health in England, the recommendations should be applicable to all of the UK. It is divided into three sections: ‘defining’, ‘preventing’ and ‘managing’ outbreaks; and is supported by web-links (w1, w2, etc) to relevant DH and outbreak reports.

1. Defining an outbreak and triggers for activating a response

Immediate activation of an organisational response is required when an outbreak is suspected. An outbreak is defined as two or more sterile site isolates of the same species, with the same antibiogram, from different babies (not twins) within the space of two weeks. Triggers for activating a response might also be: three or more babies colonised with the same GNB (in those NNUs that routinely screen for GNB colonisation), a single case of a rare or never seen GNB, or a single systemic infection with an ESBL-producing or carbapenem-resistant GNB (because these multidrug-resistant organisms confer a higher risk of treatment failure) or Pseudomonas aeruginosa (which is more likely than other GNB to indicate an environmental reservoir). Action-thresholds will be determined by an understanding of the level of activity of each NNU and its background GNB infection rate. This report defines action to take to prevent and manage outbreaks GNB in NNUs.
2. Preventing an outbreak

*GNB BSI reduction on NNUs requires an organisation-wide approach with implementation, and assurance of implementation, of best practice across all elements of HCAI improvement and Infection Prevention and Control.*

Hand hygiene

*Hand hygiene is one of the most effective ways to minimise the transmission of GNB [7] and should be practiced by all healthcare workers, all of the time. Alcohol-based gels are at least as effective, and more immediately available, than hand washing and are effective at reducing GNB contamination.*

Recommendations:

- All staff should comply with national guidance on wearing of rings and false finger nails.

- Hands must be decontaminated immediately before each and every episode of direct patient contact/care and after every activity or contact that potentially results in hands becoming contaminated. Hands should be decontaminated between caring for different patients or between different care activities for the same patient.

- Hands that are visibly soiled or contaminated with dirt or organic material must be washed with liquid soap and water, but if not visibly soiled, alcohol-based gel can be used as a stand-alone agent (w4). Near patient alcohol-based hand rub should be made available in all neonatal units.

- Hands should be washed with soap and water after several consecutive applications of alcohol-based gels.

- Hands should always be decontaminated after the removal of gloves, with alcohol-based gel or with soap and water if visibly soiled. Gloves are not a substitute for hand hygiene.

- Use alcohol-based gels after hand-washing when *Pseudomonas aeruginosa* is known to be present on the NNU (w4, w5).

- Audit hand hygiene at least monthly.

Appropriate use of Personal Protective Equipment (PPE)
National guidelines recommend that PPE (i.e. plastic aprons and gloves) should be worn by all healthcare workers when there is a risk of contamination with blood, body fluids, secretions, or excretions. PPE protects staff and reduces the opportunities for transmission of micro-organisms in hospitals (w4).

Recommendations

- PPE should be single use items.
- Normally hand hygiene without use of PPE is appropriate for most patient contacts, i.e. nursing cares (excluding nappy changes) and clinical examination by doctors (see separate advice during an outbreak).

Staffing and space

High cot-occupancy rates and high numbers of babies cared for by one nurse promote errors and reduce the time for good infection prevention practices [8]. The Neonatal Toolkit for High Quality Neonatal Services, a commissioning framework developed by the NHS and DH by stakeholders including the British Association of Perinatal Medicine (BAPM) and complementing BAPM standards (w6, w7), recommends 1:1 nursing by nurses qualified for intensive care patients, 2:1 for high dependency, and 4:1 for low dependency. Spread of GNB is exacerbated by inadequate spacing between cots (w2)[4, 5]. It is important that management recognise the need for adequate space around a cot, to provide for two parents, monitors, ventilator and other equipment, as well as space to undertake sterile procedures including sterile trolleys and room for the doctor/s carrying out the procedure and nurse/s.

Recommendation:

- All NNUs should meet the recommendation for optimal staffing ratios for neonatal nurses (as set out in the Neonatal Toolkit, principle 2.2 (w6).
• Cot spacing, especially for ITU and HDU, should meet the established planning and design manual standards for existing facilities and for new builds (w7-9), for instance 20 m² per cot in a bay configuration or 17 m² per cot in glazed-type cubicles. Neonatal clinical leads have a duty to bring the space standards to the attention of management.

• Ensure that there is adequate accommodation within the NNU for storage and cleaning of equipment (especially ventilators and incubators); and avoid clutter of equipment in the ITU and HDU areas (w2, w7).

• NNUs should have facilities for segregation of infected babies (w2).

**Equipment and environmental contamination**

Environmental contamination by GNB, for instance *Pseudomonas aeruginosa* in water systems, is an important reservoir of antibiotic-selected organisms which can then be spread to vulnerable babies if there is direct contact, such as tap water for nappy changes (w2, w3). The hands of staff and multi-use equipment (such as echocardiography and ultrasound machines, ‘cold’ lights, laryngoscopes, breast pumps and stethoscopes) are also potential sources of transmission of GNB.

Recommendations:

• Every Trust should have a Water Action Plan (w2, w5) to reduce infections caused by water-borne pathogens, including *Pseudomonas, Chrysebacterium* and *Stenotrophomonas* spp. In particular:
  
  o Follow guidance on preventing and remediating Pseudomonas colonisation of tap outlets (w2, w5).

  o Where the water supply to a NNU has been shown to be contaminated with *Pseudomonas aeruginosa*, do not use tap water for cleaning
babies (for instance as part of nappy changes) - use only sterile bottled or filtered water, whilst remediation of water quality is underway (w5).

- Equipment for babies should be single use (i.e. laryngoscope blades) or dedicated to a baby (i.e. stethoscopes).

- Local NNUs should have robust cleaning routines, preferably with single use wipes, for multi-use equipment that enters the cot space (including ultrasound probes), and for equipment on the NNU (including breast pumps, blood gas analyzer screens and ports and bedside monitors); and there should be a named responsible person for cleaning routines, and evidence that best practice and policies are followed.

- Follow the Health, Social Services and Public Safety guidance on decontamination of incubators (w10).

- Every NNU should have guidance on safe handling and disposal of soiled nappies.

Infection reduction care bundles

The Matching Michigan programme [9] is an example of an effective infection reduction care bundle. It was adopted by the NHS initially for adult ITU settings, and was introduced to some English NNUs in January 2011. The Matching Michigan programme is not just about checklists, but is a system for maintaining the effectiveness of infection reduction advice. Advice is continually changing and being reinforced. At the heart of Matching Michigan are three interventions:

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<tr>
<th>Intervention</th>
<th>Example</th>
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<tr>
<td>Technical</td>
<td>Chlorhexidine-based skin cleansing, dressing changes, maximal barrier precautions and sterile pack design</td>
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<tr>
<td>Educational</td>
<td>Training on central line insertion, aseptic non-touch technique, and</td>
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Checklists are a component of this education. A root cause analysis (RCA) is held for every positive blood culture; and action points from the RCAs are fed back to staff in various ways to change behaviour.

Feedback can be:

- **Individual** - i.e. re-education for contaminated blood cultures.
- **Group** - i.e. RCA summaries and infection rates at weekly infection and monthly clinical governance meetings.

**Recommendation:**

- Introduce and actively maintain an infection-prevention care bundle such as ‘Matching Michigan’ in England or ‘1000 Lives Plus’ in Wales, both of which are particularly aimed at reducing line-related bacteraemias.
- Education/training and assurance of implementation should be an integral part of the chosen care-bundle.

**Benchmarking**

Benchmarking, such as through NDAU, neonIN or Vermont-Oxford Network’s (VON’s) Fight Bacterial Infection programmes, is an essential aspect of reducing HCAI providing it is linked to learning and quality improvement programmes.

**Recommendations**

- All UK NNUs should benchmark their BSI and catheter-related sepsis rates, for instance through the Neonatal Data Analysis Unit (w11), neonIN (w12), or
VON (w13). Use of these tools requires a consistent and regular approach by each NNU to completing on-line infection submissions.

**Information systems**

*Cot-side patient information systems (that record, in real-time, physiological parameters, ventilator changes, drugs administered and laboratory parameters)* allow easy access to data relevant to the patient’s course, including timing of antibiotics, culture results, central line days, and trends in inflammatory markers; and this information is vital to good clinical infection management and appropriate use of antibiotics.

Recommendations:

- Subscribe to a patient information system, at least for babies receiving ITU care.
- Utilise the patient information system for benchmarking, auditing practice, and investigating outbreaks.

**Antibiotic stewardship and microbiology**

*Prolonged initial antibiotic use in premature babies is associated with adverse outcomes, including higher nosocomial infection rates and necrotising enterocolitis [10-13].*

Recommendations:

- Aim to reduce antibiotic administration at the start of life, especially for preterm babies [14].
- Use antibiotics appropriate for local isolates and resistance patterns.
• Follow the NICE guidance ‘Antibiotics for the prevention and treatment of early-onset neonatal infection’ (w14) which has clear rules for antibiotic duration including stopping antibiotics at 36 hours in culture-negative babies with no on-going evidence of infection.

• For late-onset sepsis, develop proscriptive local guidelines to:
  o stop antibiotics at 36 hours after initiation, in culture-negative babies with no on-going evidence of infection,
  o optimise the duration of antibiotics and rationalise the antibiotic choice for babies with proven infection, and
  o limit use of broad-spectrum antibiotics to limit the emergence of antibiotic resistant organisms [14].

• Establish regular microbiology or paediatric infectious diseases ‘infection rounds’ - essential for maintaining good antibiotic stewardship.

• Undertake spot audits of antibiotic use, facilitated by electronic prescribing tools.

Early feeding and maternal breast milk

Every day of delayed enteral feeding, especially with maternal breast milk, increases the risk of nosocomial infection and necrotising enterocolitis [15, 16], and may have short and long term immune development effects [10].

Recommendations:

• Where possible introduce maternal breast milk on the first day of life in all preterm babies, and facilitate this through maternal counselling in the peripartum period.

• Give breast milk non-nutritive feeding, if possible, to babies with surgical intestinal conditions.

• Where formula feed is given, use sterile reconstituted liquid feeds rather than powders.
• Do not defrost frozen breast milk by placing the container in warm tap water (w2).

Screening

Colonisation of the intestine or endotracheal secretions (ETS) with GNB usually precede GNB BSIs [17-19]. Currently all English NNUs screen for surface MRSA colonisation, but only 21% undertake routine stool/rectal swabbing for specific Enterobacteriaceae and for gentamicin resistant/ESBL-producing Enterobacteriaceae [3]. The rationale is that screening allows for the earliest possible detection of an outbreak, and the earliest instigation of control measures and prescribing of the most appropriate antibiotics if colonised babies become unwell. Increasing numbers of babies colonised with the same organism may also be an early warning signal of an impending outbreak. However, there is currently insufficient evidence on clinical effectiveness to recommend weekly rectal, skin or ETS screening for GNB colonisation of babies on NNUs.

Recommendations:

• Interim guidance in this report is to not routinely undertake surface/rectal/ETS screening of babies for GNB colonisation. However, depending on microbial epidemiology, some NNUs may decide it is appropriate to undertake/continue local screening. In the event of an outbreak, rectal/ETS screening on a weekly basis should be instituted as an outbreak control measure (see below).

• Where a baby is known to be colonised with a significant GNB, for instance in a NNU already undertaking screening for resistant GNB, or swab taken for another reason:
  
  o Wear PPE (as well as perform hand hygiene) for all staff contacts with infected or colonised babies (parents do not need to do this).
• Ensure a mechanism so that colonised babies receive appropriate empiric antibiotics if they become unwell.

- Where a baby is infected with a GNB:
  - Staff should wear PPE (as well as perform hand hygiene) for all contacts.
  - If there is the cot availability and nursing capacity, cohort those babies infected with the same GNB.
  - Where isolation rooms exist, isolate infected babies; however, where isolation rooms are limited, make a risk assessment with regard to whether isolation should or should not take precedence over the effective running of the NNU and the impact on the neonatal clinical network.
  - Ensure that infection prevention and control measures are maintained in cohorted babies, so that those colonised/infecte d with similar, but non-identical strains of the same species, are not cross-transferred between babies.

3 Management of a GNB infection outbreak

In reported outbreaks, control is eventually achieved by improving hand hygiene, reducing the number of cots available (effectively improving cot spacing and nurse:patient ratios), cohorting infected and colonized patients, screening for the specific organism, source identification by environmental screening, deep-cleaning the environment, and equipment cleaning for instance with chlorine-based agents (w1, w2) [20]. Establishing a control team, investigation and instituting precautionary
control measures should be considered on suspicion of an outbreak and not await confirmation of the outbreak.

**Action when an outbreak occurs**

**Reporting**

Recommendations:

- A unit-based response should be embedded in an overall organisational response, with robust communication, through the Infection Prevention and Control Team. The team structure will vary depending on local hospital outbreak policy, but may include a lead neonatologist, preferably one with an interest in neonatal infection, paediatric infectious disease/microbiology clinician, the HPU, the Director of Infection Prevention and Control (DIPC) and the Chief Executive (w1, w2). The Health Protection Scotland 'Hospital Outbreak Checklist' (w15) is a useful practical guide to early management of a suspected outbreak.

- Set up an outbreak control team meeting as soon as an outbreak is suspected (w1, w2), and meet regularly to ensure control measures are effective.

- Microbiology teams should report pathogens and outbreaks to the local HPA HPU, and seek specialist advice where required.

- After a careful risk assessment, especially of the needs of the Neonatal Network consider closure of the NNU to admissions and avoid transfers to other NNUs.

- In the event of NNU closure or deaths related to sepsis during or as part of an outbreak, report the outbreak to the SHA/equivalent as an SUI.

- Communicate across the Neonatal Network, so that when one hospital has an outbreak, all hospitals within the network are informed expeditiously.

**Involvement of families**
o Inform parents of the outbreak as early as possible and reiterate infection prevention education (w1, w2).

o Provide parents with pre-written ‘infection outbreak’ information sheets.

o During an outbreak, pay attention to good communication with parents, particularly about their baby being colonised or infected, and inform parents early on when their baby is seriously unwell (w2).

o Work with the Trust communications department to reach the local community, through a press release, to inform relatives and pregnant women of the outbreak situation.

Hand hygiene

Recommendations:

- Re-invigorate attention to hand hygiene partly through re-education, feedback about the outbreak, and through frequent hand hygiene audits (aiming for >95% compliance and with immediate feedback on poor performance).

- PPE (plastic apron & gloves) should be worn for all staff contacts with infected and colonised babies.

- Re-educate parents about meticulous hand hygiene.

- Check staff hands for minor lesions and dermatitis, both of which may act as a reservoir for GNB – if found, refer staff members for Occupational Health for skin management

Staffing & cot spacing

Recommendation:

- Cohort or isolate infected babies (and colonised babies – see screening advice, below).
• After a careful risk assessment, especially of the needs of the Neonatal Network, consider reducing bed availability so that BAPM staffing (including taking account of skill mix) and cot spacing standards are met.

• After a careful risk assessment, especially of the needs of the Neonatal Network, consider closure of the NNU to new admissions.

• Ideally, infected and colonised babies should not be moved between NNUs during an outbreak, but decisions should be made on a case-by-case basis taking into account the needs of the Neonatal Network.

• Consider deploying staff so that a separate group of nurses and doctors look after only the colonised or infected patients.

**Environmental sampling & decontamination**

*Environmental screening is recommended when a single Pseudomonas infection occurs* (w2), *but the clinical effectiveness of screening for other GNB is unproven* [21].

**Recommendations:**

• As part of outbreak management, consider screening the environment, including inside incubators, for *Pseudomonas aeruginosa*, and screen on a case-by-case basis for other GNB.
  
  o Follow DH advice on water source and sink testing following a single Pseudomonas infection on a NNU – for instance, screen taps and sinks for colonisation in any room that the infected baby has inhabited since birth (w2, w3).

  o Consider testing any pooled water in/around the NNU (underneath sinks, air conditioning units, roof leaks, etc), and screen multi-use equipment and blood gas analysers.
• Undertake a thorough multi-disciplinary review of the ward (cleaning routines, hand hygiene, and GNB transmission risks). Use this review to inform cleaning schedules and frequencies (w10, w16).

• Consider deep-cleaning the environment, including all equipment (w17).

Patient screening

There is some evidence relating to the clinical effectiveness of patient screening for GNB colonisation as part of outbreak management. Expert opinion here is that there is a role for rectal and ETS screening (but not surface screening) once an outbreak is established.

Recommendations:

• Undertake screening during outbreaks for the specific GNB strain responsible for invasive disease, with at least weekly rectal swabs, and endotracheal secretions in ventilated babies. Screening should be for a defined period i.e. 1-2 months or until the outbreak has resolved. A limited period of screening may also be undertaken when there is a trigger for activating a response (see above).

• Set up a method to feedback screening results regularly to NNU lead staff.

• Microbiology teams will normally notify the HPA, ask for support where required, and send the isolates for typing.

Patient management

Recommendations:

• In consultation with microbiology and/or paediatric infectious diseases, change the NNU empirical antimicrobial policy to cover the outbreak organism. Revert to narrow spectrum antibiotics once the outbreak has resolved.

• Remove central venous catheters in any baby who is bacteraemic with a GNB.
Summary

GNB NNU outbreaks indicate that something in the system (environment, equipment, people or methods) is enabling the transmission of GNB. GNB infections have a high morbidity and mortality in this vulnerable patient group, and outbreaks can be devastating, both within the affected NNU and to the functioning of the Neonatal Network. Prevention outbreaks requires extremely high baseline standards of infection prevention and control practice.

When a GNB outbreak occurs consider reducing cots to improve spacing and nursing ratios, cohort infected and colonised babies, preferably in isolation cubicles, but not at the expense of the effectiveness of the Neonatal Network; use PPE for contact with all infected or colonised patients; and consider screening with rectal swabs (and ETS).

Urgent research is required in the following areas:

- Determine the feasibility and clinical effectiveness of weekly screening of babies to identify colonisation by *Pseudomonas aeruginosa* and/or antibiotic resistant GNB.
- Determine the mode of spread of GNB around NNUs using molecular typing, including bacterial whole genome sequencing.
- Improve neonatal infection diagnosis, i.e. molecular diagnostics and the use of combination bio-markers, to more accurately target antibiotics at those babies that are truly infected, and thereby help reduce antibiotic over-use.
- Explore surveillance systems that include an outbreak “early warning” tool, raising an alert when a pre-set trigger indicates an outbreak has occurred.
• Explore the clinical effectiveness of environmental measures, such as filters on taps and deep-cleansing agents, on GNB infection reduction.

• Determine the impact of oral lactoferrin and probiotics on GNB BSIs in preterm babies.

Web-links

w1  Report on *E.coli* ESBL outbreak at the neonatal unit of Luton & Dunstable Hospital NHS Foundation Trust  

w2  Review of Incidents of *Pseudomonas aeruginosa* Infection in Neonatal Units in Northern Ireland, Final Report. The Regulation and Quality Improvement Authority Independent 2012  

w3  Water sources and potential *Pseudomonas aeruginosa* infection of taps and water systems: advice for augmented care units 30 March. Department of Health 2012.  


w5  Report on hospital water supplies contaminated with Pseudomonads. Department of Health 2012  
http://www.dh.gov.uk/health/2012/06/pseudomonads/


Guiding principles for the development of decontamination procedures for infant incubators and other specialist equipment for neonatal care.

Neonatal Data Analysis Unit
http://www1.imperial.ac.uk/departmentofmedicine/divisions/infectiousdiseases/paediatrics/neonatalmedicine/ndau/

Neonatal Infection Database
http://www.neonin.org.uk/

Vermont-Oxford Network
https://nightingale.vtoxford.org/

Early-onset neonatal antibiotics
http://guidance.nice.org.uk/CG149

Hospital Outbreak Toolkit

http://www.nrls.npsa.nhs.uk/resources/?EntryId45=59818

From deep clean to keep clean - learning from the deep clean programme. Department of Health 2008.

References


19. Parm U, Metsvaht T, Sepp E, Ilmoja ML, Pisarev H, Pauskar M, Lutsar I: Risk factors associated with gut and nasopharyngeal colonization by


Good practice actions to reduce GNB infections and manage outbreaks

<table>
<thead>
<tr>
<th>Good practice</th>
<th>Number of infections</th>
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<td></td>
<td>None</td>
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<tr>
<td><strong>Trust engagement</strong></td>
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<tr>
<td>Ensure the board and executive make it a high priority to minimise GNB infections, and are supportive of all prevention and eradication measures</td>
<td>✓</td>
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<tr>
<td>Develop a Water Action Plan</td>
<td>✓</td>
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<tr>
<td>System-wide assurance of best practice for infection prevention, including audit and implementation of change suggested by audit findings</td>
<td>✓</td>
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<tr>
<td><strong>Communication</strong></td>
<td></td>
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<tr>
<td>Promptly inform and educate parents about single infections as well as outbreaks</td>
<td>✓</td>
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<tr>
<td>Set up an outbreak control team</td>
<td>✓</td>
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<tr>
<td>Once an outbreak is declared, involve the DIPC and Chief Executive</td>
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<tr>
<td>Inform the SHA about all outbreaks, but especially if there are deaths or NNU closure</td>
<td>✓</td>
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<tr>
<td>Microbiology team to report suspected outbreak to the HPA HPU</td>
<td>✓</td>
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<tr>
<td>Identify a system so that all NNUs know of any outbreak in the clinical network</td>
<td>✓</td>
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<tr>
<td><strong>Hand hygiene</strong></td>
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<tr>
<td>Use alcohol-based gels for hand hygiene (even if also wash hands)</td>
<td>✓</td>
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<tr>
<td>Comply with advice on rings and fake nails</td>
<td>✓</td>
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<tr>
<td>Audit hand hygiene monthly</td>
<td>✓</td>
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<tr>
<td>Audit hand hygiene twice daily</td>
<td>✓</td>
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<tr>
<td>Ensure a system so that audit findings and action plans are translated into practice</td>
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<tr>
<td>Staff should wear PPE (i.e. plastic apron &amp; gloves) for every patient contact</td>
<td>✓</td>
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<tr>
<td>Check for hand lesions, even minor, and dermatitis</td>
<td>✓</td>
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<tr>
<td>EDUCATE parents &amp; visitors about hand hygiene</td>
<td>✓</td>
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<tr>
<td><strong>Staffing and space</strong></td>
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<tr>
<td>1:1 nursing qualified in service for ITU, 1:2 for HDU, 1:4 for LDU</td>
<td>✓</td>
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<tr>
<td>Aim for the recommended cot spacing</td>
<td>✓</td>
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<tr>
<td>Ensure adequate accommodation for storage and cleaning of equipment</td>
<td>✓</td>
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<tr>
<td>Ensure facilities for segregation of infected or colonised babies</td>
<td>✓</td>
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<tr>
<td>Isolate infected and colonised babies, preferably in isolation cubicles</td>
<td>✓</td>
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<tr>
<td>Consider deploying staff so that some only look after the infected/colonised babies</td>
<td>✓</td>
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<tr>
<td>Consider reducing bed availability to ensure BAPM staffing and cot spacing standards</td>
<td>✓</td>
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<tr>
<td>Consider closing the NNU</td>
<td>✓</td>
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<tr>
<td><strong>Equipment and environmental contamination</strong></td>
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<tr>
<td>Purchase single-use or dedicated equipment (stethoscopes, laryngoscope)</td>
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<tr>
<td>Robust cleaning routines for multi-use items</td>
<td>√</td>
</tr>
<tr>
<td>Follow HSS guidance on decontamination of incubators</td>
<td>√</td>
</tr>
<tr>
<td>Ensure that there is a responsible person for cleaning routines</td>
<td>√</td>
</tr>
<tr>
<td>Sterile or filtered water to top and tail babies where the water supply has been shown to be contaminated with <em>Pseudomonas aeruginosa</em></td>
<td>√</td>
</tr>
<tr>
<td>Follow DH advice on water colonization by <em>Pseudomonas aeruginosa</em></td>
<td>√</td>
</tr>
<tr>
<td>Avoid clutter of equipment and trolleys</td>
<td>√</td>
</tr>
<tr>
<td>Decontaminate equipment with chlorine-based agents</td>
<td>√</td>
</tr>
<tr>
<td>Sample potential environmental sources for specific GNB</td>
<td>√</td>
</tr>
<tr>
<td>Deep clean the environment</td>
<td>√</td>
</tr>
<tr>
<td>Audit cleaning routines and ensure findings translate to practice changes</td>
<td>(✓)</td>
</tr>
<tr>
<td>Undertake a multi-disciplinary review of the ward to inform cleaning routines and frequencies</td>
<td>√</td>
</tr>
</tbody>
</table>

**Care bundles and information systems**

<table>
<thead>
<tr>
<th>Action</th>
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</thead>
<tbody>
<tr>
<td>Introduce an infection-reduction care bundle, such as the Matching Michigan programme</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Benchmark infection rates using neonIN, SEND or VON; and ensure that results are used to inform infection prevention and control improvements</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Subscribe to a patient information systems to easily track infections and antibiotic use in each patient</td>
<td>√</td>
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</tr>
</tbody>
</table>

**Antibiotic stewardship and microbiology**

<table>
<thead>
<tr>
<th>Action</th>
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<tbody>
<tr>
<td>Reduce antibiotic use, by re-writing local guidelines, to:</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Reduce administration at the start of life</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Stop antibiotics early, i.e. 36 hours, if no evidence of infection</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Reduce the duration of antibiotics for proven infection</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Limit the use of broad-spectrum antibiotics</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Change the empiric antibiotic policy</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Audit antibiotic use, and translate findings into practice change</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Remove central lines in the presence of a GNB bacteraemia</td>
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</tbody>
</table>

**Early feeding and maternal breast milk**

<table>
<thead>
<tr>
<th>Action</th>
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<tbody>
<tr>
<td>Commence breast milk feeds on 1st day of life for premature babies</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Do not use tap water to defrost frozen expressed breast milk</td>
<td>√</td>
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</table>

**Screening**

<table>
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<tr>
<th>Action</th>
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<tbody>
<tr>
<td>Screen babies at least weekly with rectal swabs and ETS for the specific GNB causing an outbreak; continue for at least 1 month and until no further spread within the NNU</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Consider screening the environment, especially taps and sinks, for the specific outbreak organism, especially if <em>Pseudomonas aeruginosa</em></td>
<td>√</td>
<td>√</td>
</tr>
</tbody>
</table>
Appendix:

The following societies received this guidance for comments:

Royal College of Paediatrics and Child Health
British Association of Perinatal Medicine
British Paediatric Allergy, Immunity & Infection Group
Infection Prevention Society
MCRN Neonatal Infection Group
British Infection Association
British Association of Paediatric Surgeons
BLISSL
Devolved Administration Government Department Health Protection Agencies, UK
Antimicrobial Resistance and Healthcare Associated Infection Committee