Management of Incidents and Outbreaks in Neonatal Units (NNUs).

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This literature review makes setting specific recommendations that are supplementary to the key recommendations in the National Infection Prevention and Control Manual (NIPCM).

2. Recommendations

What are the definitions of a healthcare infection incident/outbreak in a neonatal unit (NNU)?

Consider the possibility of an outbreak/incident and take action to investigate if:

- A higher than expected number of cases of HAI in a given healthcare area occur over a specified time period.
- Two or more linked cases with the same infectious agent are associated with the same healthcare setting over a specified time period.
- A single case of infection with an alert organism is identified.
- Three or more cases of colonisation with the same organism linked in time and place are identified.

(Mandatory)

(Good Practice Point (GPP))

What are the key measures to prevent incidents/outbreaks in NNUs and how should these be implemented in NHSScotland?

Ensure an assessment for infection risk is undertaken at the point of entry into the unit and continuously throughout the baby's stay. Neonates who present a cross-infection risk include those from mothers who have:

- been hospitalised outside of Scotland;
- received no antenatal care;
- been admitted from another unit in Scotland with an incident/outbreak;
- been previously confirmed positive for an MDRO e.g. MRSA or CPE;

or babies identified for microbiological screening by clinical risk assessment (CRA)*.

Neonates that meet any of the above criteria should be prioritised for placement in a suitable area to minimise the risk of potential cross infection pending investigation e.g.:

- incubator/cot placed in a single room with a clinical wash hand basin; or
- a cohort area/room with a clinical wash hand basin.

Ensure the management of water supply and use of water for patient care complies with national guidelines, particularly:

- flushing of all outlets (taps) for 1 minute daily;
- that there is no risk of splash or spray from water sources in the neonatal care area or into areas where medications such as IV drugs are prepared;
- consider the use of sterile water for routine personal care for those neonates considered at 'high-risk' of infection.

For further guidance refer to 'Guidance for neonatal units (NNUs) (levels 1, 2 and 3), adult and paediatric intensive care units in Scotland to minimise the risk of *Pseudomonas aeruginosa* infection from water'

*A draft CRA is currently being piloted, should you wish to view a copy please contact NSS.HPSInfectioncontrol@nhs.net.

Avoid the use of multi-use containers e.g. of saline or antiseptics.

Ensure staff and parents understand and follow the correct procedures for the hygienic preparation (including expression) and storage of breast milk/infant formula or total parenteral nutrition.

(Good Practice Point (GPP))

Ensure that there is adequate cot spacing as recommended in Health Building Note 09-03 and that there is no clutter around, or overcrowding of, incubators/cots in the unit.

The recommended space allowance in HBN 09-03 for intensive care and high dependency units is:

- 13.5sqm for the 'clinical space envelope' in multi-cot/incubator areas;
- 20sqm in single rooms and when access space and shared space for core support (pharmacy, storage etc.) is included in multi-cot/incubator areas space allowance.

The recommended space allowance in special care units is:

- 9sqm for the 'clinical space envelope' in multi-cot/incubator areas;
- 11.5sqm in single rooms and when access space and shared space for core support (pharmacy, storage etc.) is included in multi-cot/incubator areas space allowance.

(Good Practice Point (GPP))

Ensure staffing levels meet the minimum requirement for the level of care being provided, this is:

- 1:4 in special care baby units (SCBU);
- 1:2 in high dependency units (HDU);
- 1:1 in neonatal intensive care units (NICU).

(Good Practice Point (GPP))

What are the key measures to control an incident/outbreak in NNUs and how should these be implemented in NHSScotland?

If a healthcare infection incident/outbreak is suspected or confirmed, immediately begin a review of SICPs practice to identify areas for improvement and to identify potential sources of infection or transmission routes.

In addition to reviewing recent compliance monitoring reports, audit and reinforce hand hygiene compliance and education among both staff and parents; review the management of equipment and the environment; and ensure correct use of personal protective equipment (PPE).

(Mandatory)

Infected or colonised infants should be isolated or cohorted in a designated area of the NNU. An incubator is not considered a form of isolation.

Consider assigning a dedicated team of staff to care for infected or colonised infants in isolation/cohort rooms/areas. This can only be implemented if there are sufficient levels of staff available.

Consider closing the unit to new admissions, particularly if incubator/cot overcrowding or understaffing has been identified.

Consider 'enhanced cleaning' of the unit with hydrogen peroxide vapour (HPV) if other measures implemented are not bringing the incident under control and if multi-drug resistant or environmental organisms such as *Serratia* spp. or *Pseudomonas* spp. are the cause of the incident.

(Good Practice Point (GPP))

How should microbiological screening be implemented to assist in the control of incidents/outbreaks in NNUs?

Consider implementing 'reactive' microbiological screening of all babies in the unit. There should be an agreed plan to direct screening and predefined actions dependent on screening results e.g. isolation and treatment, and a plan for stepping down reactive screening e.g. 2 weeks without any new positive screening results.

The microbiological screening of staff and parents should be guided by pathogen specific guidance where available.

The microbiological sampling of care equipment and the environment should be guided by pathogen specific guidance where available.

(Good Practice Point (GPP))

3. Methodology

A rapid review was conducted to identify outbreak control measures successfully implemented during outbreaks in neonatal units (NNUs). In a deviation from the defined NIPCM methodology, outbreak reports were assessed, however only those which described specific control measures rather than general 'infection control precautions' were included. Available guidance on NNU incident/outbreak control was also identified and included.

4. Results/discussion

4.1 Implications for practice

What are the definitions of a healthcare infection incident/outbreak in a neonatal unit (NNU)?

Consider the possibility of an incident/outbreak and take action to investigate if the definitions for an incident/outbreak as per the NIPCM are met or in the event of; a single case of infection with an alert organism; or three or more cases of colonisation with the same organism linked in time and place.

Chapter 3 of the National Infection Prevention and Control Manual defines a healthcare associated infection outbreak as:

- Two or more linked cases with the same infectious agent are associated with the same healthcare setting over a specified time period; or
- A higher than expected number of cases of HAI in a given healthcare area over a specified time period

In an NNU, the majority of patients will never have been outside of that unit, and there is expert consensus that a single case of infection with certain organisms e.g. *Pseudomonas aeruginosa* may be considered an exceptional infection episode in this patient population and trigger an incident/outbreak investigation.[1] It has also been suggested that three or more babies colonised with the same Gram negative organism should trigger an incident/outbreak investigation.[1;2]

(Mandatory)

(Good Practice Point (GPP))

What are the key measures to prevent incidents/outbreaks in a NNU and how should these be implemented in NHSScotland?

Ensure an assessment for infection risk is undertaken at the point of entry into the unit and continuously throughout the baby's stay.

Patients must be promptly assessed for infection risk on arrival at the care area (if possible, prior to accepting a patient from another care area) and should be continuously reviewed throughout their stay.[3] Neonates who present a cross-infection risk include those from mothers who have:

- been hospitalised outside of Scotland;
- received no antenatal care;
- been admitted from another unit in Scotland with an incident/outbreak;
- been previously confirmed positive for an MDRO e.g. MRSA or CPE;

or babies identified for microbiological screening by clinical risk assessment (in draft, copies are available on request).

Neonates that meet any of the above criteria should be prioritised for placement in a suitable area to minimise the risk of cross infection pending investigation e.g.:

- incubator/cot placed in a single room with a clinical wash hand basin; or
- a cohort area/room with a clinical wash hand basin.

(Mandatory)
(Good Practice Point (GPP))

Ensure the management of water supply and use of water for patient care complies with national guidelines

A 2017 systematic review of waterborne infections in neonates and mothers found that infectious agents were isolated from such sources as tap water, an aqueous solution, water reservoirs (water bath, ventilator, humidifier, or incubator), sink(s), and/or faucet(s).[4] Additional sources of contamination included water used to bathe neonates, rinse bottles, formula heater water, humidifier and ventilator water, distilled water, bottled mineral water, a saline solution, aqueous chlorhexidine, and incubator water. These sources were considered to either be the

primary source of transmission or an environmental reservoir, the authors recommend disinfecting water before use (particularly for bathing).[4] A reported outbreak of *Pseudomonas putida* was traced back to contaminated water transfer containers, it was recommended that sterile, distilled water was used and all water transfer containers sterilised.[5]

Water is a known environmental source associated with *P. aeruginosa* outbreaks.[6] In NHSScotland, NNUs should follow the Health Protection Scotland 'Guidance for neonatal units (NNUs) (levels 1, 2 and 3), adult and paediatric intensive care units in Scotland to minimise the risk of *Pseudomonas aeruginosa* infection from water';[7] this includes guidance on the prevention of infection from hospital water sources such as daily flushing of all outlets (taps), the use of tap water for routine personal care of neonates, as well as instructions for investigation and control following an infection incident. There is a lack of evidence to inform the distance between water outlets (such as hand washing sinks) and the incubator/cot, however, expert opinion suggests this is between 3 and 6 feet.

(Good Practice Point (GPP))

Ensure that medications, antiseptics and solutions such as saline etc. are handled and prepared using aseptic technique and are single-use disposable wherever possible.

Neonatal outbreaks have been traced to multi-use items such as saline.[8;9] As far as possible, items should be single use, sterile and prepared and administered using aseptic technique.[8-10] Aseptic procedures such as drug preparation should not be performed in areas where there is a risk of splashes which could contaminate the aseptic field e.g. near sinks.[7]

(Good Practice Point (GPP))

Ensure staff and parents understand and follow correct procedures for the hygienic preparation (including expression) and storage of breast milk/infant formula or total parenteral nutrition.

Inadequate sterilisation of communal milk-expressing equipment[11] and contaminated expressed milk samples have been associated with outbreaks in NNUs,[12-14] as has environmental contamination of the expressing room itself.[15] Parents should be educated on the hygienic expression and storage of breast milk and posters on hand hygiene should be made available in the expressing room.[14;15] Intrinsically contaminated milk powder has been reported as the source of an outbreak of *Enterobacter sakazaki*;[16] powdered formula milk should be prepared in

a designated area, using aseptic technique and following the manufacturer's instructions.[16] Reconstituted milk should be refrigerated immediately and discarded if not used within 24hrs.[16] In addition, tap water must not be used for warming or defrosting milk.[7] In 2016 a joint working group between the Healthcare Infection Society (HIS) and the Infection prevention Society (IPS) published guidelines on the decontamination of breast pump milk collection kits and related items.[17] The implementation of these guidelines is recommended as best practice.

(Good Practice Point (GPP))

Ensure that there is adequate cot spacing as recommended in Health Building Note 09-03 and that there is no clutter around, or overcrowding of, incubators/cots in the unit.

Overcrowding is a commonly reported contributory factor to outbreaks in neonatal units.[10;18-21] Overcrowding may increase the risk of cross-contamination between equipment, the environment and the patient and should be avoided by adhering to recommended cot space requirements;[1] Health Building note 09-03 recommends that in intensive care each cot space should be able to accommodate:

- all-round access to the incubator/cot;
- space to enable staff to manoeuvre the incubator/cot, themselves and equipment safely;
- clinical equipment permanently located around the incubator/cot;
- any mobile equipment that may be required;
- a minimum of five members of staff (to attend the baby in an emergency situation);
- space for the mother to express discreetly at the cot-side;
- at least two chairs to accommodate visitors.[22]

In the schedule of accommodation the recommended space allowance for multi-cot/incubator areas in intensive care and high dependency units is 13.5sqm for the 'clinical space envelope', rising to 20sqm when access space and shared space for core support (pharmacy, storage etc.) is included and in single rooms; in special care units the recommended space allowance is 9sqm rising to 11.5sqm when access space and shared space for core support (pharmacy, storage etc.) is included and in single rooms.[22]

Cluttering of equipment has been linked to outbreaks; [1;11] this may be avoided by ensuring recommended cot/incubator spacing and room layouts are adhered to.[22]

(Good Practice Point (GPP))

Ensure staffing levels meet the minimum requirements for the level of care being provided

Understaffing has been reported as contributing to outbreaks in NNUs,[11;18;19;23;24] low nurse to baby ratios may promote errors and lapses in infection control practices.[1;23] The staffing requirements for safe care in NNUs in NHSScotland are set out in 'Neonatal care in Scotland: A Quality Framework'; in special care baby units a minimum of 1:4 staff* to baby ratio is required at all times; in high dependency units this increases to a minimum of a 1:2 staff* to baby ratio; in neonatal intensive care a minimum of a 1:1 staff* to baby ratio should be maintained at all times.[25] These staffing levels are also recommended within the Department of Health, health building note 09-03 (2013).[22]

*The requirements for staff training, registration status and supervision for each level of care are also set out in 'Neonatal care in Scotland: A Quality Framework'.[25]

(Good Practise Point (GPP))

What are the key measures to control incident/outbreaks in a NNU and how should these be implemented in NHSScotland?

If an incident/outbreak is suspected or confirmed, immediately begin a review of SICPs practice to identify areas for improvement and to identify potential sources of infection or transmission routes.

Anthony et al. suggest a multidisciplinary review of practices such as cleaning and hand hygiene should be performed.[1] In the event of a suspected or confirmed incident/outbreak a review of compliance with standard infection control precautions (SICPs) and transmission based precautions (TBPs) should be included as part of the incident/outbreak investigation as per chapter 3 of the NIPCM, this does not replace monitoring of compliance with SICPs and TBPs, which should be performed routinely.[3]

(Mandatory)

A review of the outbreak literature identified that poor compliance with hand hygiene, management of equipment and the environment and use of PPE were frequently associated with outbreaks in NNUs and therefore must be included in any practice review.

Audit and reinforce hand hygiene compliance and education among both staff and parents

Transmission via healthcare worker hands is often assumed to be a mode of transmission in neonatal outbreaks, [13;20;26;27] possibly because poor compliance with hand hygiene is often found when assessed.[9;28;29] As such hand hygiene audit and improvement is one of the most frequently reported outbreak control measures.[2;6;9;12;14;19;21;23;30-36] Hand hygiene audit should be performed early in an outbreak investigation and re-education and enforcement of hand hygiene implemented if compliance is found to be low.[1] Parents should also be educated about hand hygiene and this should be re-enforced during a confirmed or suspected outbreak.[1] At least one outbreak has been traced back to contamination of a non-medicated soap dispenser leading to transmission via contaminated HCW hands.[37] Assessment of compliance with hand hygiene should include a review of systems and processes against HPS 'Guidance for neonatal units (NNUs) (levels 1, 2 and 3), adult and paediatric intensive care units in Scotland to minimise the risk of *Pseudomonas aeruginosa* infection from water'.[7]

Review management of equipment and the environment and consider 'enhanced cleaning' of the unit with hydrogen peroxide vapour (HPV) if other measures implemented are not bringing the incident under control and if multi-drug resistant or environmental organisms such as *Serratia* spp. or *Pseudomonas* spp. are the cause of the incident.

Failure to adhere to SICPs for the safe management of equipment has been identified in the outbreak literature including failing to disinfect a blepharostat between patients;[32] contamination of weighing scales which should be cleaned between patients,[10;38] single-use pulse oximeters being re-used;[34] and incorrect disinfection of rectal thermometers.[35] A review of practice should ensure re-usable equipment is decontaminated (including sterilisation where appropriate) as per appendix 7 of the NIPCM.[3] Equipment should be single-use or patient dedicated wherever possible.[1]

Environmental contamination has been identified as a reservoir of infection[15;33] contaminated areas identified in the outbreak literature included hard to clean places such as air vents[39] and light fittings,[40] as well as areas that should be included in routine daily cleans such as computer monitors,[26] incubators and IV stands.[10] Anthony et al suggest 'deep-cleaning' the unit as part of outbreak control; enhanced cleaning is also reported elsewhere as a control measure even when environmental contamination has not been found by microbiological sampling.[1;2;13-15;23;33-35;40;41] No specific definition or guidance is available on deep-cleaning an NNU, however, use of hydrogen peroxide vapour (HPV) has been reported;[33;40] the NIPCM suggests that HPV may be considered for specific organisms (e.g. MDROs).[3] In order to carry out HPV disinfection all patients would need to be removed from the unit.

(Good Practise Point (GPP))

Ensure personal protective equipment (PPE) is being used correctly

Incorrect of insufficient use of personal protective equipment such as gloves has been associated with outbreaks in neonatal units.[10;20] In an outbreak, plastic aprons and gloves should be worn for all staff contact with patients[1] and their environments.[33] Compliance with the correct use of PPE should be assessed as part of a practice review, ensuring staff are donning and doffing PPE correctly to avoid contamination.[34]

(Good Practise Point (GPP))

A review of the outbreak literature identified microbiological screening, isolation and cohorting and ward/unit closure as key outbreak control measures.

Infected or colonised infants should be isolated or cohorted in a designated area of the NNU. Consider assigning specific staff to care for infected or colonised infants.

In reported outbreaks in NNUs the isolation and cohorting of infected or colonised babies is frequently implemented as a control measure.[2;9;10;12;14;21;23;36;38;40;42] Assigning staff to cohorted or infected infants has also been recommended.[2] As per chapter 2 of the NIPCM, patients with a known or suspected infection should be isolated or cohorted as appropriate;[3] this is also recommended by Anthony et al along with the recommendation that NNUs should provide sufficient facilities for segregation of infected babies.[1] Anecdotally, some practitioners consider being cared for in an incubator to be a form of isolation, however, given the reports of incubator

contamination during outbreaks and spread between babies cared for in incubators; there is currently insufficient evidence to support this. Exclusion of staff infected with adenovirus was described as a control measure in one of outbreak,[32] as per the NIPCM responsibilities section staff must 'not provide care while at risk of potentially transmitting infectious agents to others. If in any doubt they must consult with their line manager, Occupational Health Department, Infection Prevention and Control Team (IPCT) or Health Protection Team (HPT); and contact HPT/IPCT if there is a suspected or actual HAI incident/outbreak.'[3]

(Good Practise Point (GPP))

Consider closing the unit to new admissions, particularly if incubator/cot overcrowding or understaffing has been identified.

Consideration should be given to closing the unit to new admissions, it is suggested that this may reduce potential overcrowding and improve staff to patient ratios.[1;2;23] It was also recommended that infected or colonised babies are not transferred to other units, however, this decision should be made jointly between public health and clinical staff caring for the patient(s) to ensure the decision is appropriate for their clinical needs.[1;23]

(Good Practise Point (GPP))

How should microbiological screening be implemented to assist in the control of incident/outbreaks in NNUs?

Consider implementing 'reactive' microbiological screening of all babies in the unit. There should be an agreed plan to direct screening and predefined actions dependent on screening results e.g. isolation and treatment, and a plan for stepping down reactive screening e.g. 2 weeks without any new positive screening results.

The microbiological screening of staff and parents should be guided by pathogen specific guidance where available.

Screening of babies is often described in the reported outbreaks as a measure to identify colonised babied and isolate or cohort appropriately.[11;13;21;27;33;36;38;41;43;44] Only one outbreak report described screening of parents, an infected baby's father was found to be colonised with the outbreak strain, the direction of transmission was unknown.[43] Screening of staff is also frequently described as a means of identifying the source of an outbreak.[11-13;20;28;31;33;36;38;41-43]

However, of these 13 reports included only five found HCW colonisation and only in one was the HCW thought to be the source of the outbreak.[42]

It has been suggested that if a baby screens positive for MRSA but parents screen negative, that it is more likely that staff are the source.[23] Anthony et al suggest that screening during an outbreak should be for the specific outbreak strain and should take place weekly for a defined period e.g. 1-2 weeks or until the outbreak is over.[1]

The microbiological sampling of care equipment and the environment should be guided by pathogen specific guidance where available.

Environmental and equipment screening should be considered.[1] where pathogen specific guidance exists e.g. *P. aeruginosa*, this should be followed. It is important to consider that outbreaks may be multi-clonal, indeed this is common with *P. aeruginosa* outbreaks.[28] Microbiological sampling often does not find contamination with the outbreak strain; this is potentially because prompt and effective environmental decontamination has been implemented.

(Good Practise Point (GPP))

4.2 Implications for research

It is recognised that there is a lack of specific infection prevention and control guidelines for neonatal and paediatric care settings.[45] Very little high quality evidence was available to inform this review; the majority of the literature is assessed as expert opinion and a reporting and publication bias is likely to exist. It is currently unclear whether SICPs and TBPs as defined in the NIPCM are sufficient and appropriate for NNUs. Future work should include:

1. A gap analysis of local infection control guidelines/procedures in NNUs against the NIPCM in consultation with stakeholders,
2. Pathogen specific guidance to inform environmental and patient screening in neonatal units,
3. An outbreak checklist specific to neonatal units.

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Appendix 1 – Search strategies

Database: Embase <1974 to 2017 October 24>, Ovid MEDLINE(R) ALL <1946 to October 24, 2017>

Search Strategy:

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1 neonat*.mp. (589832)
2 newborn.mp. (1368935)
3 (infant or preterm infant).mp. (1875611)
4 (late onset sepsis or late-onset sepsis).mp. (1662)
5 infection.mp. (3162241)
6 (colonisation or colonization).mp. (144002)
7 (routine screening or microbiological screening).mp. (16755)
8 routine culture.mp. (1462)
9 (skin culture or skin swab or skin sampling).mp. (4931)
10 mucosal culture.mp. (38)
11 endotracheal aspirate.mp. (527)
12 aspirate.mp. (25632)
13 1 or 2 or 3 (2573526)
14 4 or 5 or 6 (3245994)
15 7 or 8 or 9 or 10 or 11 or 12 (48746)
16 13 and 14 and 15 (1841)
17 limit 16 to english language (1585)
18 limit 17 to human (1484)
19 limit 18 to yr="1999 -Current" (1152)
20 remove duplicates from 19 (802)

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Search Strategy:

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1 neonat*.mp. (41348)
2 newborn.mp. (34066)
3 preterm infant.mp. (1130)
4 (late onset sepsis or late-onset sepsis).mp. (233)
5 infection.mp. (12813)
6 (colonisation or colonization).mp. (922)
7 outbreak.mp. (483)
8 (screening or surveillance).mp. (19822)
9 culture.mp. (4379)
10 (skin culture or swab or skin sampling).mp. (217)
11 mucosal culture.mp.] (1)
12 endotracheal aspirate.mp. (8)
13 aspirate.mp. (137)
14 1 or 2 or 3 (58786)
15 4 or 5 or 6 or 7 (13684)
16 8 or 9 or 10 or 11 or 12 or 13 (23986)
17 14 and 15 and 16 (1530)
18 limit 17 to yr="1999 -Current" (1135)
19 limit 17 to yr="1999 -Current" (1135)

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