SCOTTISH HOSPITALS INQUIRY

Bundle of documents for the Oral hearing commencing on 12 June 2023

in relation to the Queen Elizabeth University Hospital and the Royal Hospital for Children, Glasgow

Bundle 3 – NHS National Services Scotland: Situation, Background, Assessment, Recommendation (SBAR) Documentation

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Pseudomonas risk: Taps	
Situation	NHS Greater Glasgow and Clyde (GG&C) have sought advice from Health Protection Scotland (HPS) on the requirement to remove flow straighteners from the taps procured for the new Southern General Hospital (SGH).
Background	The Horne Optitherm tap which incorporates flow straighteners, was procured for all clinical environments within the new SGH prior to the publication of UK and Scotland-wide pseudomonas guidance in June 2013[1, 2]. The HPS, Guidance for Neonatal Units (NNUs) and adult and paediatric ICUs, June 2013[1], states; *"Bio film can develop on flow straighteners and it is recommended that these are removed from taps."* This recommendation is also made within SHTM 04-01: part A Design, Installation and Testing, section 9.51, note 12[3]; suggesting that it should be applied universally in all clinical areas across the hospital.
Assessment	It is recognised that any alterations made to the taps may make the warranty of the devices invalid and therefore this assessment focuses on the: • Function of the flow straighteners as advised by Horne; and • Current guidance on minimising the risk of *Pseudomonas aeruginosa* infection from water. In assessing the HAI risks associated with flow straighteners HPS also sought the advice of Dr Jimmy Walker, Water System Microbiology and Decontamination Expert, Public Health England (Porton Down). In addition advice was sought from a Consultant Microbiologist from NHS Lothian and the Estates Department at NHS Forth Valley. Our response to Horne's statements[4] on the function of flow straighteners is set out below: • Provide laminar flow: Agreed. Flow straighteners are there to provide laminar flow which reduces the dispersal of droplets from running water. • Regulate the flow rate: Agree in part. Some sites have issues with too much flow/pressure resulting in water droplets being disseminated from the

	wash hand station which can be an issue near medicine preparation areas or where medical equipment is being decontaminated. The fitting of flow control devices would have to be balanced with a risk of HAI issues (where too much flow is present) resulting in water droplets contaminating the surrounding area. • Retain water inside the tap: There is no evidence for this claim. Although flow straighteners reduce the amount of water inside the tap, because the tap remains moist there is no evidence to suggest this would reduce the number of micro-organisms present. In considering water safety for healthcare premises, in particular minimising the risk of *Pseudomonas aeruginosa* infections arising from water, the removal of flow straighteners from taps in high risk units is one of a number of critical controls to be considered in the hospital water delivery system. The positioning of hand hygiene products around hand wash stations, water pressure, and flow rate are highlighted together with other considerations on pages 8 and 9 of the 2013 HPS guidance[1]. There are three options to tap installation in the SGH: 1. Instruct the contractor to install the procured taps in all clinical areas across the SGH. This would subsequently require NHS GG&C to commence a water sampling regimen to monitor for *Pseudomonas* in high risk units. 2. Instruct the contractor to install the: • Procured taps in all clinical areas across the hospital excluding high risk units; and • Procured taps without flow straighteners in high risk units. 3. Instruct the contractor to install: • The procured taps in all clinical areas across the hospital excluding high risk units; and • New compliant taps (without flow straighteners) in high risk units.
Recommendation	The HPS Guidance for NNUs, adult and paediatric ICUs in Scotland[1] is designed to minimise the risk of infection with *Pseudomonas aeruginosa* – the risk however can never be eliminated. Based on the above assessment and the extant national guidance on water safety and potential infection risks to patients, particularly in high risk units[1, 2] HPS recommend NHS GG&C to progress with option 2 or 3.

References

1. Health Protection Scotland (HPS) 2013, Guidance for neonatal units (NNUs) (Levels 1, 2 & 3), adult and paediatric intensive care units (ICUs) in Scotland to minimise the risk of *Pseudomonas aeruginosa* infection from water
   http://www.hps.scot.nhs.uk/haiic/ic/guidelinedetail.aspx?id=54784

2. Scottish Executive Health Department, CEL (2013) 8, Water sources and potential infection risk to patients in high risk units – a revised guidance
   http://www.sehd.scot.nhs.uk/mels/CEL2013_08.pdf

3. Health Facilities Scotland (HFS) 2012, Scottish Health Memorandum 04-01: The control of *Legionella*, hygiene, 'safe' hat water, cold water and drinking water systems Part A: Design, installation and testing
   http://www.hfs.scot.nhs.uk/publications

4. Email communication from Ian Powrie, Senior Estates Manager, NHS Greater Glasgow and Clyde, 10th March 2014, Re: enquiry regarding taps in the SGH

Time Line of Actions
NHS Greater Glasgow and Clyde
Serratia marcescens NNU

SITUATION
Between August and December 2015 there have been 16 cases of Serratia in the unit. Four different types have been identified but within these there are two possibly 3 clusters which indicate cross transmission on the unit. All babies were identified on routine weekly screening. 15 were colonised [redacted]. The literature suggests that low birth weight, low gestational age, antibiotic therapy, indwelling central venous catheters or umbilical catheters, and ventilation are all risk factors. [redacted]

Every baby was reviewed by a member of the IPCT at the time of the positive isolate, to try to determine the baby's condition, whether they were colonised or infected and if there were any obvious common links. A time line was developed in August and reviewed continually. Review is problematic with this organism in that initially and for several weeks until typing is available it is possible that this organism is part of the patients normal gut flora inherited from their parents or if it is due to cross transmission. Movement of babies in the unit is also frequent as their condition improves or deteriorates or if they need intervention by specialist colleagues. These babies have interaction with neonatologists, neonatal surgeons, AHPs, parents and siblings, nursing staff numerous times per day. Determining a single source is extremely complex and often never identified.

This is a list of some of the actions taken. A more detailed list is included in the time line below:

- The Compliance with hand hygiene has been continually monitored but education for parents has also been reviewed with literature and posters developed to reinforce this message.

- New personal protective equipment guidance has been developed to ensure consistency of practice. This has been reinforced during the daily visits to the unit.

- House keepers are present in the unit but their role has been reviewed in order to prioritise near patient equipment decontamination.

- Cleaning of equipment specifically breast pumps has been reviewed and mothers given specific instructions on how to use this equipment. This has been audited and compliance has been found to be good.

- Additional domestic services have been allocated to the unit and the national audit has returned scores of 96 and 97% in the past several months.

- Paediatric bundles to manage invasive devices will be developed by the directorate. This is a highly specialist area and will be clinically lead by the Chief Nurse who is a SPSP fellow.

- All taps have been changed on the unit to the same type used in the Royal Hospital for Children.

- Patient screening continues weekly.

- GGC will continue to review the scientific literature and implement any additional actions recommended. A single source has not been identified but this is not unusual in this type of incident.

- [redacted]
  This has been agreed with the Chief of Medicine for the Directorate. All these cases will involve the clinical risk manager and reviewed at the meeting of the Directorate Clinical Governance meeting.

BACKGROUND
The NICU in the maternity block is a 64 bedded unit with 50 of these beds currently in use. This unit cares for both medical and surgical neonates. As part of the acute services review the existing unit was merged with paediatric NICU in June 2015.

Epidemiology

Background epidemiology into this outbreak has been problematic for several reasons:

- Number of cots in the unit doubled in June 2015.
- Screening regime (weekly) which was in place in RHSC was extended to include the babies in NICU in the maternity Unit from June 2015.
- Microbiological analysis of samples was extended beyond the accepted norm of gram negative resistance to species level. The normal screening processes in these types of units is aimed at identifying resistant gram negative organisms and the majority of units conduct microbiological analysis to this point; this informs antimicrobial therapy. In the paediatric NICU in the Royal Hospital for Children, screening went beyond that to species level and this was adopted by the South Glasgow NICU. No other units in Scotland carry out this type of screening and as a consequence GGC have not been able to benchmark their rates.
- Serratia is a normal part of an individual's body flora and mums are actively encouraged to pass on their own flora as part of kangaroo care which is a normal process post birth.
- It is accepted in the literature that exposure to antibiotics during treatment and the NICU background flora may
- Without debate the epidemiology confirms that cross transmission has occurred on the unit with two or possibly three clusters. Four different sub types have been identified.

ACTIONS

20.08.15 Incident Meeting (IM) Summary
- Four cases of S. marcescens identified on the unit.
- All babies colonised in ET aspirate.
- Actions
  - Infection Control Audit carried out – score 81%
  - Infection Control Practice Audit carried out – score 90%
  - HH audit carried out –score 90% opportunities and 80% technique
  - Board HH coordinator trained clinical staff in the correct procedure with regards to local audit of practice.
  - Role of the housekeepers in terms of the cleaning of near patient equipment was to be clarified by the unit.
  - Unit were advised to review storage options.
  - Cleaning schedule for equipment out with the cot space was to be implemented by unit staff.

- Review of unit cleaning schedule to be discussed by unit and facilities staff. IPCT would assist.
- Terminal clean of the whole unit with chlorine based detergent was completed on the 14th August.
- Review of the cleaning of breast pump equipment was conducted by breast feeding coordinator. IPCT advised that breast cleaning pump checklists must be signed off.

03.09.15 IM Summary

- Six cases (no typing available – not all sent)
- All colonised no infections.
- Update on actions
  - Four HH auditors now trained.
  - HH educational sessions for medical staff commenced in response to HH audit results, commenced in response to HH audit results.
  - HH PowerPoint presentation developed for staff to view in their own time.
  - New HH poster developed for the unit, commenced in response to HH audit results. Mobile phone contamination.
  - Occupational review of HH products requested – high use of dermol 500. SCN will discussed with staff
  - Review of the role of the housekeepers now underway.
  - Checklist for equipment cleaning out with bed space is underway.
  - Twice daily cleaning with chlorine based detergent in patient areas commenced.
- Additional Actions
  - PPE SOP use to be developed with IPCT and SCN.
  - Sign off sheet for chlorine clean proposed and accepted.
  - Domestic hours to be reviewed by domestic manager
  - Domestic monitoring scores reviewed – 97% August.
  - Spot checks of breast pumps to be carried out – cleaning will be emphasised to mums.
  - Lead IPCN will discuss shared patient equipment and application of SICPs with radiology staff.

17.09.15 IM Summary

- Eight cases – 6 confirmed as the same type.
- All colonised no infections.
- Update on actions
  - Ongoing local HH audits – most recent result 95%
  - PPE SOP finalised.
  - SCN meeting with housekeepers to confirm expectations of role in relation to cleaning of equipment.
  - Twice daily clean had been stopped after meeting on 03.09.15
- Additional Actions
  - Audit of breast pumps to be done by SCN
  - Breast feeding specialities to make posters to help mums effectively clean breast pumps after use.
  - Ensure that domestic sign off sheet is completed at the weekends.
  - Clinical staff agreed to let IPCT know when new medics join the unit so that HH education can be put in place.
  - Vents not cleaned due to occupancy – IPCT will as for PPM programme and that vents must be cleaned.

- Review of laryngoscope handles – blades sent to CSSD, handles cleaned as per GGC SOP.
- Review of humidity tanks conducted. IPCT advised the unit to find out updated manufacturer's instructions and to follow these.
- Advice given by IPCT regarding the cleaning of the giraffe incubators. Some noted to have damaged doors – unit advised to have these replaces as soon as possible.
- Poster reminding parents to carry out HH after accessing the milk fridge has been placed on the milk fridge door.
- Confirmed that baby blankets are laundered twice per week by the central laundry.
- Unit advised to use disposable bowls for washing.

01.10.15 IM Summary

- 9 cases – 8 confirmed as the same type.
- All colonised no infections.
- Update on actions
  - HH audits continue
  - 'please protect me' poster on HH for parents available.
  - IPCT audits repeated. Practice 85%, General 84%. Results fed back at the time.
  - Breast feeding posters (decontamination of equipment not available yet)
- Additional actions
  - Additional domestic hours at the weekend resourced and in place
  - Vacuum extractor system advised for cleaning vents (PPM).
  - No clear guidance on the cleaning of humidity tanks available – referred to NHSGGC Decontamination Group for advice.
  - IPCT to contact medical physics to escalate damaged incubators.

15.10.15 IM Summary

- 10 cases – 8 confirmed as same type. No crossover, time, place, person with this case and the others. [redacted]
- All colonised no infections.
- Update on actions
  - HH audit by board HH coordinator conducted – score 90%.
  - HH compliance raised with Chief Medic for Directorate – advice will be given to medical staff especially those visiting the unit.
  - Unit given advice for GGC decontamination group re humidity tanks.
- Additional actions
  - PEER audit by SCN for Royal Hospital for Children was carried out – HH reported to be very good.
  - Any items stored on the floor must be removed and stored appropriately.
  - Breast pump audit completed. [redacted] had received education on how to decontaminate equipment.
  - Follow up meetings with staff and occupational health has taken place.

9.10.15 IM Summary

- Thirteen cases – three new in the past three weeks.
- All colonised no infections. [redacted]
- Two different types identified.
- [redacted]
- Update on actions
  - Equipment storage – unit to look at this again.

- Additional actions
    - Formal Walk round IPCT – noted in addition to other factors, PPE difficult to access, HH sinks difficult to clean. Storage of equipment still not adequate.
    - Neonatal transport Room – sink to be removed.
    - Relocate PPE dispensers
    - Flushing compliance sheets for sinks to be reintroduced.
    - Twice daily clean of HH sinks with chlorine.
    - Samples of residue from ventilator circuits done.
    - Clinicians on the unit to review CVC/PVC bundles and work with practice development to ensure compliance.
    - Wipes to be used instead of water to clean babies.

02.11.15 OCT summary

- Thirteen cases. [redacted]
- HIIAT RED
- 8 cases confirmed with the same type.
- [redacted]
- Additional actions
    - Press statement released
    - HPS informed and invited to review practice and attend OCT.

03.11.15 OCT summary

- Thirteen cases. [redacted]
- HIIAT GREEN
- [redacted]
- All colonised no infections
- Additional actions
    - PVC and CVC care bundles reinforced
    - Breast pumps to be swabbed.
    - Spreadsheet with all gram negative isolates from the unit sent to HPS as requested.

05.11.15 OCT Summary

- Thirteen cases. [redacted]
- HIIAT GREEN
- [redacted]
- All colonised no infections
- Additional Actions
    - SICPs training carried out with new staff.

09.11.15

- Thirteen cases. [redacted]
- Three different types identified.
- HIIAT GREEN
- [redacted]
- All colonised no infections
- Actions update
    - Serratia not isolated from ventilator circuits tested. Four more will be tested.
    - Serratia not isolated from breast pumps.
    - All patients isolated if possible.
- Additional Actions

- Floor plan from estates for HPS
- Review of patient bed movement requested

12.11.15

- Thirteen cases. [redacted]
- Three different types identified.
- HIIAT GREEN
- [redacted]
- All colonised no infections
- Additional actions
  - Review of sensor taps – replace with horn taps
  - Audit of cleaning equipment
  - OD event for staff – support for merger – practice issues
  - Line listing requested by HPS

19.11.15

- Thirteen cases. [redacted]
- Three different types identified.
- HIIAT GREEN
- [redacted]
- All colonised no infections
- Actions update
  - CN to lead QI group on CVC and PVC bundle compliance
  - Audit of cleaning equipment complete
  - All environmental samples negative for Serratia
- Additional actions
  - 75 water samples taken
  - Quality of medical gasses checked
  - High contact surfaces swabbed.

26.11.15 OCT Summary

- Fourteen patients identified, [redacted]
- Three different types identified.
- HIIAT GREEN
- Additional Actions
  - Occupational health review of all members of staff with local education on the correct use of the range of product available to promote good skin integrity.
  - Line listing continues to be developed.
  - Foam soap to encourage compliance with HH installed.
  - Clinicians in the unit requested a national policy recommendation on screening. HPS agreed to consider this question and advise the group accordingly.

02.12.15

- Fifteen patients identified. [redacted]
- Three different types identified.
- HIIAT GREEN
- Update on actions

    - Draft line listing completed – will meet with HPS next week to complete.

- Additional Actions
    - Observational audit of dummies.
    - Swab breast pump kit used by mum.
    - [redacted]
    - Review draft of national guidance on the decontamination of breast pumps.
    - Review stoma washouts to determine if this is contaminating the environment – not found in environmental swab but action will be taken.
    - Review of steam sterilisers and the possible use of Milton will be carried out.
    - New clinical PEER review to be done.
    - Antibiotic review to be discussed with clinicians.
    - Drip trays from condensate from pipes in ceiling to be sampled.

RECOMMENDATIONS

We would recommend the following:

- We have yet to identify a source. The scientific literature would suggest that in outbreaks of this type no single source is often identified, however we will continue to review this literature and put in every possible action suggested. At the next OCT we are also going to discuss staff screening.

- After review of the cases we are working on the hypothesis that the last two cases are linked. [redacted]

- We will continue with the action plan and meetings until there have been no new cases for two weeks.

- Members of the IPCT will continue to review the ward on a daily basis.

- We will propose and try and identify resource to conduct a case controlled study as soon as possible.

- [redacted]. This has been agreed with the Chief of Medicine for the Directorate. All these cases will involve the clinical risk manager and reviewed at the meeting of the Directorate Clinical Governance meeting.

SBAR: HPS Outbreak support visits to NICU, Neonatal Unit, Royal Children's Hospital, NHS GG&C: 5th and 12th November 2015

1. Situation

On Tuesday 3rd November 2015, SGHSCD contacted HPS to invoke formally the National Support Framework CNO (2015) (http://www.documents.hps.scot.nhs.uk/hai/infection-control/guidelines/cno-algorithm-v2-2015-10.pdf) *"..to address in particular the reasons for the number of cases of Serratia marcescens identified in the NICU, Royal Hospital for Children since July 2015*." The email noted SGHSCD concern that the number of cases had not been communicated as per national policy. The following four questions were requested by SGHSCD for NHSGG&C response:

- *How many patients in total have been colonised or infected and what body sites?*
- *In the past 6 months have any other environmental Gram-negative organisms been identified from patients within the unit?*
- *What immediate IPCT measures are in place?*
- *What are the environmental/SICPs audit activity in place?*

2. Background

On Monday 2nd November 2015, SGHSCD and HPS ICT were made aware, via an email forwarded from the HPS On-call Consultant, of:

- An upgrade of a HIIAT assessment from GREEN to RED. [redacted],

[redacted]

- An increase in incidence of *Serratia marcescens* in the NICU at the Royal Hospital for Children. A NHSGG&C Problem Assessment Group (PAG) Meeting was held on Thursday 29th October 2015 when it was noted that there had been 4 new cases of *S. marcescens* colonisation in October 2015, bringing the total number of cases since 20th July 2015 to 13: Twelve of these being colonisations. The HIIAT assessment was confirmed GREEN on 29th October and the NICU remained open to admissions. A local action plan was in place.
- The HIIAT RED assessment was confirmed by NHSGG&C to SGHSCD and HPS ICT in the afternoon of Monday 2nd November 2015.

Following SGHSCD invoking the National Support Framework CNO (2015); HPS ICT attended (via T/C) the NHSGG&C Outbreak Control Team (OCT) meeting at 4pm on Tuesday 3rd November. A timeline of cases and a local action plan were tabled at this meeting. No further cases of *S. marcescens* had been reported since 26th October 2015. The NICU remained open to admissions.

3. Initial assessment

A rapid search of the literature for *S.marcescens* outbreaks in neonatal settings identified the following sources of contamination:

- Healthcare workers hands
- Contaminated hand hygiene products (anti-microbial and non-antimicrobial soaps, dispensers etc)
- Taps, sinks, sink drains
- Respiratory equipment
- Milk formula/expressed milk, enteral/parenteral feeding solutions or additives
- Incubators/cribs
- Overcrowding
- Contaminated analysers (Blood-gas, glucose/lactate etc)
- Suction/aspirating equipment

Single point-sources were unusual, some studies did not identify an environmental source and the role of the sources that were identified was not always clear e.g. contaminated sink drains were possibly a result of contaminated hands and not contributing significantly to the outbreaks.

Other sources included: baby shampoo, internal tocographs, laryngoscope blade, hand washing brushes and an air conditioning unit (see Appendix 1: Rapid Review of the Literature).

With the above information in mind, and in answer the SGHSCD questions: "*What immediate IPCT measures are in place?* [and] *What are the environmental/SICPs audit activity in place?"* HPS ICTs initial review of the NHSGG&C ICT action plan was that infection control measures were appropriate and promptly put in place (action plan commenced August 2015). Further discussion and confirmation was sought on the following actions listed in the NHSGG&C ICT plan:

Hand hygiene

- Do hand hygiene audits include compliance of staff with: no false nails/nail varnish, breaks in the skin (note from the plan that there are a high number of staff using Dermol 500), in addition to correct technique and hand hygiene moment?
- Have all staff groups been identified on all shifts (e.g. visiting clinicians, bank staff, etc) and included in the hand hygiene messaging and auditing?
- Are all hand hygiene sinks dedicated for this purpose only?

PPE

- Single use, disposable aprons and gloves are in use for all colonised and infected babies?

Equipment

- Have all items of equipment in direct contact with the babies been identified?
- Are all staff familiar (responsibilities assigned) with the use of equipment and decontamination procedures / processes (including storage) for all reusable equipment as cited in the literature?

Environment and water

- Decontamination of frequently touched surfaces?
- Aseptic procedures are prepared and performed in areas where there is no splash contamination?
- All controls are in place as per national guidance for NNUs to minimise risk of *Pseudomonas aeruginosa*? (http://www.documents.hps.scot.nhs.uk/hai/infection-control/guidelines/pseudomonas-2014-07-v2.pdf)
- The need for environmental sampling has been formally assessed?

Ventilation

- All ventilation units / air-conditioning units have been commissioned and are part of a planned preventative maintenance programme?

In addition:

- Has there been any independent observation of standard workflow practices to identify any sub-optimal practices/behaviours/procedures?
- Has the patient journey been explored to determine possible exposures / where cross contamination may be occurring?
- Were there / are there any commonalities with the colonised / infected babies?
- Did something change in June/July 2015 e.g. did the population of the ward change recently i.e. population more at risk of acquiring infection?
- What are the outcomes from the actions in the plan? Have the interventions been evaluated to provide assurance on the understanding of the importance of the control measures and ownership of these going forward?

4. Onsite Visit: 5TH November 2015

An onsite visit to the Neonatal Unit at the Royal Hospital for Children was arranged for Thursday 5th November 2015. The purpose of this visit was to discuss the above questions and:

1. See the unit to understand the environment, equipment, procedures to further consider potential reservoirs for infection and transmission routes; and review the NHSGG&C ICT action plan post visit to the unit (first drafted August 2015 to address the increased incidence of *S.marcescens*) with the ICT ; and
2. Review the revised epidemiological timeline from NHSGG&C ICT and establish whether a line listing had been completed.

4.1 Visit to the Neonatal Unit and review of NHSGG&C Action Plan

(Pamela Joannidis and Sandra McNamee, NHSGG&C, Lisa Ritchie and Heather Wallace, HPS)

The NNU accommodation comprises two levels with a capacity of 64 cots; there is currently 50 cots staffed.

Lower Level (NICU/HDU):

- 2 single rooms (room 2 and 3) for non-inpatients: ward attendees' from home for clinical review/ assessment; and babies transferred for clinical procedures from post natal wards e.g. IV antibiotics
- 4 single rooms (1, 2, 9 and 10) for inpatients
- 4 x 6-bedded bays: room 4, 5, 6 and 7
- 1 x 4-bedded bays: room 1
- Blood Gas Analyser room, Equipment Cleaning Room, single room used for equipment storage with sink (unused water outlet), single room used for storage neonatal transport equipment with sink (unused water outlet), Disposal Room, Milk/Expression Room, Breast Milk Store, CSSD, Parents sitting room, mortuary holding area, Linen Store, Medical Gases Room, Pharmacy, drug area, Overnight room, Toilets, Service Lift for removal of waste etc.

Upper Level (SCBU/HDU):

- 2 x 4 bedded bays: room 1 and 2
- 1 x 6 bedded bay: room 9
- 3 single rooms: room 3, 4 and 5
- Supplies Room, Equipment cleaning room, Milk Room.

Service changes

Often an outbreak will start with a change in something e.g. a new process or a new product. Recent, key changes that may have increased the likelihood of this outbreak arising was discussed with the ICT and NNU SCN:

Service amalgamation:

- The merger of the neonatal services in NHSGG&C, starting in 2009 (Queen Mother Hospital and Southern General), was completed mid-June 2015 with the amalgamation of the NNU staff team and neonates (medical and surgical) from Yorkhill ward 2B moving to the Royal Hospital for Children.

Staffing:

- Staff cover is made up of core staff with additional floating staff; team nursing is not practiced. Staffing ratios for patient safety and optimal management were reported by the SCN to not always able to be facilitated: ITU 1:1; HDU 1:2; and SCBU 1:4
    - Shortages of staff in a busy unit caring for neonates with complex clinical needs may increase the risk that SICPs may not be followed adequately to negate all cross-transmission risks.

Visiting:

- In June, the NNU changed to an open visiting policy; the handling of neonates' remains restricted to parents and siblings only.
    - Poor hand hygiene practice by visitors is difficult to control. Parents are directly involved in the care of their babies.

Patient screening:

- Prior to amalgamation of the NHSGG&C NNUs; Yorkhill protocol was to screen on admission and weekly thereafter; the Southern General only screened if clinically indicated following a negative admission screen. Current screening sites:
    - Admission screening:
        - In-born: ear, umbilicus and throat
        - Out-born <48 hours old: ear, umbilicus, throat and rectal
        - Out-born >48 hours old: mouth and rectal

Environment:

- The scrub (trough) sinks in the patient rooms on level 1 were reported to be causing splash contamination of the surrounding area. The length and position of the sensor taps were reported to increase the risk for splash. There were a number of issues identified at the sink areas e.g. PPE kept next to sink, numerous products available, and not enough hand towel dispensers.
- The level of equipment required in each cot area was also identified as causing access issues for routine environmental decontamination.

Equipment:

- A change of use in some of the rooms from patient care areas to equipment storage rooms meant there were unused water outlets where equipment is stored.

Breast Feeding Equipment:

- This is the responsibility of mums using the equipment; designated area, five breast pumps available for use (dedicated use if known infected patient); single use breast milk collection bottles; single parent use breast feeding equipment and storage container; decontamination using detergent only.
    - Swabs of breast pumps sent for laboratory testing – negative result returned on 9th November. Repeat swabs to be taken.

Ventilators:

- Concern in the increase in condensate in a specific type of circuit tubing was reported by clinical staff since a change of supplier. The manufacturer has been contacted regarding this.
    - Condensate sent for laboratory testing – Gram-positive organisms only reported on 9th November 2015. Repeat samples to be taken.

4.2 Review of the revised epidemiological timeline

[redacted]

4.3 HPS Recommendations

NHSGG&C ICT / OCT:

- Check all controls are in place as per national guidance for NNUs to minimise risk of *Pseudomonas aeruginosa*?
- Consider use of sterile water for washing babies whilst new washing wipes for babies are procured.
- Consider undertaking:
    - Independent observation of standard workflow practices to identify any sub-optimal practices/behaviours/procedures.
    - Unannounced visits on all shifts to monitor compliance and to watch who and what is coming into contact with these babies e.g. hands, PPE, shared multi-dose products.
- Evaluate the interventions on the action plan; make sure any identified failures are being addressed; and confirm ownership for actions going forward.
- Implement a programme in this unit that monitors healthcare staff to ensure ongoing compliance with SICPs and contact precautions; and promotes the same with parents and visitors to the unit.

- Ongoing surveillance to identify colonisation/infection to evaluate the effectiveness of control measures implemented.
- Consider sampling of environmental surfaces and taps to identify potential sources of *S. marcescens.* The rationales for the screening the breast pumps and the ventilator tubing was not clear; suggest that a formal assessment of environmental sampling is undertaken.
- Gather further information on each of the cases; clinical, demographic and exposure information in the line listing to determine any similarities between the cases and consider whether the case definition for this outbreak requires review.
- Agree/specify the methodology of identification of colonisation versus infection cases.
- Review the microbiology laboratory data for the last 6 months for the NNU; agreed HPS would look at ECOSS data using CHI numbers of the 13 cases.

It was agreed that a further meeting would be scheduled to review the confirmed *S. marcescens* samples/cases between July and October 2015 and address the other two questions asked by the SGHSCD:

- *How many patients in total have been colonised or infected and what body sites?*
- *In the past 6 months have any other environmental gram-negative organisms been identified from patients within the unit?*

5. Onsite Visit: 12TH November 2015

(Dr Craig Williams, Dr Heuchan and Pamela Joannidis, NHSGG&C, Dr Michael Lockhart and Lisa Ritchie, HPS) The purpose of this meeting was to:

5.1 Review the confirmed *S. marcescens* samples/cases between July and October 2015

The case definition was discussed with regards to its inclusiveness: *"Any baby colonised or infected with S. marcescens from any sample/screen site in the NNU from 27th July 2015."*

NHSGG&C based the case definition on the timing of the two staff groups (Yorkhill and Southern General) coming together in June 2015 and *S. marcescens* being a rare organisms in the NHSGG&C NNU screening samples prior to this time. NHSGG&C agreed to confirm the rarity of *S. marcescens* in the NNUs prior to June 2015.

A decision was taken by NHSGG&C to fix processes in recognition that some basic practices in the NUU e.g. SICPs were considered to be sub-optimal. Thus, the action plan was/is the main focus for the ICT/OCT. However, it was agreed that further development of the line listing including clinical, demographic and exposure information of the cases e.g. gestational age, delivery mode, antibiotics, presence of lines, cot numbers, etc would assist in developing hypothesis and determining whether further interventions are required (and any further case ascertainment).

From the antibiograms of the 13 cases; it was noted that there was variation around the Tobramycin sensitivity results. NHSGG&C confirmed that an audit of antimicrobial prescribing in the NNU was underway

5.2 Gain more information on the isolation of other gram negative organisms from clinical specimens from neonates.

HPS tabled ECOSS data (using CHI numbers) on the 13 cases. This data showed that three out of the 13 babies had "coliform species" reported prior to *S. marcescens* being reported (in two cases this was a week before); therefore it is possible that these coliforms could have been *S. marcescens* too. Henceforth, it was agreed that all coliforms from all screen sites of babies in the NNU be identified to species level.

Patient screening methodology, as previously discussed on 5th November, prior to amalgamation was/is not standardised; Yorkhill protocol was/is to screen on

admission and weekly thereafter; the Southern General only screened if clinically indicated following a negative admission screen. Yorkhill use the screening to guide empiric therapy. A NHSGG&C group is currently being established to agree standard procedures for patient screening for all NNUs.

5.3 Provide assurance that current reporting and surveillance is robust and consistent; addressing the two questions asked by the SGHSCD:

- *How many patients in total have been colonised or infected and what body sites?*
- *In the past 6 months have any other environmental Gram-negative organisms been identified from patients within the unit?*

Typing on the 13 *S. marcescens* cases:

- 10 babies colonised with Type SERN07SE-4 (one of these Types was similar but different from the other 9)
- 3 babies (2 colonised and one infected) with Type SERN07SE-5

Further typing was requested.

HPS tabled ECOSS data covering the last 6 months for NNUs in NHSGG&C (recognising the limitations and potential inaccuracies of this data) NHSGG&C disclosed that in addition to the *S. marcescens* outbreak in the NNU [redacted] Other potential environmental Gram-negative bacilli were also noted from this data e.g. *Stenotrophomonas maltophilia.* HPS reiterated that this should have been HIIAT assessed at the time (HIIAT Red) and reported via the HAIORT.

HPS Recommendations

NHSGG&C ICT / OCT:

- Review previous microbiological data to confirm rarity of *S.marcescens.*
- Re-check all controls are in place as per national guidance for NNUs to minimise risk of *Pseudomonas aeruginosa*?
- Based on the *Pseudomonas aeruginosa* isolate in addition to the *S.marcescens* and other potential Gram-negative bacilli, confirm the need for environmental sampling has been formally assessed. Check and review with Facilities/Estates water sampling within the unit.

- Gather further information on each of the cases (the line listing: clinical, demographic and exposure information) and reconsider the case definition for this outbreak.
- Ensure all laboratory reported coliforms from all screen sites of babies in the NNU are identified to species level.
- Continue to notify receiving units of colonisation status for neonates transferred from this unit.
- Agree standard procedures for patient screening for all NNUs including; clarity on screening sites and discharge screening (a group was reported to be being established to develop this for NHSGG&C).
- Reflect on HIIAT assessments and outbreak reporting: The objective of the HIIAT tool is to provide all those who manage and need to know about hospital infection incidents; an impact assessment. [redacted]

HPS:

- Continue to offer support to NHSGG&C.
- Request HFS to make contact with NHSGG&C Estates.
- Pursue further information with PHE and other UK organisations with regards to water sampling protocols and GNO triggers within NNUs.
- Consider the development of a national NNU screening policy.

Appendix 1

Rapid Review of outbreaks of *Serratia marcescens* in neonatal intensive care units

Introduction

Serratia marcescens, a member of the Enterobacteriaceae family, is an important cause of invasive infections in neonatal intensive care units (NICUs), with significant associated morbidity and mortality.[1] The microorganism cause infections such as pneumonia, urinary tract infection and bacteraemia and is able to survive in moist nosocomial environments and colonise the gastrointestinal tract of neonates and the hands of health care workers. *S. marcescens* often develops multidrug resistance and tends to spread rapidly in the nosocomial environment, and has been implicated in outbreaks of nosocomial infection both in neonates and adults.[1] *S. marcescens* is more likely to colonise the respiratory and urinary tracts of hospitalised adults but the gastrointestinal tract in neonates. Some of the environmental sources associated with cross infection include contaminated disinfectants, sinks, adhesive tape, bronchoscope, ventilator equipment, breast pumps, expressed breast milk, incubators, suction/aspirating equipment and contaminated analysers (blood-gas, glucose/lactate etc.). In most outbreaks no point source is identified and the contaminated hands of health care workers are thought to be the principal means of spread. Other sources included; baby shampoo, internal tocographs, laryngoscope blade, hand washing brushes, overcrowding, transfer of high risk infants and an air conditioning unit.

Risk factors for nosocomial infection of neonates include;

- Low birth weight <1500g
- Premature delivery
- Use of invasive devices
- Prolonged hospital stay and intensive care
- Prolonged use of antibiotics
- Maternal infection prior to delivery

The objective of this rapid review was to identify outbreaks of *Serratia marcescens* outbreaks in NICUs and to identify sources of transmission.

Rapid literature review of outbreaks

A rapid search of literature for *S. Marcescens* outbreaks in NICUs returned 82 articles of which 32 are included in Table 1. The most common source of transmission reported as contributing to the outbreaks of *S. Marcescens* were: contaminated medical equipment (15/32 [46%]), contaminated hygiene products (8/32 [25%]), healthcare worker hands/person to person transmission (8/32 [25%]), contaminated parental nutrition (6/32 [19%]), water tap/drains (5/32 [16%]) and other sources accounting for (7/32 [22%]). All the included reported outbreaks were from the neonatal setting and in one publication the outbreak extended from the NICU to the nursery in the same hospital.[2]

Table 1: Serratia marcescens outbreak reports in the literature

Total no	Possible source	No infected/colonised/deaths	Incident type	Year
8	**Contaminated hygiene products –** soaps, dispenser, baby shampoo	127 affected/43 infected/3 deaths	outbreak	2013[3]
		54 affected	outbreak	2012[4]
		6 cases/2 deaths	outbreak	2011[5]
		14 affected	outbreak	2011[6]
		32 infected	outbreak	1997[7]
		56 cases	outbreak	2001[8]
		5 infected	outbreak	2009[9]
		4 colonised/5 infected/2 deaths	outbreak	2008[10]
15	**Contaminated medical equipment –** respiratory oscillator, laryngoscope blade, incubator etc	127 affected/43 infected/3 deaths	outbreak	2013[3]
		54 affected	outbreak	2012[4]
		7 affected	outbreak	2011[11]
			outbreak	1982[12]
		1 infected/36 colonised	outbreak	1999[13]
		16 infected/colonised	outbreak	2008[14]
		6 infected/14 colonised/3 deaths	outbreak	2008 [15]
		26 infected/82 colonised	outbreak	1984[2]
			outbreak	1985[16]
		4 infected/2 death	outbreak	2005[17]
		9 colonised/infected	outbreak	2001[18]
		17 colonised/2 deaths	outbreak	2000[19]
		3 infected/colonised/1 death	outbreak	1999[20]
		5 infected/colonised/2 deaths	outbreak	1997[21]
5	**Contaminated water taps/drains**	12 affected/13 infected/3 deaths	outbreak	2013[22]
		37 colonised/20 infected/20 deaths	outbreak	2012[1]
		2 infected/11 colonised/1 death	outbreak	2004[23]

		4 colonised/infected	outbreak	2004[24]
			outbreak	1985[16]
8	**Healthcare worker hands and person to person transmission**	9 infected/1 colonised/3 deaths	outbreak	2011[25]
		26 infected/colonised	outbreak	2011[26]
		115 infected/38 colonised/4 deaths	outbreak	1984[27]
		16 infected/colonised	outbreak	2008[14]
		9 infected/10 colonised	outbreak	2004[28]
		9 colonised/infected	outbreak	2001[18]
		4 colonised/infected	outbreak	2004[24]
		56 colonised/infected	outbreak	2001[8]
6	**Contaminated parental nutrition –** expressed breast milk	7 infected/colonised/1 death	outbreak	2010[29]
		34 infected/41 colonised/3 deaths	outbreak	2002[30]
		17 infected/colonised/2 deaths	outbreak	2000[19]
		1 infected/36 colonised	outbreak	1999[13]
		54 affected	outbreak	2012[4]
		37 colonised/20 infected/20 deaths	outbreak	2012[1]
7	**Other sources –** antibiotics	34 infected/41 colonised/3 deaths	outbreak	2002[30]
	Overcrowding	26 infected/colonised	outbreak	1984[2]
	Air condition unit	115 infected/38 colonised/4 deaths	outbreak	1984[27]
	Air condition unit	36 infected/colonised/5 deaths	outbreak	2002[31]
	Hand washing brushes	54 infected/colonised	outbreak	2012[4]
	Transfer of high risk infants	7 infected/colonised/1 death	outbreak	1981[32]
		26 infected/82 colonised	outbreak	1984[2]

Discussion

Outbreaks of *Serratia marcescens* infections in NICUs have been widely documented[1-32] and different sources have been implicated in these outbreaks, including contaminated healthcare worker hands, contaminated hand hygiene products, taps, sinks, sink drains respiratory equipment, milk formula/expressed milk, enteral/parenteral feeding solutions or additives, incubators/cribs, overcrowding, contaminated analysers (blood-gas, glucose/lactate etc.) and suction/aspirating equipment. In some outbreaks no means of cross infection or environmental source was identified and hands of health care worker were suspected to be the principal means of spread. In one report an outbreak in two hospitals implicated transfer of high risk patients and emphasised the importance of communication between the units in relation to colonisation status of transferred newborns babies during an outbreak; isolation of all infants transferred from such a unit should be considered whilst admission screening results are pending.[19]

Person to person transmission, overcrowding and understaffing have been identified as important reasons for breaches in Standard Infection Control Precautions (SICPs), and are suspected to contribute to the actual outbreak.[2;7;28] Nearly all reported outbreaks that stated breaches in hand hygiene precautions were suspected to represent an important mode of transmission. Healthcare worker re-education, particularly in relation to hand hygiene practices was an integral part of the interventions reported in most studies. Control measures reported in the literature included temporary closures of the affected unit to new admissions and reviews of staff to reach a better nurse to patient ratio. Furthermore, most publication reported that enhanced environmental cleaning/surveillance was implemented along with dedicated both clinical and domestic staff to the affected unit.[8;9;14;15;18;21-23;28] Infection control measures were intensified in most outbreaks especially in relation to hand hygiene protocols, cohorting of patients and staff, contact isolation precautions for affected neonates in some cases keeping isolation precautions in place until cultures are negative[29] and enhancing patient screening/surveillance for *S. marcescens*.[9] It is important to note that two publications reported ongoing transmission of *S. marcescens* despite intensified SICPs and contact isolation, and the outbreaks were only halted when the units were closed to new admissions.[2;20]

It is apparent throughout this review that very low birth weight, premature infants, use of invasive devices and length of hospital were significantly related to *S. marcescens acquisition*.[1-32] The acquisition of *S. Marcescens* is devastating in preterm infants and has been confirmed in identified literature causing serious infections including sepsis,

pneumonia, brain abscess and meningitis. Death has also been reported in infants with severe conditions and/or congenital malformations, meningitis and septicaemia. This rapid review identified that colonised or infected patients represent the most important reservoir for cross transmission and therefore SICPs and Transmission Based Precautions (TBPs) should immediately be implemented. Staff education and closure of the unit should be considered without compromising patient safety when SICPs and TBPs fail to interrupted transmission and halt the outbreak.[14]

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Queen Elizabeth University Hospital (NHSGGC) Bone Marrow Transplant Unit	
Situation	NHS Greater Glasgow and Clyde (NHSGGC) requested support from Health Protection Scotland (HPS) in the review of their Bone Marrow Transplant Unit within Queen Elizabeth University Hospital (QEUH) prior to transfer of patients from the Beatson Oncology Centre. This review focussed mainly on the ventilation and provision of a safe environment for the care of these patients within the QEUH.
Background	The decision to transfer the care of bone marrow transplant patients from the Beatson Oncology Unit to the QEUH was made in June 2013. Construction of the QEUH was well established at this point and therefore the unit was not purpose built. When the new hospital opened patients transferred to ward 4b from the Beatson Oncology unit. Concern was raised following environmental and air sampling yielded high particulate counts and fungal spore growth. On identification of these results the patients were relocated back to the Beatson Oncology Unit as a temporary measure whilst remedial work was undertaken in ward 4b. HPS were contacted on by Dr Inkster and support requested for a pragmatic assessment of the ventilation requirements which would allow NHSGGC to provide a safe environment for the care of BMT patients to resume within ward 4B QEUH and also for those who were being cared for within the critical care unit. HPS were also asked to consider whether additional precautions would be required over the coming years to protect these patients from environmental micro-organisms generated from the building works ongoing on the surrounding hospital site. This SBAR focuses primarily on the adult BMT (Ward 4b): HPS have been requested to support NHSGGC with other areas including the paediatric BMT (Schiehallion ward), Critical care and the ID unit relating to ventilation.
Assessment	A situational assessment was undertaken by HPS. This was undertaken by : • Requesting information from NHSGGC via a series of questions

	• Contacting Health Facilities Scotland to request support with the technical aspect of relevant guidance. • Liaising with Peter Hoffman (Public Health England) who is a recognised infection control ventilation expert. • HPS undertaking a rapid literature review (Appendix 1) Guidance: There is no single piece of suitable guidance applicable in this situation. The UK guidance comes from various sources including Scottish Health Technical Memoranda, Health Technical Memoranda, Scottish Health Planning Notes, CDC guidance and expert opinion. As the planning of this unit commenced in June 2013, the applicable Scottish Guidance is SHTM 03-01. Additional reference guidance includes • HTM 0401 : Supplement 1: however this guidance states that it doesn't offer protection for severely immuno-compromised patients • SHFN 30 • HAI scribe Expert Opinion/Scientific Evidence: HPS liaised with HFS regarding the technical requirements and guidance applicable. A rapid literature review was undertaken by HPS (Appendix 1) A teleconference was held between HPS and Peter Hoffman to discuss the minimum requirements for the provision of a safe environment for bone marrow transplant patients. Three of the most important aspects required include rooms that are held at positive pressure in comparison to the surrounding environment, rooms that are sealed and the air circulating has passed through a HEPA filter. This is supported by SHTM 03-01, consensus in the scientific literature and expert opinion [14]. The purpose of having HEPA filtration is primarily to remove fungal spores. These require to be well fitting to ensure that any air does not bypass the filtration system. The patients within this unit should be breathing air, 100% of which has passed through HEPA filtration.

	There should be 2 pre filters located in the air handling unit prior to the HEPA filter. The HEPA filter should be E12 (H13)[14] and to enable this to function correctly will require an appropriately sized and designed air distribution system. The room must be sealed with no ability to open windows. The room can leak clean air out however it must be protected from unfiltered air coming in. To enable this, the room must always be at positive pressure, with a rate sufficient to ensure a robust outward flow. In line with SHTM 03-01, 10Pa or above is required. In addition to having adequate pressures and to ensure safety there must be a monitoring system which allows continuous monitoring of the pressure within the room. This system must have an alarm system which will alert a drop in pressure. To allow a robust positive pressure system the walls and ceilings must be sealed smooth and impervious with any access hatches and service fittings securely sealed. Ceiling tiles are not suitable and therefore not recommended. In an ensuite room the clean air will pass from the main room into the bathroom, therefore the bathroom also requires to be sealed to ensure no access of unfiltered air. The recommended bedroom air changes detailed with SHTM 03-01 is 10 per hour. The proper holistic design of the air distribution system will aid dilution and removal of microorganisms released into the room. Ante rooms/Lobbies: there are no rooms within this unit which have ante rooms/lobbies. This presents a bigger challenge when the corridor air is not supplied via a HEPA filter and challenges the reliability of the HEPA filtered air and positive pressure within the room when the door is opened. A strict protocol which minimises the air entry via this route is required. To commission (or recommission) this unit particulate and settle plate testing should be undertaken to ensure useful reassurance however what is of greater importance is robust smoke testing to ensure any leaks are outwards. Ideally the corridor should also be HEPA filter supplied however this is normally only achieved in a purpose built unit and is less important if the rooms are appropriately ventilated and achieve positive pressure in comparison to the corridor. If deemed to be required these can be retrospectively fitted. The only room within this unit which requires to be at negative pressure is the “pentamidine” treatment room. The room must fully comply with health and safety legislation. When bone marrow transplant patients require more intensive support they will be managed in the critical care unit (ICU/HDU). The

	patients should be managed in a room which achieves the same standard required by guidance as those within ward 4B and achieve the same positive pressure and air changes and has HEPA filtered air. It must also be a sealed room.
Recommendation	To allow the provision of a protective environment for patients within the bone marrow transplant unit (Ward 4B) • The rooms must be positively pressured at 10 pa • ALL air entering the room must be via the HEPA filter • The HEPA filter should as a minimum be E12 (H13) and located within the supply air diffuser • The rooms must be sealed and no air which has not passed via the HEPA filter should access the room • A strict protocol which minimises the length of time the door is opened and reduces air entry via an open door is required. • There must be a continuous pressure monitoring system for each room which alarms and gives an early indication of a pressure drop within the room • Bedroom Air changes of 10 ACH must be achieved • The walls and ceilings within the rooms and ensuite must be sealed. • All room services must be sealed • All service access hatches within the bedrooms/ensuite must be sealed • The pentamidine room must be negatively pressured and comply with health and safety legislation • There must be at least one room available in the critical care unit capable of providing the same level of protection as those proposed in ward 4B • HPS will continue to co-ordinate and provide support with this issue and subsequently the Children's unit and additional areas of ventilation concern (Critical care, ID Unit, theatres) • HPS will co-ordinate and provide support a required relating to water control and testing in this unit

Appendix 1:

Rapid review on microbial air quality in bone marrow transplant units

Introduction:
Invasive infections caused by *Aspergillus* species are relatively rare in immunocompetent hosts; however the pathogen is recognised as being the second most common cause of fungal infections in certain immunocompromised patient groups.[1] The most frequently affected patient populations include bone marrow transplantation (BMT) recipients and patients with haematological malignancies undergoing intensive chemotherapy. Prolonged neutropenia is the major risk factor for invasive aspergillosis.[1] As *Aspergillus* spp. can be readily found in the environment, it has been widely believed that aspergillosis occurs as a consequence of exogenous acquisition of the fungus.[2] *Aspergillus* spp. are ubiquitous, aerobic fungi that occur in soil, water, and decaying vegetation; the organism also survives well in air, dust, and moisture present in health-care facilities.[3]Stringent environmental controls in transplant units such as air filtration, particularly by laminar air flow (LAF) or high efficiency particulate air (HEPA) filters, has been shown to decrease the level of fungal contamination in the air and the incidence of invasive *Aspergillus* infections in immunocompromised patients.[1;4] Construction work inside or adjacent to the hospital can cause aspergillosis outbreaks, particularly if the ventilation system is faulty or if the protective measures around the construction area are not sufficient.[5-7]

Site renovation and construction can disturb *Aspergillus*-contaminated dust and produce bursts of airborne fungal spores. Increased levels of atmospheric dust and fungal spores have been associated with clusters of healthcare–associated infections in immunocompromised patients.[8] Current guidelines and standards support the use of adequately managed isolation to prevent the transmission of pathogens from the outside environment to profoundly immunocompromised patients. Such isolation consists of negative air pressure rooms (for isolating patients who are capable of transmitting infections via airborne droplets) and positive pressure rooms (for protecting immunocompromised patients susceptible to infection) fitted with HEPA filters (among other types of filters, such as ultra-low penetration air filters and medium efficiency particulate air filters) which assist in protecting immunocompromised patients.[9]
Several environmental pathogens have life-cycle forms that are similar in size to droplet nuclei and may exhibit similar behaviour in the air. The spores of *Aspergillus fumigatus* have a diameter of 2–3.5 μm, with a settling velocity estimated to be at 0.03 cm/second (or about 1 meter/hour) in still air. With this enhanced buoyancy, the spores, which resist desiccation, can remain airborne indefinitely in air currents and travel far from their source.[7;8] The spores are echinulate (spiny), increasing air resistance, to enhance wind-aided dispersion. As a result, *A. fumigatus* spores are found in unfiltered air whenever they have been sought.[7]
There are consistent recommendations for the requirements of protective environments (positive pressure rooms) for bone marrow transplant patients, these are:

- Positive pressure should be maintained at either ≥ + 10 Pa, or a pressure differential of ≥ 2.5 Pa [0.01” water gauge] in comparison to the corridor[10]

- Ventilation to maintain ≥ 10-12 air changes per hour[8,14]
- To have directed air flow (intake at one side and exhaust at opposite)[11]
- To have central or point of use HEPA filters H12 (99.97% efficiency) capable of removing particles 0.3µm in diameter for supply (incoming) air[5;8;9;11,14]

Inadequate filtration of outside air by the air handling system is the most obvious source of *Aspergillus* spores in hospital. Rhame *et al*[7] demonstrated that following introduction of 'in room' HEPA air filters *aspergillus* spores were reduced from 2 CFU/m^3 to 0.9 CFU/m^3; this reduced but did not completely prevent *aspergillus* infections in patients. The authors speculate that this is due to patients coming into contact with spores in other areas of the hospital, where corridor counts were 5 CFU/m^3. The study also discussed HEPA filtration efficiency and determined that when functioning properly all *aspergillus* spores should be removed i.e. 0 CFU/m.[3;7] A review on microbiological air quality and its association with fungal infections in haematology/oncology patients concluded that there is a clinical benefit associated with the treatment of ambient air in haematology/oncology units using HEPA filters and positive pressure, although various forms of bias were identified.[12] The study also highlighted the importance of maintenance of filtration systems and operation following manufacturer's instructions. There was no consensus regarding the maximum permissible fungal count in the air because levels varied widely between studies.[12]

What is the average CFU/m^3 during fungal outbreaks in bone marrow transplant units reported in the literature?

Environmental sampling during outbreaks has revealed a wide range of *Aspergillus* CFU/m^3. Outbreaks have occurred when *Aspergillus* spores were present at counts as low as 0.9 CFU/m^3 and up to at least 100 CFU/m^3.[9] Clusters of *Aspergillus* infections have been associated with poorly maintained or malfunctioning HEPA ventilation systems. HEPA filters should be replaced regularly based on the manufacturer's instructions and regular monitoring should be conducted during construction/renovation. In addition, high numbers of spores observed during environmental sampling could indicate contamination of the filters or air-handling system prior to installation.[11]

What is the recommended air quality (CFU/m^3) in bone marrow transplant units?

Most current guidelines are unable to present recommendations for environmental (air) sampling; this is due to the variability in the literature, variety in sampling methods and results, in addition to a lack of consensus on defined tolerable limits for microbial air contamination. [12]

The CDC suggests a threshold of 15 CFU/m^3 for total fungal counts and of <0.1 CFU/m^3 for *Aspergillus* spp. This is consistently recommended in national and international guidelines.[5;8-11;13]

Properly functioning HEPA filters with 99.97% filtering efficiency are theoretically capable of removing all *Aspergillus* spores and health facilities are required to ensure adequate maintenance of HEPA filtration systems and other appropriate types of filters with medium to high efficiency filtration.[9] There is no tolerable level/concentration for *Aspergillus* spores in HEPA filtered air samples. An exposure level of < 5 CFU/m^3 of *Aspergillus* spp. in protective isolation areas and < 0.1 CFU/m^3 in HEPA-filtered environments, with limits of 15 CFU/m^3 for total colony counts of all fungal organisms, is recommended.[2;9]

What is the optimum method for air sampling?

Active air sampling – a quantitative method, typically samples large quantities of air in a short time period. It is suggested that in highly filtered areas it may be difficult to detect low numbers of spores and that at least 1000L should be sampled.[11]

Passive air sampling (settle plates) – a qualitative method and not suitable for monitoring microbial counts in clean rooms as this method selectively collects larger particles and does not detect airborne pathogens that may remain suspended indefinitely. However, it has been suggested that settle plates are a more reliable measure of risk due to fallout onto wounds/surfaces etc. than airborne contaminants. If settle plates are used these should be in conjunction with active air sampling.[8]

Discussion:

Given the lack of conclusive evidence-based guidance in the literature, it is not possible for HPS to make a specific (CFU/m^3) recommendation on acceptable limits for microbial counts air counts on bone marrow transplant units. However, the most recent (2014) consensus guidelines[9] suggested that sampling values should be compared to a 'scientifically determined or baseline value'; a possible approach for newly commissioned haematology/oncology units in NHSScotland to determine acceptable limits for microbial air quality would be to calculate the theoretical capabilities of their air management systems to remove airborne pathogens based on known filter efficiencies and rates of air exchange. In addition, the Beatson Oncology Centre in NHS GG&C currently cares for bone marrow transplant patients and performs routine air sampling; acceptable baseline values for microbial air quality for similar units throughout NHSScotland could be determined using available routine sampling data from this unit.

The HPS *Aspergillus* Cribcard gives additional guidance on the prevention and management of *Aspergillus* outbreaks during construction work. It was highlighted in the literature that HEPA filter installation alone is likely insufficient to guard against infection; proper maintenance must also be performed. If any preventive benefit is actually associated with the use of this type of system, this benefit will likely occur only when the equipment is operated according to the manufacturer's recommendations, using unsaturated filters.[12]

Specific construction measures have been highlighted in another study stating that in addition to a well-functioning air filtration system, infection control measures such as building protective barriers, using negative-pressure ventilation on in-hospital renovation areas and isolating the traffic to and from the construction area from other traffic are important in preventing the invasion of fungal spores to the specialist ward during construction work.[4]

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SBAR Ventilation Systems at QUEH BMTU

Situation

Concern for patient safety within ward 4B of the Bone Marrow Transplant Unit (BMTU) of the Queen Elizabeth University Hospital (QEUH) has been raised after environment and air sampling yielded high particulate counts and fungal spore growth.

On identification of these results, patients were relocated back to the Beatson Oncology Unit where this, severely immuno-compromised, patient group had been treated prior to their transfer to the QEUH.

The Infection Control Doctor (ICD) for Regional services NHS Greater Glasgow and Clyde (NHSGGC) has questioned the ventilation strategy which had been agreed by the Board & put in place within said ward. It is thought that the ventilation system in place at the QEUH is not designed to a standard which would provide a safe environment for the treatment of these patients and the following has been requested;

- a review of the current ventilation system within the (BMTU) and
- a determination of ventilation requirements need to provide an environment for the safe treatment of said patient group.

HFS has been asked to provide Technical input into the review.

To this end HFS has;

- reviewed the guidance available on ventilation systems for severely immuno-compromised patients.
- ~~attempted to~~ gained an understanding of the current ventilation system place within the Bone Marrow Transplant Unit of QEUH. At this juncture HFS is not yet fully informed, and is seeking clarification of a number of gaps.

Background

Dr Teresa Inkster ICD for Regional services NHS Greater Glasgow and Clyde (NHSGGC) requested support from Health Protection Scotland (HPS) in the review of the ventilation system within their Bone Marrow Transplant Unit within Queen Elizabeth University Hospital (QEUH).

Annette Rankin, Nurse Consultant Infection Control, Health Protection Scotland requested that Health Facilities Scotland provide Technical input into said review, the output of which will be an SBAR which will provide recommendations to NHSGGC on the ventilation requirements needed to help ensure patient safety within the bone marrow transplant area.

Guidance available in UK states that it doesn't offer protection for severely immuno-compromised patients. Therefore to help establish a set of ventilation requirement which offer protection for this group of patients, guidance outside the UK was reviewed. The following guidance was reviewed;

- Centre for Disease Ccontrol ~~guidance~~
- Facilities Guidelines Institute
- American Society of Hospital Engineers (ASHE)
- American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)

This information will be provided in the SBAR provided to NHSGGC.

HFS requested information from NHSGGC to help HFS gain insight into the current ventilation system, there are gaps in the information provided and consequently HFS is not in a position to fully understand the current ventilation system and the decision making process which gave rise to

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Commented [e1]: Too passive. We wither gained an understanding or were prevented from doing so.

Commented [e2]: If it's a review of the ventilation syatem, what is Annette doing? I dare say she doesn't know much about ventilation syatems.

Commented [e3]: You say above that we reviewed it. Have these patients been deemed severely IC?

Commented [e4]: No one will know what this is.

it. HFS will continue to engage with the Board via HPS to gain a clearer understanding of the ventilation system and to this end HFS is meeting at QEUH on Wednesday 23/12/15.

Assessment

This situation has highlighted that ventilation requirements for severely immuno compromised patients is an area not covered by the guidance provided by Health Facilities Scotland or indeed UK equivalents (HFS has contacted DH to verify this position).

There is an expectation from NSS, Government and other Stakeholders that the guidance produced by HFS, which has significant implications for patient safety, will be underpinned by a documented evidence base in a similar way to that produced by colleagues in other parts of the service or NSS, such as HPS, on similar risks. HFS has made a submission to the RAM to request resource to address the associated risk.

Recommendation

It is recommended that PC&F director be aware that this situation

- has possible service and patient safety implications
- is being supported by HFS,

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Queen Elizabeth University Hospital (QEUH) Neurology Theatres 1, 2, 3, 6&7 visit 6th May 2016	
Situation	Request form the medical Director NHSGGC for HPS support with an ongoing incident within Neurology theatres at the Queen Elizabeth University Hospital (QEUH) Glasgow. Theatres 4 and 5 formed part of an earlier review and an SBAR was produced from this visit.
Background	The theatre facilities within the Neurology Building at the QEUH consist of 5 theatres on the first floor (1-5) and a further two theatres located on the ground floor (6 & 7) which are used by the maxillo-facial surgeons. The theatres within the unit are conventionally ventilated. The theatres are located within the Neurology building circa 1980; however there is no documented evidence to support whether the unit was built according to the preceding guidance at the time (SHTM 2025). The current guidance (SHTM 03 01) came into circulation 2011. In February 2016 there were 2 significant leaks into theatres 1 & 3 on the first floor from sewage waste pipes above the operating theatres. The theatres were closed and the full theatre suite inspected including the ceiling voids above all rooms. The inspection found; • There was sewage water contamination to the ceilings of theatres 1 & 3 and to a sterile store within the theatre suite on the ground floor below. • There was no involvement noted of any of the air handling or ventilation ducts for any of the theatres The three affected areas were sealed off from the rest of the theatre area and all surveys and remedial works have been undertaken following HAI Scribe guidance. Theatres 4 and 5 were not contaminated in any way from the incident and previous visit by HFS/HPS on the 21st April supported the local Infection Prevention and Control team advice to reopen those theatres. Therefore theatres 4 & 5 are not included within this visit report. This report should be read in conjunction with the SBAR produced by HPS dated 21st April 2016, which considered theatres 4 and 5. The Neurology surgeons raised concerns around patient safety regarding continuing to operate within any of the theatres in the unit. The surgeons have ceased elective surgeries and are only performing emergency or urgent procedures until they have reassurance the theatres are safe to use.

	HFS and HPS were requested to provide opinion on the suitability of the ventilation in theatres 2, 3, 4 and 5 at Queen Elizabeth University Hospital Institute of Neurological Sciences. A site visit was undertaken on the 6th of May.
Assessment	HPS and HFS undertook a visit to Queen Elizabeth University Hospital, Institute of Neurological Science with NSH GGC on 6th May 2016, to view theatres 1,2,3,6, and 7. It should be noted that we were advised that theatre 1 would not be returning as a theatre and would be converted to a prep area. **1. Visit report.** NHS GGC provided PDFS of the "SHTM 03-01 Critical Ventilation Annual Verification and Inspection Reports" for all theatres after the visit to QEUH as the company (H&V Commissioning), who carried out the tests, had not published the documentation at the time of the visit on 21st April 2016. NHS GGC provided paper copies of the drainage alterations which took place, together with the Crown House Technologies (CHT) Drainage inspection Survey documents. a. The CHT survey reports detail for the various areas of pipe work which were isolated, checked, CCTV surveyed, remedial action taken and new pipe work installation. They show that for all the areas noted, the problems have been removed. b. The drawings associated with the CHT survey show the extent of the existing pipe work removed and resulting new drainage pipe work. c. As noted above, the H&V report was not available at the time of inspection; therefore the following notes are based on observations made, rather than empirical data. d. **Generic works undertaken in all theatres (2, 3, 6, &7)** Local estates sealed any visible gaps within the theatres following a previous visit by H&S commission 4/05/16. i.e. gaps between notice boards and walls, trunking along walls etc. e. **Theatres 1, 2 and 3** Theatres 1 & 3 were directly affected by the sewage leak. Theatre 2 was not affected but sits between theatres 1 and 3. All three theatres have a shared scrub area and no prep areas which was residual from the original building specifications.

Assessment cont.	Therefore all instrument trolleys are set up within the theatre area between cases. The SCN was asked about the scrub area being potentially busy with staff before and between cases. Whilst the staff recognised it is not optimal the nature of neurosurgical cases is that they are generally long cases and that congestion in the scrub area tends not to be a problem. f. **Theatre 1.** This area is under an HAI SCRIBE as work is being carried out to it. A contractor had air filtration plant running in the room, which had access panels open to the roof void. This room is not being returned to operation as a theatre, however one of the pressure balancing dampers had been removed and as a result of the contractor's plant running, dust is blowing into the scrub area. The pressure balancing damper from theatre 1 to the corridor is sealed at the internal face of the theatre only and as a result a ledge has been created in the corridor which is gathering dust. There is no access to theatre 1 from the "clean" theatre areas. The Air Handling Unit serving Theatre 1 is switched currently off. g. **The scrub area** serves theatres 1, 2 and 3 does not have a door fitted to the corridor, but has pressure balancing dampers to theatres 1 and 2. h. **Theatre 2** No works were undertaken within this theatre as it had not been directly affected by the sewage leak other than the works mentioned in the generic works section. The pressure balancing dampers where either broken or require adjustment. There were no locks on the surgeons panel (either section). The air diffusers showed signs of slight paint damage. The theatre underwent a deep clean following the incident however the theatre did not appear to be at the same good standard as the other theatres visited. This may be due to the fact the other theatres have received a touch up of paint and some remedial works but this theatre has not. HPS advised a further deep clean of the area and the vents which would bring it to the same standard as the others. All surfaces and equipment were visibly clean. i. **Theatre 3** The pressure balancing dampers were not working as expected (either not opening or only one blade opening during a transition to/from the theatre). There were no locks on the surgeons panel (either section). HPS asked what cleaning was undertaken for the pendant light and the services fittings as they were contaminated following the leak. It was reported the theatre underwent a deep clean and that

Assessment cont.	domestic services have cleaned the area on a number of occasions. HPS asked for clarity on what products were used for cleaning. General condition of the theatre was good. All surfaces and equipment were visibly clean. j. **Theatres 6 & 7** have a shared scrub and store area which was residual from the original building specifications. The store area was previously a prep area however it was recognised as a risk of infection to patients to set up trolleys as this is a small area and is busy with staff walking through. Therefore all instrument trolleys are set up within the theatre area between cases. The SCN was asked about the scrub area being potentially busy with staff before and between cases. Whilst the staff recognised it is not optimal but they tried to ensure cases overlapped rather than commence and cease at the same times. k. **Theatre 6** had not sustained any contamination from the sewage leak and therefore no large works has been undertaken. Only the minor works mentioned in section a. The pressure balancing dampers were not working as expected (either not opening or only one blade opening during a transition to/from the theatre). General condition of the theatre was good. All surfaces and equipment were visibly clean. l. **Theatre 7** had not sustained any contamination from the sewage leak and therefore no large works has been undertaken. Only the minor works mentioned in section a. The pressure balancing dampers were not working as expected (either not opening or only one blade opening during a transition to/from the theatre). General condition of the theatre was good. All surfaces and equipment were visibly clean. m. **Scrub area serving theatres 6 and 7** The pressure balancing dampers did not operate and waste bins had been placed in front of them. The general condition of the area was good and all surfaces were clean. n. **Theatre AHU** There was not the amount of corrosion present as noted in our previous report, although there is a certain amount present on all louvers. The pressure differential gauges were all reading around zero (this indicates there are potentially issues with either the filters or the pressure gauges). Theatre 6 and 7 are served from a single AHU. Maintenance access to Theatre 3 AHU is limited due to the scaffolding installed for the cladding works.

Assessment cont.	**2. Post inspection review of H&V Commissioning documents** As noted in the previous SBAR, the theatre Air Handling Plant (AHU) was designed and installed between twenty five and thirty years ago to the standard applicable at that time. The current Scottish Technical Memorandum for Ventilation, SHTM 03-01, was published in 2011, and this the document which H&V Commissioning have used as their reference document. The AHU have been engineered to meet SHTM 03-01 as closely as possible. It should be noted that the SHTM allows a figure of 75% of the original design figure to be met. a. The H&V commissioning reports indicate that all the AHU are of average condition given their age. b. The test results for Theatre 1 are not considered for the reasons given above. c. **Theatre 2.** The air change rate is measured at 85% of the SHTM figure. There are some controls issues which are required to be addressed and the temperature and humidity sensors require to be calibrated. d. **Theatre 3.** The air change rate is measured at 99.6% of the SHTM figure. The temperature and humidity sensors require to be calibrated and the AHU motorised dampers require maintenance. e. **Theatres 6 and 7.** For theatre 6, the air change rate is measured at 84% of the SHTM figure. For theatre 7, the air change rate is measured at 91% of the SHTM figure. The noise level in the theatres is very slightly higher than the standard sets, but that should be noted against item 2a. The sensors and motorised dampers require some calibration and maintenance. The air change rate in the dirty utility is 53% of that in the current SHTM. The pressures in the Scrub/prep and the dirty utility (both shared between the two theatres) are below current levels (64% and 60% respectively) **3. NHS GGC Clarifications** a. NHS GGC confirmed that they had already commenced the remedial actions noted and were nearing completion of these b. To overcome the issue with the pressure dampers NHS GGC have confirmed that “During the recent verification of theatres 1 to 7, the pressure relief dampers where all installed in the correct orientation and confirmed as fully functional. However during the verification when the full design volume of these dampers’ was

Assessment cont.	released, the pressure regime in the theatres collapsed to well below the required pressure differential. The baffles where therefore returned to the conditions originally found which generally restored the pressure and air change regimes maintaining the hierarchy of control as detailed in the H&V verification reports." To overcome this NHS GGC propose that the excess blades be removed and the transfer grille size be reduced using appropriate materials hence removing the risk of inadvertent alteration of the pressure control regime. This is would be supported, as the duration of the installation would be short term and if confirmation is given of the materials to be used (including the sealing method) and a inspection protocol put in place c. NHS GGC confirmed that the AHU filter differential pressure gauges (Manometers) parts had been placed on order and will be restored to full working order by Thursday 12th May 2016. During the ventilation verification the filter differentials were recorded using a calibrated Micro Manometer ref 6554 (recalibration due Oct 2016) and found to be within acceptable parameters. d. NHS GGC has confirmed that the replacement locks on the surgeon's panels have been fitted. e. NHS GGC has confirmed that the issue with the filtration plant and open pressure damper aperture has been resolved. f. NHS GGC has confirmed that the paint has been removed from the air diffusers in theatre 2 and no dust was found. g. NHS GGC has confirmed that the small amount of corrosion present on the noted AHU will be painted by 13th May 2016. It is noted that there are plans to decommission these theatres which should be complete between 2017 and 2019. New theatres will be established elsewhere on the site prior to this. Air sampling was undertaken by the local IPCT which found to be within normal limits. There is currently no guidance set out within SHTM 03-01 [1] regarding microbiological sampling within a conventional operating theatre; however this is detailed within the Working Party Report on the Microbiological commissioning and monitoring of operating theatre suites (Hospital Infection Society 2002 [2]). The testing undertaken by the local IPCT is in accordance with the parameters set out by the Hospital Infection Society. [2] It was confirmed that NHSGGC have employed the services of a Ventilation Authorising Engineer who will carry out further audits on the

	ventilation systems.
Recommendation	We would suggest that the theatre 1 pressure relief damper apertures are sealed on both sides. 1. As the AHU for theatre 1 will still be used for the room in its changed function we would suggest that this is re-commissioned according to the requirements of the SHTM 03-01. Consideration should be given to the pressure strategy for theatre 2, the prep and the corridor, given that there is no door on the prep. 2. All the missing surgeon panel locks should be replaced and we further recommend that until this happens the surgeons' panels are electrically isolated with the appropriate labels applied to these panel. 3. Theatre 2 air diffusers should be re-cleaned. 4. All pressure relief dampers should be checked for operation and those which are broken or damaged should be replaced. 5. Theatre 2 should have a further deep clean and removal of paint from vent grills. 6. We would suggest that all theatre AHU are checked as noted in the H&V Commissioning reports. The AHU pressure differential gauges and AHU filtration should be checked. 7. On receipt of confirmation that these works are complete, we confirm that the air handling plant serving these areas provide ventilation to the noted theatres as close as practicable to SHTM 03-01 and can see no reason as to why theatres 2, 3, 6 & 7 could not return to being operational. 8. All affected areas are terminally cleaned using recommended products before the areas become operational. 9. It is recognised that the current facilities are not optimal and shared scrub areas and lack of preparation areas are non compliant with current recommendations however it is recognised that the directorate have procedures in place to minimise any risk associated with this and new theatres are under construction, therefore not feasible to carry out any significant refurbishment of this area.

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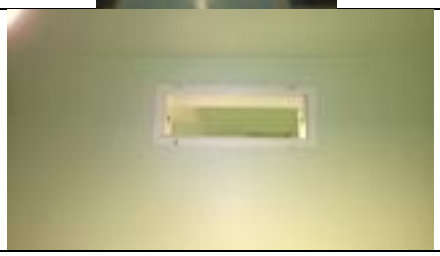
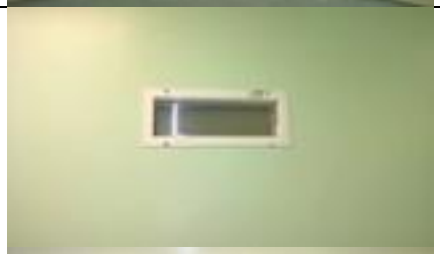
Appendix:

2. Photographs (taken prior to rectification works implemented)

item	Photograph	Comment
1.		Theatre 1. Drainage contractor's equipment. Hole with no damper and no seal
2.		Theatre 1 Access to ceiling void via light fittings. NOTE this area is sealed off and controlled under HAI SCRIBE process
3.		Prep between Theatres 1 and 2. No door to corridor (door at far end is to access theatres)
4.		Theatre1/prep Pressure balancing damper has been removed

item	Photograph	Comment
5.		Theatre 2
6.	 	Theatre 2 Pressure balancing dampers do not work or are damaged.
7.		Theatre 2 Locks missing on surgeons panel
8.		Theatre 2 Air diffusers
9.		Theatre 3 Pressure balancing dampers do not work or require adjustment.

item	Photograph	Comment
10.		Theatre 3 Locks missing on surgeons panel
11.	 	Theatre 6 Pressure balancing dampers do not work or require adjustment.

References:

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(2) Hoffman PN, Williams J, Stacey A, Bennett AM, Ridgway GL, Dobson C, Fraser I, Humphreys H, (2002) Microbiological commissioning and monitoring of operating theatre suites; a report of a working party of the Hospital Infection Society, Journal of Hospital Infection 52: 1-28.

Health Protection Scotland

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Queen Elizabeth University Hospital (NHSGGC) Bone Marrow Transplant Unit	
Situation	NHS Greater Glasgow and Clyde (NHSGGC) requested support from Health Protection Scotland (HPS) in 2015 in the review of their Bone Marrow Transplant Unit within Queen Elizabeth University Hospital (QEUH) prior to transfer of patients from the Beatson Oncology Centre (WOSBOC). This review focussed mainly on the ventilation and provision of a safe environment for the care of these patients within the QEUH. HPS liaised with HFS and support has continued since the initial request.
Background	The decision to transfer the care of bone marrow transplant patients from the Beatson Oncology Unit to the QEUH was made in June 2013. Construction of the QEUH was well established at this point and therefore the new unit was not purpose built. When the new hospital opened patients transferred to ward 4b from the Beatson Oncology unit. Concern was raised following environmental and air sampling which yielded high particulate counts and fungal spore growth. On identification of these results the patients were relocated back to the WOSBOC as a temporary measure whilst remedial work was undertaken in ward 4b. Currently the patients remain in the WOSBOC whilst works have been ongoing in ward 4b in an attempt to make the unit compliant. It is noted that there is no current UK guidance on BMT isolation rooms. General ventilation guidance is contained within SHTM 03-01 (Parts A and B) and SHPN 04-01 Supplement 01. An SBAR was produced in May 2015 which provided NHSGGC with recommendations to allow the provision of a protective environment for patients within the bone marrow transplant Unit. The SBAR focussed primarily on the adult BMT transfer to ward 4B was produced by HPS/HFS in December 2015. Whilst NHSGGC has continued to work towards these recommendations it is noted that the solution proposed does not meet the guidance nor does it seek to address all the recommendations in the SBAR(2015). As a result HFS cannot comment on the effectiveness of the measures intended to be put in place. NHSGGC are working towards transfer of the patients from the BOSWOC to ward 4B by early 2018. A staged approach to repatriation of the BOSWOC BMT patients back to ward 4B has been proposed. This includes; • transfer of existing medical patients to other areas within the hospital, • positive pressure?? ventilation within the area turned back on once medical patients have vacated the area and • external validation and commissioning of the unit undertaken. Once this has been completed and agreed with facilities, IPCT and

	management haemato-oncology patients from South Glasgow will occupy ward 4b for a period of 6 months whilst microbiological monitoring is undertaken. HPS have been requested to provide support relating to initial monitoring of the environment prior to transfer of haemato-oncology patients and during the first six months of their transfer to allow early identification of airborne fungal spore risks. A rapid literature review relating to microbiological risks was undertaken and support sought from Peter Hoffman (Public Health England)
Assessment	The recommendations outlined in the SBAR (2015) relating to ventilation included: To allow the provision of a protective environment for patients within the bone marrow transplant unit (Ward 4b) • The rooms must be positively pressured at 10pa • ALL air entering the room must be via the HEPA filter • The HEPA filter should as a minimum be E12 (H13) and located within the supply air diffuser • The room ceilings must be sealed so no air which has not passed via the HEPA filter should access the room • A strict protocol minimising the length of time the door is opened and reduces air entry via an open door is required. • There must be a continuous pressure monitoring system for each room which alarms and gives an early indication of a pressure drop within the room • Bedroom Air changes of 10 ACH must be achieved • The walls and ceilings within the rooms and ensuite must be sealed. • All room services must be sealed • All service access hatches within the bedrooms/ensuite must be sealed NHSGGC have confirmed that the rooms meet 10Pa however fall short on air changes at 6 AC/hr instead of the recommended 10 AC/hr. Air changes dilute the microbial content of the room from what is already dispersed within the room. The main focus from protection of the immune-compromised patient is to ensure protection is provided from outdoor contamination via hepa filtration. The integrity of the hepa filter requires to be insitu checked with particles to ensure its efficiency to ISO 14644-3:2005 and correct fitting as far as reasonably practicable. It should be noted that BSRIA are recommending that air permeability should be between 2.5-1.0m3/hr/m2 at 50Pa and given the limitations of the existing solution. Extract ventilation ductwork should be separate and terminate as described in SHPN 04 Supplement 01.

Ventilation rates:
The validation of the entire system should be as detailed in the generic guidance given in SHTM 03-01 part A and verification of the entire system should be as outlined in SHTM 03-01 part B. These may have to be adapted to meet the requirements of this situation. The frequency of verification should be at least annually, or more frequently if issues arise.

Sampling:
There are two ways of sampling:

- Active air sampling
- Passive air sampling

Active air sampling involves using the air sampler and monitoring all patient rooms and corridor on the same day and sampling a high volume of air of at least 1 cubic metre of air from each room. There is no requirement for rooms to be empty during sampling as the testing is to identify fungi not bacteria

Passive air sampling involves using settle plates in every room and allowed to remain in situ for a period of approximately 5-6 hours. Settle plates will sample fungal spores relatively inefficiently but can sample over a far longer time than active air samplers and so capture isolated contamination dispersion events that active sampling is likely to miss. The medium used should be selective medium which only allows the growth of fungi. (e.g Sabaraud's with appropriate selective supplements),

Sampling should take place in an adjacent unprotected environment simultaneously to those within the rooms. Fungal levels in the outdoor environment (i.e. the challenge to any system of patient protection) will vary over time. A finding of low fungal counts in the protected environment may just be the result of a low challenge level. This sampling strategy allows the determination of a contamination ratio of the protected environment versus unprotected environment.

A combined approach of both passive and active air sampling undertaken in parallel utilising media which selects fungi only, is the preferred method for commissioning and monitoring purposes, with both methods being undertaken simultaneously including an external unprotected control sample. Samples taken at weekly intervals for a period of 4-6 weeks at varying times should provide sufficient information on the integrity of the ventilation system with consideration being given to a follow up one month later. Thereafter sampling should return to the agreed boards protocol. Microbiological sampling is used as a validation of engineering and engineering controls and should only be done after the engineering parameters have been assured as adequate. Annual validation of engineering is important and must be undertaken.

Results: Fungal growth does not require to be speciated. If controls are in place the optimal level should be zero growth. The presence of any fungal spores on active sampling should prompt a review. The

	following strategy per cubic metre of air sampled is proposed • Zero growth = optimal • Single digit = review room air supply, confirm direction of outward air passage at multiple gaps in the room's integrity, examine room for areas of dampness or fungal growth. Investigate possible errors in sampling technique and resample • Double digits and above = indication of a serious problem. Urgent investigation and clinical consideration of fungal prophylaxis It is worth noting that a zero result, whilst optimal, does not always assure engineering efficacy as it may be reflective of no circulating fungal spores at the time of testing. **Lighting and power:** Luminaires to be recessed into a solid ceiling and be (minimum) IP44 with clear access strategy for maintenance including gear and lamp replacement. Any power, trunking or other services penetrations into the space must be sealed. **Water:** The water systems should be to SHTM 04-01 and free of any waterborne pathogens at the point of use. **Contingency:** As it is proposed that only one air handling unit serves the BMT isolation rooms at the QEUH (ward 4b), planned shut downs or unplanned events (such as motor failures or power failures) require to be addressed. The result of these shutdowns may mean that patients may need to be relocated. It is suggested that contingency plans include:- • AHU complete failure for prolonged period • AHU complete failure for short duration • AHU maintenance (air related – filters, fans, cleaning, etc) • AHU maintenance (water related - cleaning, testing, inspecting) • Cleaning or deep cleaning of rooms following occupation. • If the AHU does not have a duty/standby arrangement, spare supply fans are sourced and stored locally to the AHU. • If ALL the ductwork is not fire rated, what happens in the event of a fire scenario. It may also be prudent to have contingency plans for local power failure and in the event of pathogens found in the local water supplies to the BMT isolation facilities

Recommendation	• Both active and passive air sampling should be undertaken in parallel • Sampling should be undertaken weekly at varying times for a period of 4 -6 weeks and a follow up one month later • All patient rooms within 4b should be included in each sample period • An external adjacent unprotected area should be identified and passive sampling undertaken in parallel with protected (BMT unit rooms) sampling • Standard sample plates should be used which are selective for fungi and that inhibit bacterial growth • Any fungal colonies identified require to be counted but not speciated • As the medium used are selective for fungi and not bacteria, the rooms do not require to be vacated during the sampling period. • Passive sampling/settle plates should be left insitu for 4-6 hours approximately ensuring the plates do not dry out. • Active sampling volume should be approx 1,000 litres per room. • The air sampler should be placed on a clean trolley or stand • The medium for both passive and active sampling should be the same • Results should be interpreted: • Zero growth = optimal • Single digit = review room air supply, confirm direction of outward air passage at multiple gaps in the room's integrity, examine room for areas of dampness or fungal growth. Investigate possible errors in sampling technique and resample • Double digits and above = indication of a serious problem. Urgent investigation and clinical consideration of fungal prophylaxis • Annual validation of ventilation should be undertaken in line with the agreed protocol, based on selected components of SHTM 03-01 part B. • Once completion of commission monitoring as outlined above the normal monitoring protocol endorsed by NHSGGC should be resumed.

Health Protection Scotland

NHS National Services Scotland

Royal Hospital for Children (NHSGGC) Ward 2b	
Situation	NHS Greater Glasgow and Clyde (NHSGGC) requested support from Health Protection Scotland (HPS) relating to environmental/ventilation monitoring in Schiehallion ward, Royal Hospital for Children.
Background	There are currently eight positive pressure ventilated lobby (PPVL) rooms within Schiehallion ward which are predominantly utilised to nurse severely immunocompromised and/or bone marrow transplant (BMT) recipient children. There has been concern raised regarding the suitability of these rooms in terms of protection for this category of patient. In addition there has been a number of patients reported to have fungal infections which may be healthcare related. Currently there is no UK guidance on BMT isolation rooms, and as a result NHSGGC have requested support. General ventilation guidance is contained within SHTM 03-01 (Parts A and B) and SHPN 04-01 Supplement 01. NHSGGC sought support from HPS relating to environmental, ventilation and monitoring requirements for this group of patients. HPS have liaised with Health Facilities Scotland (HFS) to ensure the recommendations provided are technical and clinically focussed. HPS have provided support to NHSGGC relating to the environment and ventilation within the adult BMT unit and the requirements are the same for a paediatric area. All isolation rooms are currently supplied by an individual air handling unit and whilst the main room is at neutral ventilation the lobby is at positive pressure. NHSGGC are undertaking work to convert four of the eight PPVL rooms to isolation rooms utilising the existing plant. This will result in the room becoming positively pressured, with the extract grille in the ensuite. The pressure cascade will be compliant with that of a theatre (in the absence of specific BMT guidance). The room will achieve 10 air changes and the pressure gauge will measure the pressure between the room and the corridor. This work will be undertaken with two rooms being completed at a time. Validation and environmental testing will be undertaken by an external contractor prior to patients being relocated within the refurbished four rooms. Once this has been completed and validation and microbiological monitoring agreed and signed off by facilities, IPCT and management patients will occupy the first two rooms and another two rooms will be converted from PPVL to isolation rooms.

Assessment	The assessment and recommendations broadly follow those made previously in relation to the adult BMT unit within NHSGGC. NHSGGC have confirmed that the rooms meet 10 Pa and 10 air changes per hour (ACPH). The main focus of the immune-compromised patient is to ensure protection is provided from outdoor contamination. This is achieved via HEPA filtration. HEPA filtration The integrity of the HEPA filter requires to be insitu checked with a particulate counters to ensure its efficiency and correct fitting. Ventilation rates: Validation of the entire system should be as detailed in SHTM 03-01 part A and verification of the entire system should be as outlined in SHTM 03-01 part B. The frequency of verification should be at least annually or more frequently if issues arise. The purpose of carrying out extensive commissioning sampling is to support the findings of the validation. Sampling: There are two ways of sampling: • Active air sampling • Passive air sampling Active air sampling involves using the air sampler and monitoring all patient rooms and corridor on the same day and sampling a high volume of air of at least 1 cubic metre of air from each room. There is no requirement for rooms to be empty during sampling as the testing is to identify fungi not bacteria. Passive air sampling involves using settle plates in every room and allowed to remain in situ for a period of approximately 5-6 hours. Settle plates will sample fungal spores relatively inefficiently but can sample over a far longer time than active air samplers and so capture isolated contamination dispersion events that active sampling is likely to miss. The medium used should be selective medium which only allows the growth of fungi. (e.g Sabaraud's with appropriate selective supplements), Sampling should take place in an adjacent unprotected environment simultaneously to those within the rooms. Fungal levels in the outdoor environment (i.e. the challenge to any system of patient protection) will vary over time. A finding of low fungal counts in the protected area may just be the result of a low challenge level (external fungal counts). This sampling strategy allows the determination of a contamination ratio of the protected environment versus unprotected environment. A combined approach of both passive and active air sampling undertaken in parallel utilising media which selects fungi only, using the same medium, is the preferred method for commissioning and monitoring purposes, with both methods being undertaken simultaneously including an external unprotected control sample. Samples taken at weekly intervals for a period of 4-6 weeks at varying times should provide sufficient information on the integrity of the ventilation system with consideration being given to a follow up

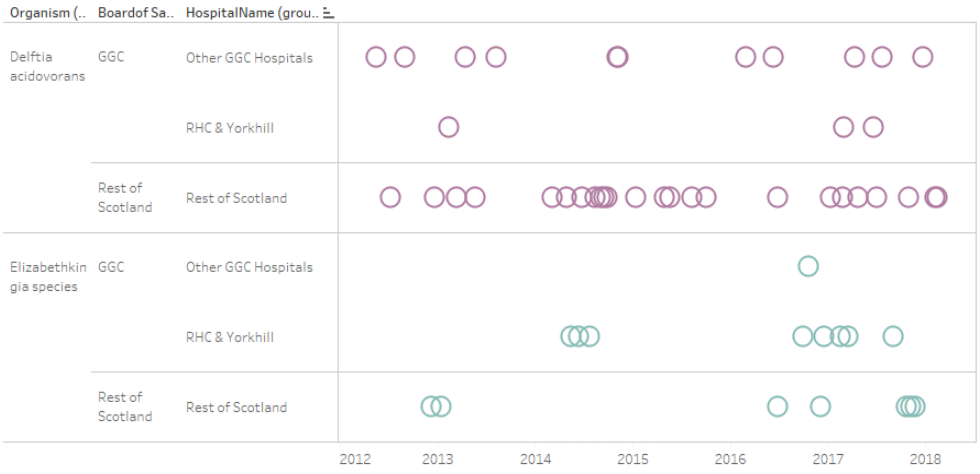
	one month later. Thereafter sampling should return to the agreed boards protocol. Microbiological sampling is used as a validation of engineering and engineering controls and should only be done after the engineering parameters have been assured as adequate. Annual validation of engineering is important and must be undertaken. Results: Fungal growth does not require to be specialised. If controls are in place the optimal level should be zero growth. The presence of any fungal spores on active sampling should prompt a review. The following strategy per cubic metre of air sampled is proposed • Zero growth = optimal • Single digit = review room air supply, confirm direction of outward air passage at multiple gaps in the room's integrity, examine room for areas of dampness or fungal growth. Investigate possible errors in sampling technique and resample. Check extract grilles for dust. • Double digits and above = indication of a serious problem. Urgent investigation and clinical consideration of fungal prophylaxis. It is worth noting that a zero result, whilst optimal, does not always assure engineering efficacy as it may be reflective of no circulating fungal spores at the time of testing.
Recommendations	The recommendations relating to ventilation to allow the provision of a protective environment for patients isolated within the isolation rooms of Schiehallion ward are; • The rooms must be positively pressured at 10 Pa. • ALL air entering the room must be via the HEPA filter. • The HEPA filter should as a minimum be E12 (H13) and located within the supply air diffuser. • The rooms must be sealed and no air which has not passed via the HEPA filter should access the room. • A strict protocol which minimises the length of time the door is opened and reduces air entry via an open door is required. • There must be a continuous pressure monitoring system for each room which alarms and gives an early indication of a pressure drop within the room. • Bedroom Air changes of 10 ACPH must be achieved. • The walls and ceilings within the rooms and ensuite must be sealed. • All room services must be sealed. • All service access hatches within the bedrooms/ensuite must be sealed. • Rooms must have achieved satisfactory validation and commissioning parameters. • Both active and passive air sampling should be undertaken in parallel. • Sampling should be undertaken weekly at varying times for a period of 2-4 weeks. • An external adjacent unprotected area should be identified and passive sampling undertaken in parallel with protected (isolation rooms) sampling. This may be being undertaken as part of the Ward 4b monitoring and if undertaken in a timely manner may be the same sample. • The corridor should also be sampled at the same time as the

	isolation room and external environment • Standard sample plates should be used which are selective for fungi and that inhibit bacterial growth • Any fungal colonies identified require to be counted but not speciated. • As the medium used are selective for fungi and not bacteria, the rooms do not require to be vacated during the sampling period. • Passive sampling/settle plates should be left insitu for 4-6 hours approximately ensuring the plates do not dry out. • Active sampling volume should be approx 1,000 litres per room. • The air sampler should be placed on a clean trolley or stand. • The medium for both passive and active sampling should be the same. • Results should be interpreted: - Zero growth = optimal - Single digit = review room air supply, confirm direction of outward air passage at multiple gaps in the room's integrity, examine room for areas of dampness or fungal growth. Investigate possible errors in sampling technique and resample - Double digits and above = indication of a serious problem. Urgent investigation and clinical consideration of fungal prophylaxis. • Annual validation of ventilation should be undertaken in line with the agreed protocol, based on selected components of SHTM 03-01 part B. • Once the commissioning monitoring as outlined above is complete the normal monitoring protocol endorsed by NHSGGC should be resumed. • If the ventilation parameters are compliant with SHTM 03-01, and the IPCT are content that the parameters are acceptable routine microbiological monitoring is at the discretion of the local IPCT and consideration may be given to annual monitoring, post annual validation or on an adhoc basis. HPS are happy to work with NHSGGC to establish an ongoing monitoring protocol.

Health Protection Scotland

NHS National Services Scotland

Review of *Delftia acidovorans* and *Elizabethkingia* species in NHS Greater Glasgow and Clyde. Author: SHAIP HPS April 2018	
Situation	NHS Greater Glasgow and Clyde (NHSGGC&C) requested Health Protection Scotland (HPS) to review numbers of bacterium caused by *Delftia acidovorans* and *Elizabethkingia* species within their Health Board.
Background	*Delftia acidovorans* and *Elizabethkingia* species are usually non-pathogenic environmental bacteria which can be found in water sources. Although clinical infection is rare they can cause serious infection in immuncompromised individuals. NHS GG&C are currently investigating a water related incident within the Royal Hospital for Children and requested this data to support this investigation.
Assessment	Positive blood sample for *Delftia acidovorans* and *Elizabethkingia* species were extracted from ECOSS on the 29/03/2018 for the date range from 2012 to present. Data was deduplicated on 14 day blood samples excluding clotted blood samples and post mortem samples. Figure 1 shows positive episodes from the organisms broken down into three groups: • Royal hospital for Children (RHC) and Yorkhill Hospital • Other GGC hospitals • Rest of Scotland During the time period there were 38 episodes reported of *Delftia acidovorans* bacteraemia in Scotland. Only 3 episodes were reported in RHC and Yorkhill combined, 11 in the other GGC hospitals and 24 episodes reported across the rest of Scotland. Two of the episodes in RHC were in February and June 2017. A total of 16 episodes of bacteraemia relating to *Elizabethkingia* species were reported through ECOSS; 8 reported in RHC and Yorkhill combined, with 1 episode reported in another GGC hospital and 7 episodes reported across the rest of Scotland. Three episodes in Yorkhill hospital were a month a part in 2014 and the other 5 isolates from RHC were in September, December 2017 and February, March and August 2018.

	Figure 1 Episodes of bacteraemia relating to *Delftia acidovorans* and *Elizabethkingia* species by location.  *Limitations* The analysis was carried out using national laboratory data only without any clinical assessment or validation. Numbers are small and should be treated with caution.
Recommendations	1. All analysis has been carried out on laboratory data and therefore further clinical review would be required to assess the clinical significance. 2. The SBAR should be shared with the Lead Infection Control Doctor for NHSGG&C to assist in the review of their incident.

SBAR: HAI Situation Needs Assessment NHS Board: NHS Greater Glasgow & Clyde (GGC) Contact name/designation: T. Inkster (ICD) GGC/Rachael Dunk HAI policy lead, SGHSCD	
Situation	Increased reporting of incidents of Healthcare associated infections linked to wards 2A/2b Royal Hospital for Children: NHS Greater Glasgow and Clyde since 2015.
Background	Since mandatory HIIAT green reporting commenced in 2015 it has been observed that there is an increased number of incidents relating to wards 2A/B Royal Hospital for Children NHSGGC. Whilst some of the incidents have been gastrointestinal in nature a number have been blood stream infections. HPS have been providing support into a water contamination incident since March 2018. HPS offered NHSGGC support for a review of wards 2A/B on 11th April 2018. This offer was supported by Scottish Government. NHSGGC accepted support from HPS for the review on 22nd May 2018. Scottish government added this review to the national framework support requested by them into the water related incident.
Assessment	HPS will undertake a "roots and branches" review of wards 2A/2B RHC which will include as a minimum: • Walkorunds/observation of practice will be undertaken by a NCIC/SNIC in wards 2A/2B • Informal interviews/discussions will be held with nursing, medical and support staff • Comparison on bed numbers/occupancy/practice/staffing between Yorkhill and current provision. • Review of facilities, including ventilation, room provision against published literature and national guidance • Epidemiology review including extraction of data from ECOSS for all paediatric bacteraemia (all cases below 16 years of age) from 2012 to present • Examination of trends of bacteraemia with comparison to historic Yorkhill data, rest of Scotland. • Approach PHE to request comparable bacteraemia data.
Recommendation	1. HPS will coordinate national support to undertake this review in line with the framework requirements 2. HPS will liaise with other agencies as required. 3. HPS will produce a report for Scottish Government and NHSGGC which will include local and national recommendations by 17th August 2018.
HPS Lead	A Rankin/NCIC
Other HPS Support:	HPS Incident management team
Additional support	HFS, PHE

Draft SBAR Review of SHTM 04-01 and responsibilities of microbiological/infection control roles

Situation

There have been apparent failures in healthcare water safety management in Scotland. These have involved failures in design, commissioning and testing of water systems. SHTM 04-01 is the Scottish document which describes the responsibilities and processes to follow to ensure the safety of healthcare water services in Scotland. To help identify lessons to be learned for the role of members of the infection control team, a targeted review of SHTM 04-01 Parts A-G has been carried out.

Background

SHTM 04-01 describes the responsibilities for all of those involved in delivering safe water systems in healthcare. The roles described include those for infection control teams, infection control doctors and Consultant medical microbiologists. To help identify key areas of future healthcare improvement in this regard for infection control teams and microbiological sampling a focussed review of SHTM 04-01 was carried out.

SHTM 0401 is divided into Parts A-G, all of which were reviewed for this analysis.

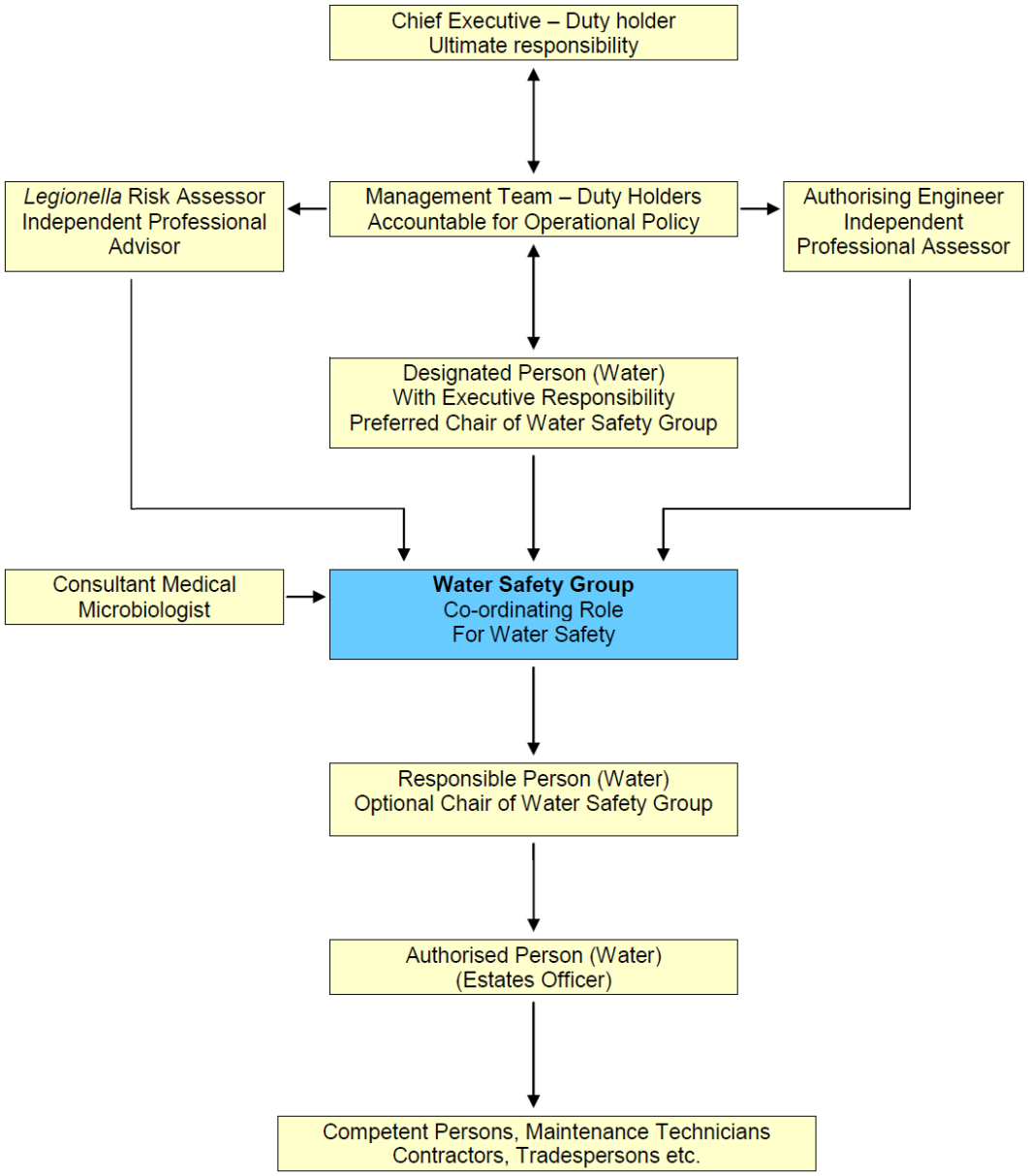
4 main topics were considered:

1) What are the microbiology responsibilities identified and are they clear?
2) What are the infection control team responsibilities identified and are they clear?
3) What are the educational requirements identified and are they clear?
4) What are the microbiological testing requirements described and are they clear?

Assessment

1) What are the microbiologists responsibilities identified and are they clear?

The first description of a role for a microbiologist is in SHTM 04-01 Part b, which states on Page 36 that, “The Head of Maintenance (or appointed deputy) is the “Responsible Person (Water)” managing day–to–day risks and will be the estates lead in the event of an operational incident. In the event of *Pseudomonas* infection, Estates responsibility is limited and the Responsible Person (Water) will require to draw upon experience and specialist advice from a consultant medical microbiologist, who shall also be a member of the Water Safety Group, to advise and lead on these issues; “ There is no description of what or how the issues should be led. Also Page 38 of part b describes the typical structure hierarchy as:



Typical structure of hierarchy

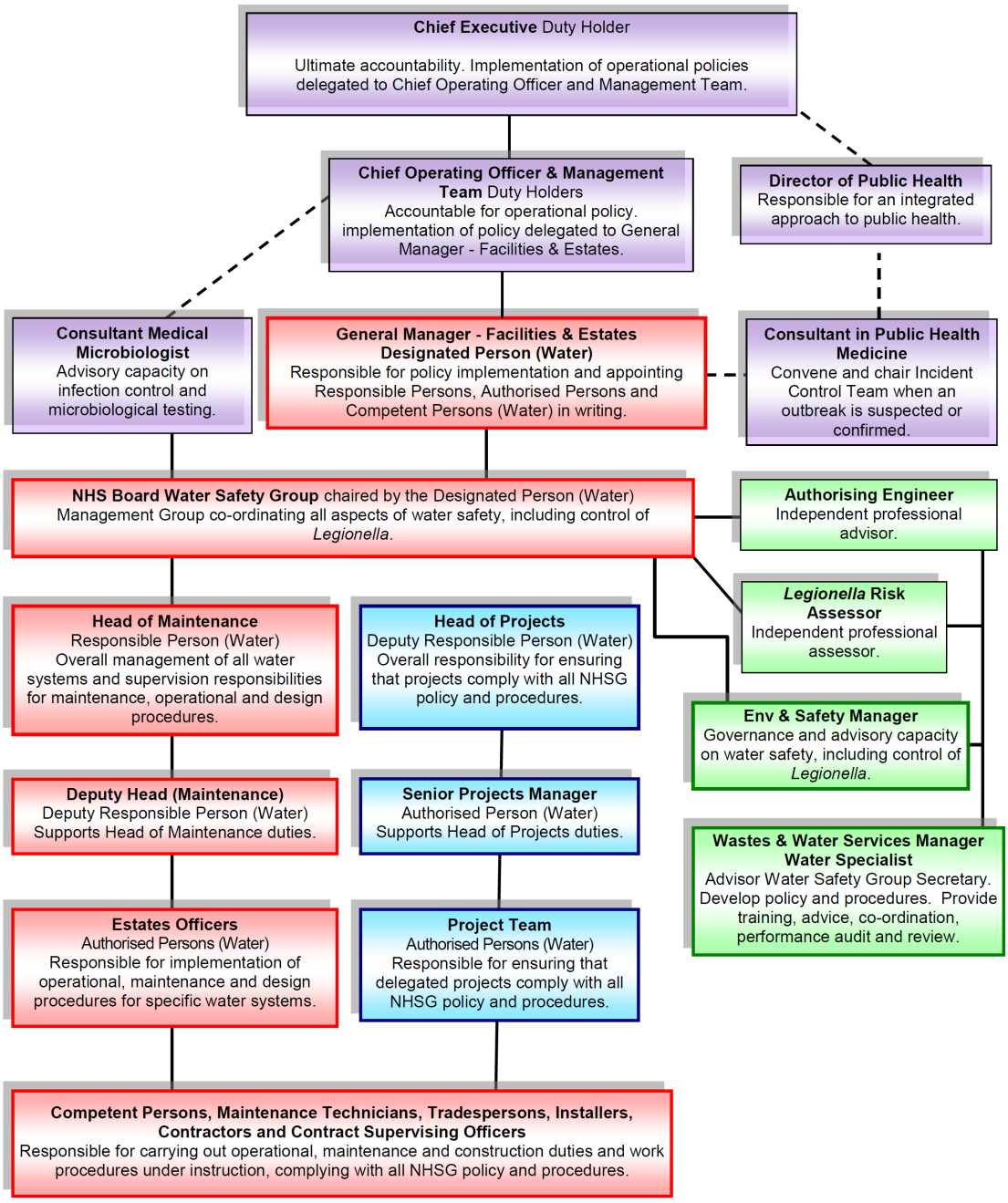
This would suggest that the role of 'Consultant Medical Microbiologist' is responsible to the Board Water Safety Group.

Part b then goes onto describe the roles of the infection control team in paragraph 6.6 and states under the heading "Infection Control Officer": that the "Infection Control Manager, the Infection Prevention and Control Doctor (also known as the Infection Control Doctor) and the Consultant Microbiologist are nominated by management to advise on infection control policy and to have responsibility for the maintenance of water quality from the point it leaves the tap.
The policy should be acceptable to the Infection Prevention & Control Team and they should agree any amendment to that policy." Arguably this poorly defines the separate

infection control team members roles. Paragraph 6.7 appears to clarify this by suggesting that ultimately the role of consultant medical microbiologist would be the primary contact in Pseudomonas incidents, whether or not they are an ICD, stating that: "*Pseudomonas* outbreaks would have an over-bearing influence from clinical and cleaning procedures and would primarily come within the responsibility of the Infection Prevention and Control Team who would be represented on the Water Safety Group and from whom the Responsible Person (Water) would draw appropriate expertise via a consultant medical microbiologist."

SHTM 04-01 Part C specifically provides a TVC testing protocol, and with regard to the responsibility of the microbiologist states that for most results both the Authorised Person and Consultant Microbiologist must be informed of results. Going on to say either that "The Authorised Person (Water) would provide interpretation (with the Consultant Microbiologist when and where required) on the results and confirm if any actions are required." Further clarifying this by stating that -"The Consultant Microbiologist would provide interpretation on the results and confirm the necessary actions prior to bringing the water system into use."

The next mention of the role of a medical microbiologist is in Part G, which explains that all boards will have a water safety policy and provides a draft policy, within which it states that it "...requires all management and staff across the organisation to be aware of statutory regulations, NHS Scotland mandatory guidance documents and responsibilities with specific arrangements." Presumably this equally affects Consultant Microbiology staff, and specifically mentioning on page 14, that the Chief executive and team:
"seeking support from a consultant medical microbiologist in the event of suspected exposure to *Legionella*, *Pseudomonas* Spp and other similar harmful bacteria;"
And that a new organisational structure (presumably replacing that described in Part A) for NHS Boards with regard to water management should be similar to the figure below, which now appears to suggest that the Water Safety Board will report to the "Consultant Medical Microbiologist":



It is worth noting in this diagram that all infection control and microbiological responsibilities are attributed to the ‘Consultant Medical Microbiologist’ role.

However Table 1 in Part G then introduces a role for Biomedical scientist and CPHM’s as described below. Worth noting the footnote to this table also suggests that there should be a training needs record also kept, presumably applicable to all roles in Part G Table 1.:

Others involved				
Infection Prevention & Control			Consultant Medical Microbiologist	
Laboratory Services			Biomedical Scientist	
Governance and Advisor			Environment and Safety Support Team Manager	
Water Specialist Advisor			Wastes & Water Services Manager	
Public Health			Consultant in Public Health Medicine	
O H & S Auditor			Health & Safety Auditor	
HSE	Health and Safety Executive			

Table 1 continued: Role Holders

Note: The names of any member of staff yet to receive relevant training should be entered separately.

The final mention of the role of Microbiologists in SHTM 04-01 is in Part G Section 23, for course of action for suspected nosocomial Legionnaires' disease which are similar to 04-01 Part C.

In summary SHTM 04-01 suggests that a lot of the responsibility for providing a safe healthcare supply lies with the role of Consultant Medical Microbiologist.

2) What are the infection control team responsibilities identified and are they clear?

Although SHTM 04-01 mainly mentions the role of Consultant medical microbiologist it does occasionally mention an infection control role. Below is a summary of all of these:
In SHTM 04-01 Part A – the first mention of ICT's is in paragraph 17.9 which states that "After disinfection, microbiological tests for bacteria colony counts at 37°C and coliform bacteria, including *Escherichia coli*, should be carried out under the supervision of the infection prevention control team to establish that the work has been satisfactorily completed. Water samples should be taken from selected areas within the distribution system. The system should not be brought into service until the infection control team certifies that the water is of potable quality."
In SHTM 04-01 Part B, it is stated in paragraph 6.4 that "Water Safety Groups (WSG) within NHS Boards will be led and chaired, as a minimum, by the Responsible Person (Water) who will ensure that responsibility is taken for microbiological hazards and are identified by appropriate Group members They will assess risks, identify and monitor control measures and develop incident protocols. WSG should be a sub-group of and report to the Chair of the hospital Infection Control Committee and ensure a coordinated approach exists between Infection Prevention and Control Teams, clinical staff and Estates & Facilities on all water issues. There should be a clear line of responsibility to the Chief Executive through the Infection Control or other Committee." Further on in the same part in section 10, it suggests that – "The infection prevention and control team, however, will need to consider the level of risk before deciding that *Legionella* testing is indicated." So suggesting that the responsibility for deciding on where routine Legionella culture is carried out, this is led by the ICT.
The next specific mention is in the 'Tank cleaning' section where on page 51 it is stated that :"on receipt of analysis results, ...The assistance of Infection Prevention and Control team may be required to aid with the interpretation of the results, and the identification of remedial actions if necessary".

Reflecting on these first 2 questions looking at the respective roles of the infection control team, ICD and Consulatnt medical microbiologist, the suggestions seems to be that the majority of microbiological and infection control input should be sought

from a “Consultant Medical Microbiologist” although what the document means by that role is not defined. Reflecting on the roles of the IPCT it may be that the assumption by those who wrote the document, is that the IPCT role will generally be delivered by an Infection Control Doctor, and that ICD role will generally be delivered by a Consultant medical microbiologist. It is now worth considering the advice given in the document for microbiological educational requirements to fulfil the role.

3) What are the educational requirements described in the SHTM and are they clear?

   There is no specific mention as to the educational requirements for a Consultant Medical Microbiologist to deliver the role/functions described in the SHTM. However there are a number of potentially related generic references all of which are described here.

   SHTM 04/01 Part B states in paragraph 5.2 under the heading ‘Competence’ – that “Management should implement a programme of staff training to ensure that those appointed to devise strategies and carry out control measures are appropriately informed, instructed and trained, and should be assessed as to their competency.” Further in Part B under paragraph 6.2 it states that “A person intending to fulfil any of the staff functions specified below should be able to prove that they possess sufficient skills, knowledge and experience to be able to perform safely the designated tasks. Consultant medical microbiologist is mentioned in the following text but no explanation as to how a microbiologist would demonstrate satisfactory competence for this role.

   Given the educational requirements to fulfil the Consultant Medical Microbiologist role is poorly described in the SHTM 04-01 it is worth considering whether there is any separate guidance that clearly describes the competency requirements of Medical microbiologists in regard to water safety. It is worth noting that the primary role and education for those fulfilling the Consultant Medical Microbiologist role is to advise on the investigation and treatment of infection in patients. There is no current document that describes the specific training requirements for a Consultant Medical Microbiologist fulfilling the role of Infection control doctor, however the Royal College of Pathologists have developed a detailed Medical Microbiology training curriculum. This 99 page document has a single relevant entry to the current discussion, found in the following list. Given the current move to joint infection training for ID and medical microbiology, it may be that a focus on the microbiologists role in delivering the role outlined in SHTM 04-01 may become even more difficult.

To evaluate and assess an IP&C programme, using the principles of infection prevention and control learned in the CIT curriculum

Knowledge

Describe and explain the science and evidence base that underpins IP&C

Describe and explain various surveillance methodologies, data extraction, analysis and reporting of HCAIs (including mandatory reporting)

Describe and explain the processes involved in undertaking IP&C inspections and their interpretation

Explain engineering and design concepts relevant to IP&C as published by the Department of Health (Health Building Notes and Health Technical Memoranda)

Have a working knowledge of how to evaluate infection control risks associated with

- operation theatre design and ventilation
- ventilation in augmented care areas
- design and ventilation of source and protective isolation facilities
- design of central sterile services departments including evaluation and assessments of the processes of sterilisation and disinfection
- water safety standards including those related to Legionella and Pseudomonas
- endoscopy design, maintenance and monitoring including the use of appropriate high level disinfecting agents
- assess and commission new and refurbished facilities in a healthcare environment
- safe injection practices and make recommendations on choice of product
- management of sharps and splash injuries and the principles of post-exposure prophylaxis

Skills

Create policy documents related to common and important aspects of IP&C in hospital and community based healthcare systems

Create evidence based policy documents and guidance in the event of infections with novel or imported agents

Use knowledge of surveillance methods to make effective judgements on advantages and disadvantages before making a recommendation on the most appropriate surveillance methodology

Suggest appropriate interventions based on surveillance data interpretation

Design, lead, analyse and disseminate results of in-depth audits of policies and practices related to IP&C

Undertake IP&C inspections, analysing the findings and providing a judgement on the quality of the processes adopted by the institution

Demonstrate good report and policy writing skills

Critically appraise evidence when creating policy documents

Demonstrate organisational, leadership and mentoring skills in taking a project to completion

4) What are the microbiological testing requirements in SHTM 04-01 and are they clear?

The first specific mention of microbiological testing requirements in the delivery of safe healthcare water services is in Part b, Operational management and paragraph 9.1 ‘Microbiological monitoring’ which states that “Apart from situations

where there are taste or odour problems, microbiological monitoring for TVCs is not considered to be necessary. However, many estates management staff continue to test for TVCs notwithstanding any conflict with the requirements of L8 as any obvious changes in monitored levels provide a useful rule of thumb early warning of possible emerging problems." Reviewing this single paragraph is informative, given its suggestion not to routinely test TVC's but then to state that despite this estates staff may wish to test, even though primary responsibility for testing apparently lies with the Consultant medical microbiologist. This advice is further reinforced in the Introduction to Part C TVC testing, which suggests that "Although Scottish Health Technical Memorandum (SHTM) 04-01 Part B paragraph 9.1 states that routine quality control microbiological testing for TVCs is no longer considered to be necessary (other than where there are taste or odour problems), many estates personnel invariably have them undertaken on a regular basis after acceptance of installations as a 'rule of thumb' indicator by which an abnormal change assists in identifying potential problems at an early stage."Part C provides further guidance which is potentially confusing, for example in paragraph 3.1 it states that in addition to TVC being carries out quarterly, that:

"This should be carried out quarterly - although TVCs are in themselves innocuous the testing procedures are intended to provide an early warning system whereby elevated TVCs should trigger some form of action to determine the identity of the organism and implement the appropriate treatment;". Thus apparently endorsing the need for quarterly TVC testing, against the advice of the introduction in the same document.

The next specific mention describing laboratory requirements for microbiological testing is in Part E"Alternative materials and filtration", which provides advice on testing following disinfection and commissioning of a new system. Paragraph 2.66, suggests that "Water samples should be obtained from appropriate points in the system after each recharging. Potability analysis of these samples of water should be carried out by the Public Analyst, or an approved independent body, and the contractor should supply a full set of the analysis to the site supervisor for approval before the system is put into use." This is the only mention throughout SHTM 04-01 of the potential role of the expert environmental services provided by the Public Analyst laboratories in Scotland, who expertise includes bot the analysis and interpretation of environmental water samples, and also suggest that interpretation rests with the 'site supervisor'. Part E also describes the documentation required at handover and cleanliness requirements , but appears not to describe a role for infection control in cross checking these documents, should it?

Finally Part G "Operational Procedures and examplar written schemes" has some final advice on microbiological testing. Paragraph 1.8 states that "*Pseudomonas aeruginosa* is a Gram negative organism most commonly found in soil and water. It can be isolated from any moist environment. It is often termed an 'opportunistic pathogen'. Water within systems can periodically be contaminated with these organisms. Although mains supplied water is treated and disinfected, it contains at the point of use, only residual (relatively low) levels of disinfectant chemicals (e.g. chlorine). Water is therefore not sterile and has a (highly variable) background level of micro-organisms, measured in terms of the Total Viable Count (TVC). Levels of TVC organisms in water samples give an indication of the effectiveness of residual disinfection and consequently the likelihood of finding potentially pathogenic micro-organisms." Hence again apparently arguing that routine TVC analysis is informative in water system management, providing

further detailed information in Paragraph 1.9. Section 3 provides a table of testing requirements, apparently further reinforcing the need for quarterly TVC testing, as in:

Frequency	Item	Procedure	Description
Quarterly during periods of Change	Water System Sampling (at random water outlets in High Risk Patient Areas) in Water Systems still serving High Patient Risk Areas.	As described in Section 23. Post-Flush sampling without disinfection (as BS7592: 2008) at sentinel and other randomly selected outlet points in High Risk Patient Areas.	In Water Systems serving multiple Wards or Departments, where during periods of change or decanting Section 7 Procedures may not be practical and there are still pockets of operational Wards or Departments with High Patient Risk areas - there will be Water System Sampling (following the protocols and any actions as described in Section 23) in areas where patients may be most at risk for the entire period of change or where there is reduced water use. Sampling Reports to be tabled at Water Safety Group Meetings.

There are a couple of other mentions in Section G of testing requirements, but most clearly Section 23 titled “The course of action for suspected Nosocomial Legionnaires’ disease”.
Paragraph 23.8 states that

General microbiological and Legionella sampling in hot & cold water systems

23.8 Circumstances under which samples are taken:

- prior alterations to an existing water system;
- as part of commissioning process, prior to handover of a new building or introduction of a (altered, refurbished or new) water system into use;
- one week following handover of a new building or new water system;
- as part of the tank cleaning and disinfection process;
- as part of an assessment programme;
- in response to taste, odour or sustained discoloured water complaints.

SHTM 04-01 Section C details Total Viable Counts (TVC) and *Legionella* water quality testing requirements (to BS EN ISO 5667-1, BS6068 and ISO 11731) to identify sampling for the following harmful bacteria:

Coliforms	*Legionella*
Escherichia coli	*Salmonella*
Pseudomonas aeruginosa	*Campylobacter*
Aerobic Colony Counts	*E.coli O157*
Environmental Mycobacteria	*Staphylococcus aureus*
The following may also be identified:	
Cryptosporidium	*Klebsiella*
Clostridia	*Enterococci*

There are also a variety of other organisms that can behave in a similar way to that of *Pseudomonas aeruginosa* that may also be identified. These organisms are less pathogenic and less frequently isolated than *Pseudomonas aeruginosa:*

Burkholderia cepacia	*Ralsotonia picketti*
Chrysebacterium spp	*Serratia marsecens*
Stenotrophomonas maltophilia	*Acinetobacter spp*
Sphingomonas spp	*Enterobacter spp*

Then stating that, “The Consultant Microbiologist will provide interpretation on the isolation of particular bacteria, the results and confirm any necessary actions.” Further suggestionsa re raised around the need to take comparative mains supply water samples and on the specifics of testing for Legionella spp..

In summary, the SHTM provides a changing emphasis on the need for microbiological monitoring of water supplies and who should carry out the testing.

Recommendations –to be completed after discussion

Summary Update on NHS Greater Glasgow and Clyde: Queen Elizabeth University Hospital/Royal Hospital for Children Water Contamination Incident and Recommendations for NHS Scotland

Friday 17 August 2018

Author: Annette Rankin, HPS

Situation	NHS Greater Glasgow and Clyde (NHSGGC) reported a contaminated water system across the Queen Elizabeth University Hospital (QEUH) and Royal Hospital for Children (RHC) with possible linked cases of bloodstream infections associated with ward 2A RHC. NHSGGC requested incident support from Health Protection Scotland (HPS) on 16 March 2018 and Scottish Government invoked the national support framework on 20 March 2018. HPS and Health Facilities Scotland (HFS) have collaborated in providing national support with the ongoing incident and associated investigation.
Background	An initial summary report of this investigation was prepared, shared with NHSGGC and submitted to Scottish Government on 31 May 2018 (Appendix 1). A detailed technical report is currently being undertaken with the final delivery date to be agreed. The Incident Management Team (IMT), set up by NHSGGC and Supported by HPS and HFS, agreed the case definition “any child linked to wards 2A/B RHC with a blood stream infection (BSI) caused by a gram negative bacillus that had been identified from organisms identified within the water system”. Ward 2A RHC is a haemato-oncology unit (also known as Scheihallion) and houses the national paediatric bone marrow transplant unit. As a consequence to their condition and or treatment many of the children within this patient population are immunocompromised and as such are the extremely vulnerable to infection.

	Since the incident was identified in January 2018 there have been 17 patient cases identified. The initial summary report (Appendix 1) issued on 31 May 2108 detailed the first 7 cases identified. A further 10 cases were identified between 31 May 2018 to date. There have been no new reported cases since 12 June 2018. The control measures detailed in the summary report remain in place with additional controls being introduced to address the discovery of hand wash basin contamination from biofilm build up evident within the hand wash basin drains. Microbiological testing of drains isolated *Enterobacter* and the IMT agreed a hypothesis that splash caused by the point of use filter was a factor in environmental and person contamination with *Enterobacter* present within the drains resulting in a number of BSI. A programme of drain cleaning in all high risk wards across QEUH and RHC was commenced, staring with wards 2A/B. In addition both these wards underwent a series of environmental decontamination using hydrogen peroxide vapour. It was also observed that the aluminium drain spigots were showing signs of corrosion and may be contributing to drain contamination and biofilm therefore aluminium spigots were replaced with PVC spigots in wards 2A/2B and a planned programme of replacement in high risk areas was implemented. No further cases have been reported within these wards since drain cleaning has been completed and point of use filters remain in place. Whilst the clinical IMT has been stood down since 21 June 2018, weekly water IMT is being held by NHSGGC and supported by HPS/HFS. This group will continue to meet on a weekly basis throughout the year and meeting schedules will be reviewed early 2019.
Assessment	There are a number of workable hypothesis that continue to be explored, it is currently considered the most likely cause of the widespread contamination is a combination of hypothesis B and C. **A: Ingress contamination** A small low level number of micro-organisms may have been present in the water supply at the point of entry. Lack of temperature or chemical control may have enabled biofilm formation. Due to the increasing biofilm throughout the system this may have allowed any subsequent micro-organisms present at point of entry an opportunity to flourish and cause widespread contamination of the system. **B: Regression contamination** This may have occurred due to contamination caused by organisms in the water occurring at the taps/outlets or flow straighteners and

	contamination has regressed backwards throughout the system causing widespread contamination. The widespread positive results and array of bacteria point to contaminated outlets at installation or contamination of high risk components in the tap from ingress as opposed to the patient contact route **C: Contamination at installation/commissioning** Contamination may have occurred due to presence of contaminated pipework or outlets. Prior to handover the system required to be disinfected as part of the commissioning process and high TVC counts were noted. It is unclear what infection control input was to this process and the counts at handover. It is also unclear if a robust flushing regime was in place from installation to handover and from handover to occupancy to prevent further contamination. NHSGGC are currently procuring the preferred option of treatment of water by chlorine dioxide however it is recognised that this may take up to 2 years to ensure the water system is within acceptable parameters from a microbiological perspective. A detailed technical report will explore the possible causes leading to the contamination water system through design, construction, commissioning, handover and maintenance.
Recommendations **Short Term – 6-12 months (ST)** **Medium Term – 1 to 2 years (MT)** **Long Term – 2 to 5 years (LT)**	A number of local and national recommendations have been made for consideration based on the investigation to date: **NHSGGC** 1. Continue implementation of the decontamination maintenance protocol of flow straighteners. (ST) 2. Ensure that any tap replacement programme has no flow mesh flow straighteners. (MT) 3. Provide assurance that the management of the water systems is as described in guidance, including letters of appointment; appropriate numbers of authorised persons and competent person and appropriate training. (ST) 4. Resolve outstanding issues with Energy Centre. (ST-MT) 5. Consider revising the Employer's Requirements for future projects to include current guidance, competency checks for all contractors, project management, project supervision (specialised clerk of works) and project handover requirements. The inclusion and collaboration of the Estates Department for all Capital projects should be considered. (MT)

	6. Resolve all the points noted in the two Legionella Risk Assessments and Authorising Engineers reports. (ST) 7. Consider having a formal process in place to prioritise, manage, record and react to any BMS alarms from anywhere in the campus network. (ST) 8. Carry out routine maintenance and reactive maintenance on the hot and cold water systems and components as per the Planned Preventative Maintenance (PPM) schedules in ZUTEC and specific manufacturers' recommendations and ensure that all infrequently used outlets are managed and flushing is recorded. This should include all water dump valves and checking turnover of the water tanks. (ST) 9. Have the seasonal commissioning as required by the specification carried out by the Contractor (MT) 10. Ensure all pipe work to removed external bib taps has been removed and all EPDM flexible hoses have been removed or managed by risk assessment. (ST) 11. Ensure that the BMS server provided under the contract meets the requirements of the contract specification in relation to data storage integrity. (ST) 12. Have all electronic records checked and any missing or incorrect documentation rectified and provided. (ST) **All NHS Boards** 1. To ensure facilities teams are adequately resourced to ensure maintenance of all aspects of the water system are maintained in accordance with both local and national policies and national guidance. (ST) 2. Record all maintenance undertaken and maintenance records should be reviewed regularly to ensure all aspects of the water system are maintained in accordance with both local and national policies and guidance (ST)

	HPS/HFS **1.** Review sink and drain cleaning guidance as part of the HPS infection control built environment programme (ST) **2.** Via the existing HPS infection control built environment programme will, in conjunction with HFS: a) Prioritise water safety and undertake a review of NHS Scotland current approach to water safety (MT) b) Review existing National and international guidance relating to water safety and consider robust requirements for building handover requirements in relation to the water systems. (MT) c) Review the role of the IPCT into the built environment, including day to day activities, refurbishments and new builds (ST) d) Develop an evidence based/best practice built environment manual which will cover as a minimum the technical requirements from a clinical and HAI perspective (LT) e) Establish a risk based approach to water testing and any remedial action required, including roles and responsibilities (MT) f) Produce evidence based guidance on water coolers, ice machines and dishwashers from a water safety and decontamination perspective (MT) 3. HPS/HFS will continue to provide support to NHSGGC relating to the current water incident and provide input into the weekly meetings until 2019 as appropriate (ST) 4. Further develop Scottish expertise in the built environment programme (mainly water and ventilation) at national level (MT) 5. Review of construction management guidance to establish how it can provide assurance that similar issues will not occur in future projects.((MT)

	6. Consideration to be given to production of updated “standard” Employer’s Requirements (also known as Authority Contract Requirements (ACR) or Board Contract Requirements (BCR) as a National resource for all Boards. (LT) 7. Consideration for updated water and other guidance to include (LT) • Thermal disinfection in sections of water distribution systems • Handover checklists • Contract management procedures • Design guides to eliminate thermal pickup in cold water systems • Update advantages and disadvantages of chemical disinfection techniques • The organisms Boards should test for and action to take on defined levels • Drain cleaning regimes • Biofilm growth in drainage systems The recommendations provided within this SBAR are based on the evidence from the ongoing investigation. There may be further recommendations given within any further update reports.

Appendix 1- Initial findings report: 31 May 2018

Health Protection Scotland

NHS National Services Scotland

Initial report on the findings of the NHS Greater Glasgow and Clyde: Queen Elizabeth University Hospital/Royal Hospital for Children water contamination incident and recommendations for NHS Scotland

Report prepared on behalf of HPS/HFS

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Control Health Protection

Scotland

Title: NHS GGC potential water contamination Version: 1.0
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Status: Final

Contents

Executive summary

NHS Greater Glasgow and Clyde (NHSGGC) are currently investigating a potentially contaminated water system across the Queen Elizabeth University Hospital (QEUH) and Royal Hospital for Children (RHC) with possible linked cases of bloodstream infections associated with ward 2A RHC.

Ward 2A RHC is a haemato-oncology unit, also known as Schiehallion, and houses the National Bone Marrow Transplant Unit. In 2016 a patient within ward 2A RHC was identified as having a blood stream infection (BSI) as a result of *Cupriavidus pauculus*. NHSGGC investigations included water samples from outlets within the aseptic suite of the pharmacy department where the parenteral nutrition was made that the child had received. *Cupriavidus pauculus* was isolated from water samples taken from a tap on a wash hand basin within this area. The wash hand basin was subsequently removed as a result. A further single case of *Cupriavidus pauculus* was identified in September 2017 however no environmental or water sampling was undertaken at this time.

Between the period of 29th January and 3rd April 2018 7 cases of blood stream infections (3 different organisms) with potential links to water contamination were identified. As a result widespread testing of the water supply was undertaken across both hospital sites. This testing identified widespread contamination of the water system. Control measures implemented included sanitisation of the water supply to ward 2A, the use of point of use filters in wash hand basins and showers in ward 2A and other areas where patients were considered high risk. There have been no new linked cases identified since the implementation of the control measures and whilst the investigation remains ongoing the clinical incident has been declared over with a full debrief held on 15th May 2018.

NHSGGC requested support from HPS with this incident on 16th March 2018 and Scottish Government invoked the national support framework on 20th March 2018 which requires HPS to lead an investigation and provide board support. This report is an initial summary of the findings from this investigation. A detailed technical report will be produced for NHSGGC by 31st July 2018.

Introduction

NHS Greater Glasgow and Clyde (NHSGGC) are currently investigating a potentially contaminated water system across the Queen Elizabeth University Hospital (QEUH) and Royal Hospital for Children (RHC) with possible linked cases of bloodstream infections associated with ward 2A RHC.

NHSGGC requested support from HPS with this incident on 16th March 2018 and Scottish Government invoked the national support framework[1] on 20th March 2018 which requires HPS to lead an investigation and provide board support. This report is an initial summary of the findings from this investigation. A detailed technical report will be produced for NHSGGC by 31st July 2018.

Background

NHS Greater Glasgow and Clyde's (NHSGGC) Queen Elizabeth University hospital (QEUH) is a 1109 bedded hospital with 100% en suite single side rooms which was handed over to the Board on 26th January 2015 with patient migration commencing from 24th April 2015 until 7th June 2015. The adjoining Royal Hospital for Children (RHC) is a 256 bedded childrens hospital which was handed over to the Board on 26th January 2015 with migration of patients occurring between 10th and 14th June 2015. The QEUH and RHC were both fully occupied from 15th June 2015 There are a number of additional healthcare facilities in the surrounding grounds including the maternity unit, neurosurgical unit, elderly care unit and the national spinal injuries unit.

Ward 2A RHC is a haemato-oncology unit, also known as Shiehallion, and houses the National Bone Marrow Transplant Unit. In February 2016 a patient within ward 2A RHC was identified as having a bloodstream infection (BSI) as a result of *Cupriavidus pauculus*. NHSGGC investigations included water samples from outlets within the aseptic suite of the pharmacy department where the parenteral nutrition was made that the child had received. *Cupriavidus pauculus* was isolated from water samples taken from a tap on a wash hand basin within this area. The wash hand basin was subsequently removed as a result. A further single case of *Cupriavidus pauculus* was identified in September 2017 however no environmental or water sampling was undertaken at this time. Appendix 1 details all incidents reported to Health Protection Scotland under the Healthcare associated incident investigation tool[2] related to ward 2A since 1st January 2016.

On 29th January 2018 *Cupriavidus pauculus* was identified from a bloodstream infection (BSI) in a patient in ward 2A. A series of investigations were undertaken including water sampling from outlets within the ward area. On 21st February *Pseudomonas* was identified from a BSI and between 11th and 16th March 2018 4 cases of *Stenotrophomonas maltophilia* were identified from patients in ward 2A and 1 patient in Paediatric ICU. *Cupriavidus, Pseudomonas and Stenotrophomonas* (amongst other gram negative bacillus and fungi) were identified. This led to enhanced control measures being applied within ward 2A and an extensive investigation into the potentially contaminated water system across the QEUH and RHC. Testing of the organisms in this incident has not provided an exact link to the patient cases and the water system. Testing in an incident like this can be difficult and should only be used to include cases rather than exclude. To attain appropriate representation of the bacteria within the water would require significant sampling of each organism identified to ensure a representation of strains was identified. A timeline of the patients with infections included in this incident is detailed in Appendix 2. A further case of *Stenotrophomonas* bacteraemia presented on admission to 2A on 3rd April 2018. Due to previous ward contact before implementation of control measures this case was included.

This report is an overview report of this investigation due to the large volume of data and complexities associated with this incident. A second more detailed and technical report is currently being produced which will cover more technical details and will be issued to Scottish Government and NHS GGC by end of July 2018. The longer timescale for this report is as a result of this incident being an ongoing live situation and covers information from the design and commissioning of the hospitals to the current position. HPS worked with the support of Health Facilities Scotland (HFS) as the technical engineering experts to support this investigation and report production.

Organisms linked to cases of infection in this incident

Details on the 3 organisms (*Cupriavidas, Stenotrophomonas and Pseudomonas*) that are linked to patient cases in this current investigation are covered in appendix 3.

The role of biofilm

Biofilm is a group of microorganisms in which the cells adhere to each other and often to a surface. These cells then become embedded within a slimy substance and can be prevalent in natural, industrial and hospital settings. There is a multitude of information in the published literature which directly links biofillm production/biofilm producing organisms to water source related outbreaks. In addition, 3 recent review articles focussed on the role of water in healthcare associated infections, with specific mention of biofilm formation as a key mechanism for sustained contamination of water systems.[3-5] Biofilm formation has been described for *Cupriavidus* species and *Pseudomonas spp*, particularly in association with water systems. Biofilm formation with *Stenotrophomonas* on a variety of surfaces has also been demonstrated.[6] As a specific example; an *S maltophilia* biofilm was found to be formed within a flexible tube running from a carbon filter to a chiller, which was connected to a tap in a kitchen sink, used to supply patients with drinking water.[6]

Initial findings

HPS, HFS and NHS GGC initiated a detailed investigation into the contaminated water system within QEUH/RHC. This includes reviewing commission, installation and maintenance records provided by the contractor. This has proved challenging due to the archiving of data and the fact that there are very few members of the initial project team available who are technically qualified to retrieve data and provide verbal clarification.

Results from ongoing water testing are being reviewed on a weekly basis and would appear to confirm that there continues to be regressional seeding of contamination and supports the theory that a whole system remedial approach is required. In addition to the 3 organisms associated with the clinical incident, numerous additional gram negative bacilli and fungal species have been identified from samples.

A technical and epidemiological report is currently being produced which will include details of this investigation. Initial preliminary findings have identified that prior to handover from the contractor there were a number of water samples taken that produced results with high level of total viable counts (TVCs). TVCs are indicators that there are hygiene issues within the water system and are quantified as a generic indicator for microbial contamination. Specific microorganisms which can be tested for include: Coliforms, *Escherichia coli (*including O157), *Pseudomonas aeruginosa, Salmonella spp*, *Campylobacter spp* and Environmental Mycobacteria. Testing for these is not conducted as standard within current guidance and typically occurs in response to a suspected or confirmed outbreak, or due to identification of a series of sequential cases.

Commissioning and design of the hospital system

As part of the normal water system commissioning water samples were obtained. Some samples yielded high TVCs. In response to the high levels of TVCs NHSGGC did not accept the handover of the hospital at this time sanitisation of the water supply was undertaken prior to handover, with some impact and a reduction in TVCs in most areas, however there are a number of reports which indicate that there may still have been a number of areas with higher than normally acceptable levels of TVCs however work is still ongoing with this.

Evidence has been requested from NHS GG&C in relation to the infection control sign off of results and the system at commissioning/handover. Work continues to locate appropriate documentation and will be discussed in the final report. Water was first placed on the Infection prevention and control (IPCT) risk register in 2018.

The design and construct of wash hand basins, showers and taps in this hospital were agreed with NHS GGC in line with the Scottish Health Technical Memorandum (SHTM) in place at the point the hospital was designed, this included the installation of taps with flow regulators. HFS and HPS were involved in this decision making process as was NHSGGC Infection Control team. The SHTM (SHTM 04-01)[7] was revised in 2015 and no longer supports the use of flow regulators in clinical wash hand basins.

Biofilm formation in flow straighteners has been identified in a previous published outbreak.[8] The manufacturers of the taps/flow regulators recommend regular removal of the flow straighteners for cleaning/decontamination. Any records relating to decontamination of the flow straighteners will be reviewed in the wider review being undertaken.

The taps in place across all clinical wash hand basins in the hospital are not compatible with silver hydrogen peroxide, a product used during commission stage to sanitise the water system in view of the high TVC results. It is unclear whether this has caused any degradation of the taps, however NHS GGC have sent taps removed from the installation for metallurgical testing. In addition a tap was deconstructed and examined for the presence of biofilm, in addition to microbiological sampling. The presence of high levels of gram negative bacteria and fungus in the water system suggests that temperature control required has not always been achieved. This will be reviewed as part of the wider review being undertaken. In line with the national guidance there is a water safety group (WSG), and local Sector/Hospital Water Safety Groups. The Board Water Safety Group is a sub group of the Board Infection Control Group .Water Safety is a standing agenda item for the infection Control Team Senior Managers Team meeting.

There is a flushing regime in place across both hospitals however it is unclear whether the flushing process is adequate and all outlets are being flushed, including little used outlets, water coolers, baths etc. Due to the size of the system this is extremely difficult to assess. The wider report will review this.

Current management of situation

Point of use filters

Point of use (POU) filters were installed as one of the main control measures initially in high risk areas (wash hand basins and showers) to ensure a safe water supply at the point of use. These filters have been installed across all areas within QEUH and RHC where there are likely to be immunocompromised patients or in identified clinically higher risk areas. POU filters require to be changed every 30 days and are a costly approach. However, in the interim until the water contamination can be addressed, is the only feasible approach to ensure safe delivery of water. A number of studies found that installation of point of use filters reduced either infection rates in associated healthcare settings[9, 10] or pathogen counts within tested water samples.[11]

Water treatment

It is well recognised that drinking water distribution systems contain a diverse range of microorganisms.[12-14] The presence of microorganisms is affected by various factors including; the disinfection processes employed, the location and age of the system as well as pipe material.[15]

There are a number of options to be explored for longer term water treatment and NHS GGC are preparing a feasibility report on the most appropriate solution: these options include

Chlorine dioxide

A number of studies were identified which utilised chlorine dioxide systems within hospital settings, and use of these was found to reduce bacterial numbers.[14;16;17]

Various advantages and limitations associated with use of chlorine dioxide are known, with the most relevant summarised below.[18;19]

Advantages: Known to be effective against a wide range of bacteria, viruses and some protozoa including Giardia.

Limitations: Production of disinfection by- products (DBP's). Although potential production of DBP's always needs to be considered, the efficacy of water disinfection should not be compromised in trying to eliminate these. [19]

UV light

A number of drinking-water treatment technologies are available which employ UV light radiation to inactivate microorganisms.[19]

As with chlorine dioxide, various advantages and limitations associated with use UV are known, with the most relevant summarised below.[18-20]

Advantages: Bacteria, fungi and protozoa (considered to be more effective at killing Cryptosporidium than chlorine dioxide) are readily inactivated at low UV doses, with higher doses required for virus inactivation. In addition, UV disinfection does not result in the formation of DBP's like chlorine dioxide.

Limitations: UV disinfection does not leave any residual compound in treated water and therefore does not offer protection against possible microbial re-growth in distribution pipe-work.

Thermal disinfection

Very limited information was identified in the published literature in relation to advantages and limitations of thermal disinfection.

One study found that heat shock treatment at 80 ˚C reduced Gram negative bacteria in a hospital water system but did not lead to complete eradication.[21]

A risk benefit analysis of each option will be undertaken as part of the wider report. An additional approach for sanitisation which will also be reviewed is copper silver ionisation.

Hypothesis

There are a number of workable hypotheses being explored; it is currently considered the most likely cause of the widespread contamination is a combination of hypothesis B and C

A: Ingress contamination

A small low level number of micro-organisms may have been present in the water supply at the point of entry. Lack of temperature or chemical control may have enabled biofilm formation. Due to the increasing biofilm throughout the system this may have allowed any subsequent micro-organisms present at point of entry an opportunity to flourish and cause widespread contamination of the system.

B: Regressional contamination

This may have occurred due to contamination occurring at the taps/outlets or flow straighteners and contamination has regressed backwards throughout the system causing widespread contamination. The widespread positive results and array of bacteria point to contaminated outlets at installation or contamination of high risk components in the tap from ingress as opposed to the patient contact route.

C: Contamination at installation/commissioning

Contamination may have occurred due to presence of contaminated pipework or outlets. Prior to handover the system required to be sanitised due to high TVC counts. It is unclear if a robust flushing regime was in place from installation to handover and from handover to occupancy to prevent contamination.

Summary

There have been no new reported cases since 3rd April 2018 and the clinical aspect of this incident has been closed. This will be reopened if any new cases are identified. Control measures are in place to mitigate the risk however further work to address the widespread contamination is required. HPS will continue to liaise with HFS and NHSGGC and co- ordinate and produce a detailed technical report for NHSGGC and Scottish government which will include the review of installation, commission and maintenance and the risk/benefits of remedial approaches such as water dosing and tap replacement. This report will be prepared by July 2018.

Recommendations:

- Point of use filters will continue to be in place in ward 2A and other areas identified by the IMT until the risk to patients from the current situation of water contamination has been minimised.
- HPS will continue to liaise with HFS and NHSGGC and co-ordinate a wider technical report by 31st July 2018.
- HPS via the existing Infection Control Built environment programme will, in conjunction with HFS:
  A. Prioritise water safety and undertake a review of NHS Scotland current approach to water safety
  B. Review existing national and international guidance relating to water safety and consider robust requirements for building handover requirements in relation to the water systems.
  C. Establish a risk based approach to water testing and any remedial action required, including roles and responsibilities.

Appendix 1 - NHSScotland Incident and Outbreak Summary Ward 2a RHC (January 2016- April 2018).

NHS Greater Glasgow and Clyde have reported a total of 10 outbreaks and incidents for the clinical setting paediatric haemato-oncology. Of the 10 incidents and outbreaks HIIAT assessed; 4 were Red, 2 were Amber and 4 were Green. The data is displayed in the tables below providing a breakdown of the outbreaks reported by annual period with exception of the current period to date for 2018 and HIIAT Green in 2016 following introduction of mandatory report (non Norovirus) from April. Comparative data for this setting within NHSScotland identified no reported incidents or outbreaks out with NHS Greater Glasgow and Clyde.

2018:

Table 1 NHS Greater Glasgow & Clyde, RHC haemato-oncology (ward 2A), HIIAT RED 2018 ± Total (1)			
Date reported	**Organism**	**Infection Category**	**Summary**
01/03/2018	*Pseudomonas aeruginosa* or *Cupriavidus pauculus*	BSI	**Current ongoing** incident following initial reporting water system contamination with Cupriavidus pauculus/ Pseudomonas aeruginosa within ward 2A (haemato-oncology ward) at the Royal Hospital for Sick Children following 2 confirmed cases, 1 with *Cupriavidus pauculus* bacteraemia, 1 with *Pseudomonas aeruginosa* bacteraemia resulting in invokement of the national framework by Scottish Government on 21/3/18.

Table 2 NHS Greater Glasgow & Clyde, RHC haemato-oncology (ward 2A), HIIAT AMBER 2018 ± Total (1)			
Date reported	**Organism**	**Infection Category**	**Summary**
10/04/2018	Astrovirus	Respiratory	12 patient cases identified with Astrovirus

2017:

Table 3 NHS Greater Glasgow & Clyde, RHC haemato-oncology (ward 2A), HIIAT GREEN 2017 ± Total (3)			
Date reported	**Organism**	**Infection Category**	**Summary**
03/03/2017	*Elizabethkingia miricola*	BSI	Three cases BSI infection since September 2016. Action plan - focus on the environment
03/03/2017	Mixed	BSI	IPCT and clinical team noted a general increase in the number of blood cultures over January and February
31/5/2017	Norovirus	GI	3 cases, 2 of which HAI (some cases amongst parents within the unit)

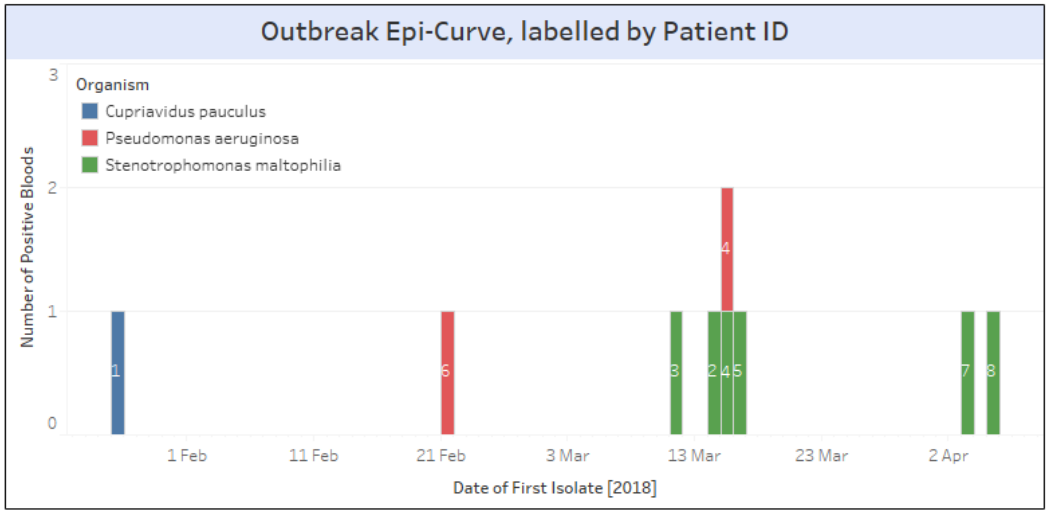
Table 4 NHS Greater Glasgow & Clyde, RHC haemato-oncology (ward 2A), HIIAT RED 2017 ± Total (3)			
Date reported	**Organism**	**Infection Category**	**Summary**
7/3/2017	*Aspergillus fumigatus*	Airborne	A higher than expected incidence of Aspergillus in this patient population since June 2016. Three patients met the case definition of probable Aspergillosis
13/04/2017	Rotavirus	GI	5 patient cases of VRE 3 of which have rotavirus. 2 staff members confirmed rotavirus
26/7/2017	Stenotrophomonas	BSI	Two patients with positive Stenotrophomonas bacteraemia within 8 days. Both cases considered to be HAI. Control measures in place

2016:

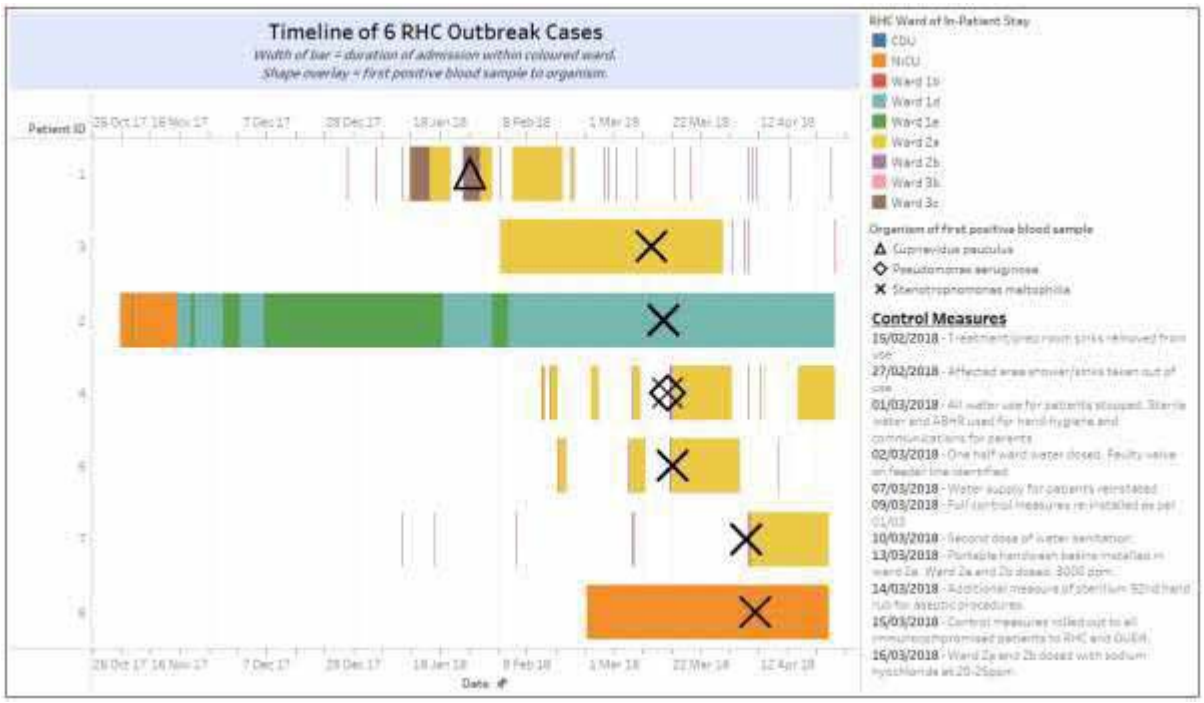
Table 5 NHS Greater Glasgow & Clyde, RHC haemato-oncology (ward 2A), HIIAT GREEN 2016- Total (1)			
Date reported	**Organism**	**Infection Category**	**Summary**
04/08/2016	Vancomycin Resistant *Enterococci*	GI	Increase in VRE

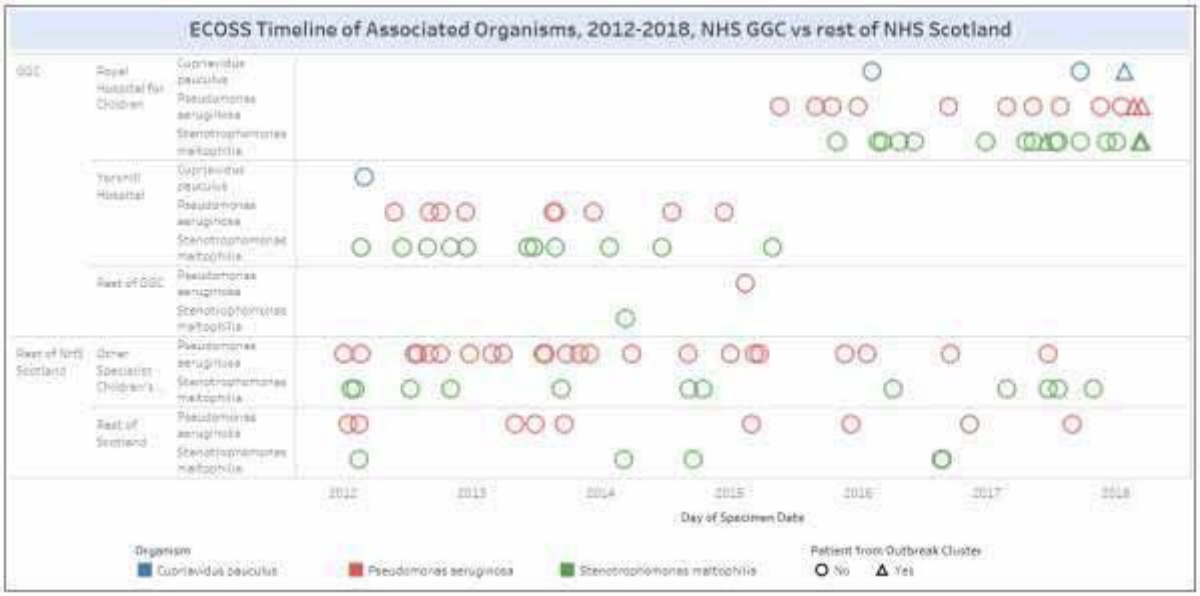
Table 6 NHS Greater Glasgow & Clyde, RHC haemato-oncology (ward 2A), HIIAT AMBER 2016- Total (1)			
Date reported to HPS	**Organism**	**Infection Category**	**Summary**
05/08/2016	Aspergillus	Respiratory	Two cases: one confirmed and one probable Neither giving cause for clinical concern specific to Aspergillus. Possible contributing environmental factors for cross transmission.

Appendix 2 Timeline of cases



The epi-curve demonstrates that only one case of *Cupriavidus pauculus* was reported from 26th January 2018, with the other associated cases being *Stenotrophomonas maltophilia* and/or *Pseudomonas aeruginosa* positive between 21st February 2018 and 5th April 2018.




ECOSS Timeline of Associated Organisms, 2012-2018, NHS GGC vs rest of NHS Scotland
GGC
Royal Hospital for Children
Cupriavidus pauculus
Pseudomonas aeruginosa
Stenotrophomonas maltophilia
Yorkhill Hospital
Cupriavidus pauculus
Pseudomonas aeruginosa
Stenotrophomonas maltophilia
Rest of GGC
Pseudomonas aeruginosa
Stenotrophomonas maltophilia
Rest of NHS Scotland
Other Specialist Children's ...
Pseudomonas aeruginosa
Stenotrophomonas maltophilia
Rest of Scotland
Pseudomonas aeruginosa
Stenotrophomonas maltophilia
2012
2013
2014
2015
2016
2017
2018
Day of Specimen Date
Organism
Cupriavidus pauculus
Pseudomonas aeruginosa
Stenotrophomonas maltophilia
Patient from Outbreak Cluster
No
Yes

Appendix 3 - *Cupriavidus, Stenotrophomonas, Pseudomonas*

Cupriavidus pauculus

1. Background

Cupriavidus species are Gram-negative, aerobic, non-spore-forming, motile bacilli.[22] Various naming conventions have previously been associated with this organism (formerly known as *Ralstonia paucula*, *Wautersia paucula* and CDC group IVc-2)[22-24]

a. Reservoir/s

C. pauculus and other *Cupriavidus* species are considered to be environmental organisms,[24;25] *(*although negative environmental screening when investigating incidents/outbreaks has occasionally been reported [26;27]). More specifically, water is known to be a potential source of infection, including drinking water.[24;28-30]

b. Mode/s of transmission

Very limited information on the mode of transmission of the organism is available. Contact with the environment has been proposed as the primary mode of transmission.[25-27] Person-to-person spread has been considered, but has not been proven.[31] In addition, other modes of transmission, including following a cat bite[32] have also been reported.

c. Biofilm formation

Biofilm formation has been described for *Cupriavidus* species, particularly in association with water systems.[26;30;33-35]

2. Summary of published incidents/outbreaks

There are numerous case reports of infections caused by *C. pauculus* within the published literature. Many of these occurred in Europe,[31;32;36-42] but to date, there have been no case reports of infection in Scotland, or the UK.

The majority of case reports identified one affected patient[23;25;27;32;36-38;40-50] therefore it may be most appropriate to considered these as 'incidents' rather than true outbreaks.

A number of the reports[23;31;38;43;44;47;49] considered infections to be nosocomial, although many of the patients had prolonged/intermittent hospital stays and it was therefore difficult to accurately establish healthcare versus community acquisition.

The majority of reports were associated with immunocompromised patients,[27;31;38;39;41-43;48;50] or those with various co-morbidities, with or without known immunosupression.[23;37;40;44;46;47]

A significant number of reports were associated with neonates, or paediatric patients.[23;25;31;36;44-46;48]

Various types of infections were described, the majority of reports described bacteraemia/septicaemia.[23;25;37;41-45;47;49;50] Other presentations included pneumonia,[36- 38;46] meningitis,[25] peritonitis,[40] and osteomyelitis/septic arthritis.[43] In addition, catheter associated infections were also reported.[27;42] A number of patient deaths occurred,[37;44;46;48] but in most cases it was difficult to determine whether these were directly due to infection with the organism, or other factors associated with patient immunosupression /chronic disease.

Water as a source[23;27;29;43;44;47] was suspected in a number of reports, but no source was determined in the majority of cases.

In addition, two pseudo-outbreaks were reported, due likely environmental contamination by this organism of specimen swabs[29] and blood culture bottles.[26]

Stenotrophomonas maltophilia

1. Background

Stenotrophomonas maltophilia is a non-lactose fermenting Gram-negative aerobic bacillus, previously known as *Xanthomonas maltophilia* and *Pseudomonas maltophilia.* The organism has been implicated in causing outbreaks since the 1970's.[51]

a. Reservoir/s

The organism is found in a variety of environments, including water, sewage and soil. Specifically within healthcare settings, *S. maltophilia* has been isolated from various reservoirs including taps, humidifiers, nebulizers, and ventilation equipment.[51] In addition, the organism has been isolated from bottled water.[52]

b. Mode/s of transmission

Although numerous outbreaks associated with this organism have been reported, the source and mode of transmission it often difficult to establish. Typically, direct or indirect contact with a contaminated healthcare environment/equipment has been reported. Human carriage has also been noted in a number of studies, and therefore gives rise to the potential for person-to-person transmission.[51]

c. Biofilm formation

Biofilm formation on a variety of surfaces has been demonstrated.[6] As a specific example; an *S maltophilia* biofilm was found to be formed within a flexible tube running from a carbon filter to a chiller, which was connected to a tap in a kitchen sink, used to supply patients with drinking water.[53]

Under laboratory conditions, optimum temperature for growth is considered to be 37ÛC, although environmental isolates tend to have a propensity for growth at lower temperatures (20-30ÛC). The organism is also known to survive in temperatures as low as 4˚C for significant periods of time.[54] In addition, it has been indicated that biofilm formation is temperature dependent, with one study citing optimum biofilm formation at 32˚C (in comparison to 18 and 37°C) [55]

2. Summary of published incidents/outbreaks

There are numerous published case reports and outbreak studies describing nosocomial infection and/or colonisation. One of these referred to an outbreak which occurred in the UK.[53]

The majority of studies were associated with immunocompromised patients,[56-60] or those with various co-morbidities, with or without known immunosupression.[53;61-66] 25% (4 out of 16) of identified studies were associated with neonates, or paediatric patients.[62;64;66;67].

Various types of infections were described; predominantly bacteraemia/septicaemia.[56- 61;64;66;67] Other presentations included endopthalmitis,[68] as well as respiratory,[53;62;63;69] soft tissue[58] and catheter associated infections.[59] In addition, a number of studies described cases of both colonisation and infection[53;60;63;64] and one described colonisation alone.[70]

Various sources of infection were reported including taps/tap water[53;58;64;70;71] and related environments (wash-hand basins[62;65] and a shower outlet[60]), medical solutions,[56;68] and various medical equipment;[61;63;66;69;71-73] predominantly bronchoscopes (N.B all bronchoscope related outbreaks were found to be pseudo-outbreaks).

Limited information was provided on the mode of transmission but most studies considered this to be contact with the healthcare environment, relating to the sources described above. Two outbreaks stipulated that person-to-person transmission from colonised healthcare workers may have occurred.[66;67]

In addition, a number of reports described co-infections; primarily with other Gram negative organisms.[71-74]

Pseudomonas spp

Biofilm formation

Pseudomonas spp are known to form biofilms both within the environment and in patient infections (i.e. on implanted biomaterials).[75]

P. aeruginosa is known to survive a range of temperatures; typically 4-42° C, with optimum growth occurring at 37°C.[76] Biofilm formation has been shown to be temperature dependent, with one experimental study citing optimum biofilm formation at 37°C (in comparison to 28, 33 and 42°C).[3]

Further specific information in relation to biofilm formation associated with water sources can be found in '*Are biofilms associated with water source related transmission with healthcare settings?*' below.

Summary of published incidents/outbreaks

A multitude of nosocomial *Pseudomonas spp* outbreaks have been reported in the published literature. The summary below includes outbreaks occurring in the last 10 years only.

Outbreaks were reported internationally, with four of these occurring in the UK.[4;5;9;10]

The majority of studies were associated with immunocompromised patients,[56;77-89] or those with various co-morbidities, with or without known immunosupression.[4;9;10;90-118]

9% (7 out of 63) of identified studies were associated with neonates, or paediatric patients.[77;79;99;101;106;110;114] A recent systematic review outlines risk factors and environmental sources associated *with P. aeruginosa* outbreaks in neonatal intensive care settings.[119]

Various types of infections were described; predominantly bacteraemia/septicaemia.[11;56;78-81;83;85;88;89;94;98-101;107;109;113;114;118;120-122] Other presentations included endopthalmitis,[123-126] endocarditis[127] as well as respiratory,[10;69;78;80;89;96;105;109;112;113;118;128] surgical site[88;89;115;118;129] and urinary tract infections.[80;88;95;109;118;120;122;128;130;131] In addition, a number of studies described cases of both colonisation and infection.[78-81; 93;94;97 ;99;104 ;110; 111; 114;116;128]

Various sources of infection were reported including bottled water,[91;99] taps/tap water,[5-77;82;97;101] as well as wider wash-hand basin environments[4;90;110;113;116] including a soap dispenser.[80] In addition, a further study demonstrated isolation of *P. aeruginosa* from various water fittings in intensive care rooms, in the absence of a recognised outbreak.[132] Outbreaks have also been associated with various medical solutions,[56;96;121;124;126;127] and medical equipment, including various types of endoscopes,[69;81;93;120;130;133] arthroscopic shavers,[129] a urodynamic transducer[122] and a transesophageal echocardiogram probe.[94]

Limited information was provided on the mode of transmission but most studies considered this to be contact with the healthcare environment, relating to the sources described above. A number of outbreak reports stipulated that person-to-person transmission from colonised healthcare workers/patients may have occurred.[11;79;84;92;95;98;102;104;112;114]

The majority of outbreaks were associated with *P. aeruginosa* but other species were also reported including *P. putida*[56;100;93], *P. fulva*[93] and *P. fluorescens*.[107]

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Health Protection Scotland

NHS National Services Scotland

NHS Greater Glasgow and Clyde: Royal Hospital for Children

Trough sinks in paediatric bone marrow transplant isolation ante rooms

Situation	Health Protection Scotland (HPS) have been requested to provide a national view on the removal of the trough sink from the ante rooms within the paediatric bone marrow transplant unit (ward 2A) Royal hospital for children
Background	NHS Greater Glasgow and Clyde (NHSGGC) have been investigating a contaminated water system across the Queen Elizabeth University Hospital (QEUH) and Royal Hospital for Children (RHC) with possible linked cases of bloodstream infections associated within ward 2A/2B RHC. Ward 2A RHC Advice was given from Dr Lees (external consultant from Leegionella) to reduce the number of water outlets where possible without compromising clinical care or impacting on the prevention and control of infection. The isolation rooms within ward 2A have recently been converted from positive pressure ventilation lobby rooms to positive pressure isolation rooms with an ante room. The Infection prevention and control team (IPCT) are keen to follow this advice and have proposed that the trough sink, used by clinical staff for hand hygiene, is removed with alcohol based hand rub remaining in the ante room. If hand washing is required this can be performed within the clinical wash hand basin in the isolation room. The clinical team have reservations about the removal of the trough sink. A meeting is being held between the IPCT and the clinical team on 28th October and this SBAR has been provided to support the discussion
Assessment	The main purpose of an ante room in either a PPVL, or pressured isolation room (negative or positive) is related to ventilation. A positively pressured isolation facility aims to control the airflow in the room so that the patient is protected from airborne transmission

	of any infection.[1] An ante room in this situation functions as a controlled area in which the transfer of supplies, equipment and persons can occur without contamination impacting on the surrounding health care areas, and controls the entry or exit of contaminated air when the ante room door is opened. It is also a controlled area where clinical staff can don or remove personal protective equipment prior to entry/exit of the isolation area.[1] HFN-30: Infection Control in the Built Environment (2002) states that 'isolation rooms should have a hand-wash sink in the ante-room, isolation room and en-suite facilities'.[2] However, no other guidance has been identified to support this now archived guidance. Alcohol based hand rub (ABHR) is the gold standard for hand hygiene; there is a substantial volume of evidence published in the literature, comparing hand washing with soap and water to use of alcohol based hand rubs (ABHRs). ABHR has consistently been found to be more effective at reducing microorganisms on hands, compared with hand washing using soap and water.[3-18] This is the case for both antimicrobial and non-antimicrobial soaps. In contrast, a recent RCT found that use of ABHR was equally as effective as hand washing using an antimicrobial soap.[19] There is also a further body of evidence generated through both experimental and observational studies demonstrating the antimicrobial efficacy of ABHRs against a variety of HAI causing microorganisms.[20-32] ABHR for surgical hand antisepsis has also been shown to be at least as effective as traditional surgical scrub.[33-35] There are instances where hand washing should be performed rather than hand rubbing with ABHR; as ABHRs are disinfectant agents as opposed to cleansing agents, they should not be used for hand hygiene when hands are soiled or visibly dirty.[11;12;15;36;37] ABHR should also not be used for hand hygiene when exposure to spore-forming pathogens, such as *Clostridium difficile*, is suspected or proven.[11;12;15;36-44] In these instances, hands should be washed using non-antimicrobial liquid soap and water.[35] A number of laboratory based experimental studies have focused on

	determining the efficacy of ABHRs against both surrogates of norovirus and human norovirus genogroups. However, the experimental evidence is inconsistent and a grade of recommendation cannot be given.[32;45-52] ABHR should therefore not be used for hand hygiene when norovirus infection is suspected or proven.
Recommendation	NHSGGC give consideration to the evidence provided to inform the clinical and IPCT decision on whether the trough sink within the ante rooms should be removed. The clinical team should be given the opportunity to demonstrate the need for clinical handwashing rather than hand rubbing with ABHR in the ante room. There are circumstances (described in the NIPCM) where hand washing with soap is necessary and ABHR should not be used. If the clinical team can demonstrate that these circumstances occur in the anteroom regularly then consideration should be given to the sink remaining.
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SBAR Pressure test methodology for Positive Pressure Protective Environment rooms

Situation:

There is no pressure test methodology for Protective Pressure Protective Environment rooms.

Background

Isolation rooms are used to prevent the spread of airborne infection.

Rooms are positively pressurised with respect to their adjacent spaces to limit the spread of airborne pathogens to patients that are vulnerable to infection, these are referred to as protective environment rooms (PE rooms).

An environment ventilation strategy is set up to ensure that, among other things, each room is pressurised appropriately and capable of protecting or isolating patients as necessary. One of the methods used to ensure that the pressures created by the ventilation strategy is working as designed, is a room pressure test. Air tightness testing is a recognised method of measuring the extent to which air is lost through leaks in the building fabric. It is sometimes referred to as air leakage testing or air pressure testing.

Guidance on the methodology for negatively pressurised rooms can be found in the guidance noted below, however a methodology for Protective Environment rooms is specifically omitted from this guidance. Additionally, it is also worth noting that the methodologies outlined within this guidance are incommodious, rely on testing being carried out when the AHU is switched off, rooms are unoccupied, and the source of air for the pressurisation is typically drawn from '*dirty*' sources (*e.g.* a corridor). On test completion each room requires a 'deep clean'. In an operational healthcare environment the methodologies are undesirable.

- Health Building Note 4 Supplement 1 (2005) In-patient accommodation: Options for choice Supplement 1: Isolation facilities in acute settings
- Scottish Health Planning Note 04 (2008) In-patient Accommodation: Options for Choice. Supplement 1: Isolation Facilities in Acute Settings
- Health Building Note 04-01 Supplement 1 Isolation facilities for infectious patients in acute settings (England 2013)
- Wales Health Building Note 04-01 Supp1 (Welsh Edition 2014)
- BSRIA BTS 3/2018 Air permeability testing of isolation facilities.

Assessment

From the background section we can state the following

Traditional methods of pressure testing are not suitable for Protective Environments; especially within operational buildings.

1. A Pressure testing methodology is needed for Protective Environments
2. Ideally such a methodology should be suitable for operational environments

A review via the internet has identified One company that offers produce such a technology:-

"build test solutions ltd"

https://beta.companieshouse.gov.uk/company/09910663

Pulse is a portable compressed air based system which is used to measure the air leakage of a building or enclosure. The system releases a small burst of air which generates a flow rate through gaps, cracks, openings in the building façade. The change of internal pressure of the building due to this flow is seen as a pulse and its representation is characteristic of the building's leakage. Pulse dynamically measures building air leakage directly at low pressure. Crucially, this provides an air change rate measurement that is representative of normal inhabited conditions.

The system was discussed by telephone conversation: the system has been successfully tested and used on various building types, but not specifically in healthcare environments. The company have stated that they are willing to trial the system in a healthcare environment and, if successful , help develop a methodology specific to healthcare environments. The company have not requested payment for staff time during, nor equipment required for a trial. They have asked for support on travel/transportation costs and it is agreed that this will not exceed £1,000.

There are facilities within NHSGG&C well suited to such a trial.

There are empty rooms at the old DGRI which may be suitable for trials.

Though this SBAR is specific to PE rooms, I/we foresee no reason that the method cannot be applied to negatively pressurised rooms, i.e. a universal test method for any pressurised room or space.

Recommendation

It is recommended that a test methodology be developed for Protective Environment rooms.

From telephone discussions and reading of the literature provided (see attached), "Pulse" appears to be a technology capable of, and suited to, providing a satisfactory PE room testing method.

To ascertain if Pulse can be accommodated to healthcare Protective Environments, it is recommended that the travel/transportation costs needed to enable trials are covered by HFS.

Health Protection Scotland

NHS National Services Scotland

Health Protection Scotland (HPS): Plan for the Delivery of the Recommendations from *'Summary of incident and findings of the NHS GGC: Queen Elizabeth University Hospital for Children water contamination and recommendations for NHSScotland'* through the Infection Control Built Environment & Decontamination (ICBED) Programme

SBAR : Options for HPS delivery of the recommendations.

Date: June 2019

Situation	The Antimicrobial Resistance and Healthcare Associated Infection (ARHAI) group within HPS have been requested to plan the delivery of the recommendations within the published *'Summary of incident and findings of the NHS GGC: Queen Elizabeth University Hospital for Children water contamination and recommendations for NHSScotland'* (2018)[1]. This work has begun through the ICBED programme and will continue until at least 2021. This SBAR provides options on delivery of the recommendations including the resources required to complete this work within the time frame prioritising water safety within the first year followed by ventilation safety.
Background	Since 2016 NHS GGC have investigated and managed various incidents potentially linked to water contamination. The most recent incident in 2018 where the QEH experienced an incident involving 23 cases of BSI associated with 11 different organisms linked to water prompted an investigation by HPS following an invokement of the national support framework[1]. HPS supported by Health Facilities Scotland produced a report to Scottish Government with recommendations that have implications for the wider NHS in Scotland.
Assessment	HPS plan to produce the water and ventilation guidance as an evidenced based chapter within the National Infection Prevention and Control Manual (NIPCM), following the defined methodology. This includes stakeholder engagement and extensive wider consultation and therefore to facilitate this, the delivery of this programme will be over a two year period. To support completion to produce this mandatory guidance the following additional resources are requested: 1x 1.0 WTE Band 7 Healthcare Scientist (Health Protection) 1x 1.0 WTE Band 5 Healthcare Scientist Practitioner 0.2 WTE Consultant Microbiologist 1x 1.0 WTE Project Support Officer

	In addition HPS are requesting funding for staff training and can provide an updated proposal when this is agreed. It is anticipated that costs would be an additional £10,000  This resource will be added to the existing IPCT to deliver: 1. A gap analysis of current water guidance that is used across Scotland and the UK 2. An information leaflet for Staff on how to deal with a water incident. This is to provide interim guidance whilst the Chapter for the NIPCM is underway. This will use a rapid review methodology. 3. An information leaflet for Staff on how to deal with a ventilation incident. This is to provide interim guidance whilst the Chapter for the NIPCM is underway. This will use a rapid review methodology. 4. Undertake a water survey across all NHS Boards to ascertain testing, requirements for testing etc 5. Complete the following literature reviews using the NIPCM methodology Healthcare Water Systems Literature review: Design, Testing, Commissioning and Operational measures. This will then form Chapter 4 of the NIPCM and include roles and responsibilities. The Governance for the production of this work will be undertaken using the National Policy Guidance and Outbreak Steering and Consensus Group combining ICBED steering group members and reported through the NSS ARHAI Programme Board. It is proposed that a National Water Group will be used to provide specific expertise into the Chapter of the NIPCM. This will be repeated in 2020/21 for ventilation.
Recommendations	1. HPS begin the process of planning this work with immediate effect if resources are confirmed the time scale within the plan for delivery is two years otherwise this plan would need to be considered over at least 5 years using current resources.

References:

1. HPS (2018). ***'Summary of incident and findings of the NHS GGC: Queen Elizabeth University Hospital for Children water contamination and recommendations for NHSScotland'***. Scottish Government. https://www.gov.scot/publications/qe-university-hospital-royal-hospital-children-water-incident/

Health Protection Scotland

NHS National Services Scotland

Title: To support NHSGG&C IMT: Mycobacterium chelonae cases and the incidence of gram-negative bacteraemia (paediatric haemato-oncology)
Author: HPS
Audience: NHSGG&C – Incident Management Team
Date of issue: September 2019

Situation	To support NHS Greater Glasgow and Clyde (NHSGG&C) with their investigations into an increased incidence of gram-negative bacteraemia (GNB) and data exceedance of *Mycobacterium chelonae* bacteraemia in Ward 6A (currently occupied by decanted paediatric haemoto-oncology patients (inpatient and day care services)), QEUH.
Background	Health Protection Scotland (HPS) were supporting NHSGG&C with a recent water related incident investigating and managing a contaminated water system across the Queen Elizabeth University Hospital (QEUH) and Royal Hospital for Children (RHC) with probable linked cases of bloodstream infections associated with wards 2A/2B RHC. The RHC opened in June 2015 replacing Yorkhill Hospital (YH). Wards 2A/2B RHC is a haemato-oncology unit, also known as Schiehallion, and houses the National Bone Marrow Transplant (BMT) Unit. To allow remediation works to be undertaken in 2A/2B, patients were transferred to QEUH on the 26th September 2018 to ward 6A and three rooms were allocated within the adult Bone Marrow Transplant (BMT) of ward 4B for the paediatric BMT unit. Adults from 6A were transferred to Gartnavel General.
Assessment	**Increased incidence of gram-negative bacteraemia (GNB)** A refreshed data extract from Electronic Communication of Surveillance in Scotland (ECOSS) system of all blood samples in children less than 16 years of age from 2013 to present was obtained on the 8th August 2019. For the purposes of this report, the patient population was categorised as follows • 2A/2B Group ○ Patients cared for in Yorkhill Hospital (YH) Schiehallion or Ward 7a; Royal Hospital for Children (RHC) Wards 2a and 2b; or Ward 6A and allocated rooms of 4B Queen Elizabeth University Hospital (QEUH); patients cared for in haematology/oncology specialties including A&E admissions with previous admission to RHC haematology/oncology specialties data up to May 2018. However, due to time restraints it has not been possible to establish if episodes since June 2018 with an A&E admission had a previous admission to RHC haematology/oncology specialties. Positive blood cultures of the following micro-organisms were included: • Gram-negative bacteria • Environmental bacteria (all species of the following: *Achromobacter; Acinetobacter; Aeromonas; Brevundimonas; Brevibacillus species; Brevundimonas; Burkholderia; Chryseobacterium; Citrobacter; Cupriavidus; Delftia acidovorans; Elizabethkingia; Enterobacter; Gordonia; Klebsiella; Pantoea; Pseudomonas; Rhizobium; Rhodococcus; Serratia; Sphingomonas; Stenotrophomonas).*

De-duplication were undertaken on one case per patient per species per 14-day period but only including one case of Gram-negative or environmental bacteria when two or more species were isolated from one or more blood cultures within a 48-hour period of the positive blood culture.

The latter was to avoid duplications of episodes due to polymicrobial cases.

A rolling 14-day episode definition was used to align with mandatory surveillance programmes. The exclusion criteria included any samples coded as post mortem blood, any test samples, foetal samples or non-human samples.

NHS health boards are coded by the location of the submitting laboratory. Additional hospital/ward data was derived from the ECOSS unit location field, or where incomplete free text within the medical specialty and requesting location fields were used to generate a final hospital list to be mapped against the total occupied bed days to generate hospital level rates.

For NHSGG&C hospitals, the free text within the unit location, medical specialty and requesting location fields were used to derive a location and ward within the hospital where the positive blood culture aspirated was associated, to find any specimens with a connection to wards 6A and 4B in the QEUH, 2a or 2b within Royal Hospital for Children, or the equivalent within Yorkhill hospital.

Since it was not clear how the bed days were coded following the move to the QEUH monthly cases rather than incidence rates were used in the ward analysis. However, for hospital comparisons monthly incidence rates were calculated using bed days at hospital level as the denominator. These data were obtained from the Information Services Division ISD(S)1 data source.

The cases reported by NHSGG&C plus non-validated positive blood cultures (marked with a dot) are shown in a timeline in Figure 1. The cases between August 2014 and July 2019 were analysed using statistical process control (SPC) C-charts. The SPC charts describe the incidence of positive blood cultures over time with the move to QEUH after the closure of wards 2A and 2B represented by vertical light brown line, the opening of the RHC represented in the charts with a vertical black line (Figure 2). In addition, the following control measures have been added to the 2A/2B chart – filters added to taps marked as an orange vertical line and cleaning of drains marked as purple vertical line. The centreline of the SPC was calculated as the median of the monthly cases between August 2014 and July 2019. The following SPC rules were applied:

TABLE 1: Statistical Process Control (SPC) rules

Rule	Description	Marker
Outlier	Data point(s) exceeding the upper or lower control limit (as 3 standard deviations)	Red diamond
Trigger point	Data point(s) exceeding the upper or lower warning limit (as 2 standard deviations)	Yellow triangle
Shift	A run of 8 or more consecutive data points above or below the centreline	Circle drawn round points
Trend	A run of 6 or more consecutive data points either increasing or decreasing.	N/A

Figure 1: Timeline of Environmental cases as provided by NHSGG&C plus non validated positive blood cultures up to 08/08/2019. Cases with a * are from patients with more than one episode within the time period.

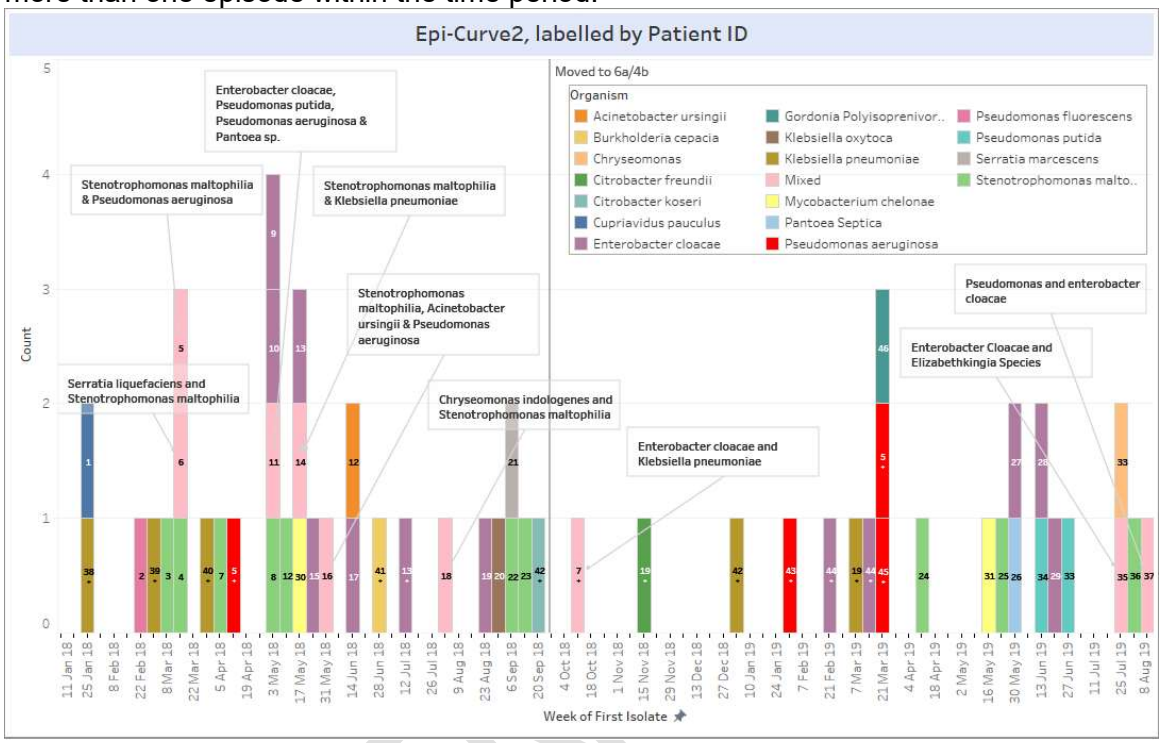
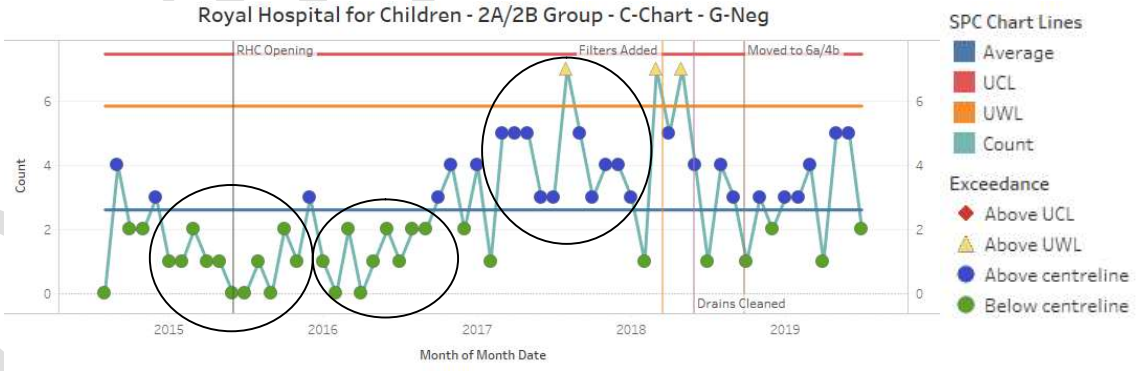
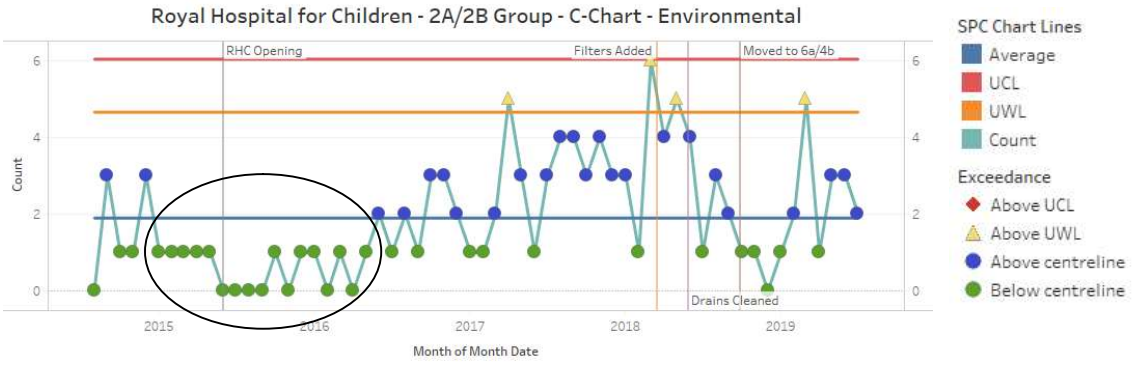


Figure 2: SPC charts of Gram-negative positive blood culture count for 2A/2B Group.



All episodes included in the timeline (Figure 1) are included within the data analysed in the SPC charts. Following the move to the QEUH the number of cases of the Gram-negative positive blood cultures has not breached the upper warning limit (UWL) or above the control limit (UCL) (Figure 2). For the environmental bacteria positive blood cultures, the number of cases breached the UWL in March 2019 but not above the UCL (Figure 3).

Figure 3: SPC charts of environmental blood culture positive count for 2A/2B Group.



When comparing the overall rate over 5 years at RCH/YH to the combined rate of the other two Scottish children's hospitals (Royal Aberdeen Children's Hospital (NHS Grampian) and Royal Hospital for Sick Children (NHS Lothian)), the incidence of positive blood cultures in RCH/YH was higher compared with the other hospitals for environmental bacteria ($p<0.001$) however there was no difference in the rates of Gram-negative blood cultures ($p=0.11$).

When comparing post move (September 2018 onwards) there was no difference in the rates of Gram-negative blood cultures ($p=0.10$) or environmental blood cultures ($p=0.11$).

Mycobacterium atypical positive cases

There is no formal surveillance of non tuberculous mycobacteria. An extract from ECOSS was obtained on the 11th July 2019, for all blood samples for all atypical *Mycobacterium* which included *Mycobacterium chelonae; Mycobacterium abseccus*; *Mycobacterium gordonae*; *Mycobacterium fortuitim* for the five-year period July 2014 to June 2019. A deduplication of one episode per 365 days was applied. The numbers were small and for patients 16 and under there were less than five episodes with a positive blood sample and 30 episodes for any specimen type as reported by the Southern General laboratory. For all Scotland there were 20 positive blood samples and 962 from any specimen type.

Limitations and Caveats

There are a number of limitations associated with the use of ECOSS blood culture data. Blood samples are non-validated records. The cases may include contaminants, and may include non-blood cases which are incorrectly mapped to a blood sample within either the laboratory system or within ECOSS. Location mappings within ECOSS records may also be prone to error.

De-duplication method may mean that a patient is recorded as having more than one episode of positive blood culture in a 14-day period leading to an overestimate of the number of bacteraemic episodes. For example, if a patient has had a positive blood culture on day one, then a different species of blood culture on day seven, this may be classed as the same clinical episode of bacteraemia but are classed as two episodes according to these definitions.

Environmental bacteria grouping include bacteria commonly found in the environment however they may also be associated with normal human microbiome and laboratory surveillance is unable to distinguish.

It is not possible to determine whether changes in episodes are confounded by changes

	in the patient population and their underlying medical conditions. Gram-negative blood culture data may be incomplete for July 2019 and non tuberculous mycobacteria data may be incomplete from 2019 onward as samples are still to be reported. It has not been possible to capture all haematology/oncology patients admitted to other RHC or YH wards who subsequently had a positive blood culture. Episodes in 2A/2B Group derived through linkage (to establish if A&E admissions had a previous admission to RHC haematology/oncology specialties) were only included in data up to June 2018. The rates used to compare the overall rate at RHC following the move to QEUH to the combined rate of the other two Scottish children's hospitals used an estimated denominator for September 2018 by taking the proportion of days following the move. In the monthly analysis of environmental bacteria positive blood cultures, the numbers are small and should be treated with caution. The non tuberculous mycobacteria ECOSS extract included patients 16 and younger however the Gram-negative blood cultures included only patients under 16 to match the extract used in the 2A/2B report. Numbers are small and should be treated with caution.
Recommendations	• Blood cultures should be continued to be monitored in this high risk patient population. • Further analysis of positive blood cultures associated with environmental bacteria in other specialities within RAH/QEUH and within other children's hospitals may be beneficial to understanding the epidemiology and risk of environmental exposure in high risk individuals.

References

1. Information Services Division of National Services Scotland, 2018. Statistical Process Control Monitoring Quality in Healthcare. Available at: https://www.isdscotland.org/Health-Topics/Quality-Indicators/Statistical-Process-Control/_docs/Statistical-Process-Control-Tutorial-Guide-180713.pdf

Health Protection Scotland

NHS National Services Scotland

Health Protection Scotland, ARHAI Group

Initial Assessment
PICU
Royal Hospital for Children
NHS Greater Glasgow and Clyde

On behalf of Scottish Government HAI Policy Unit
January 2020

Situation	NHS Greater Glasgow and Clyde (NHSGGC) are currently investigating and managing a cluster of Gram Negative infections within the Paediatric Intensive Care Unit (PICU), also known as Ward 1D, at the Royal Hospital for Children (RHC). The National Support Framework (http://www.nipcm.scot.nhs.uk/documents/the-national-support-framework-2017//) was invoked by the Scottish Government HAI/AMR Policy Unit to request Health Protection Scotland (HPS) undertake a review of the incident.
Background	The RHC is a 256 bedded childrens hospital which was handed over to the Board on 26th January 2015 with migration of patients occurring between 10th and 14th June 2015 from the previous Yorkhill site. The RHC was fully occupied from 15th June 2015. Since opening there have been a number of separate incidents where Gram Negative infections have been investigated relating to haemato oncology patient population. Following the previous investigation HPS submitted a report to Scottish Government https://www.gov.scot/publications/qe-university-hospital-royal-hospital-children-water-incident/ detailing water related issues linked to wards 2A/B. As a result of the investigations carried out at this time NHSGGC introduced a number of controls within clinical areas delivering care for high risk paediatric patients within RCH including PICU.

Assessment	An initial observational assessment walk round of PICU was undertaken by a Senior Nurse Infection Control and Nurse Consultant within HPS on 14th January 2020. During this walk round practice and environmental hygiene were observed. It was noted that overall practice, as witnessed during that walk round, were good with no major issues observed or reported. Compliance with standard infection control precautions (SICPS), where observed and environmental cleanliness was observed to be good. Senior Charge Nurse was able to describe how they escalate estates issues and reported that these were always dealt with promptly. During the month of December staff had reported two incidents of water ingress one from a toilet cistern in the ward above and one from a sprinkler above the staff base. NHSGGC had provided the findings from the estates department and on both occasions the leaks were reported and managed immediately and a further environment survey carried out by estates reported do evidence of water damage within PICU. In order to complete this assessment a series of reports and information have been requested from GGC: • **The last annual validation report for the ventilation systems including any details of work that has been carried out in this period and to date** – *information shared 27th January and under review further information will be required re NHSGGC action plan to rectify issues highlighted in external validation report* • **The estate reports related to the water ingress reported in the unit** *– no report available a statement was provided that all works had been completed* • **The SPC for PICU including any definitions and methodology** – *Following IMT 27th January request made to NHSGGC to update as previously shared SPC dated 31st December 2019* • **SOPs for water and environmental testing (inclusive of frequency within this unit)** – *awaited* • **Bed occupancy for the unit over the current annual period** – *provided and under review* • **Epidemic curves for RSV for 19/20 and if there is any descriptive epidemiology on how this compares to previous year** – *provided and being reviewed in conjunction with all epidemiology* • **A timeline for all reported cases per organism and then combined** *– separate timelines provided (organism specific) HPS carrying out analysis to review all Gram Negative isolates. Requested updated detailed timeline following the IMT 27th January 2020* • **SOP for decontamination of point of use filters** –to be provided

	• **IPC tools or bundles that are used to prevent infection within the unit, there was mention discussion around 'blind' BAL process** – *policy for BAL procedure provided reviewed and comments have been shared with HPS as there was no reference to hand hygiene or PPE. Awaiting respond from NHSGGC.* A review of the incidents from PICU reported to HPS since 2015 (appendix 1) shows a total of 12 incidents of which 11 relate to a Gram Negative incident. • No incidents reported during 2015, • One reported in 2016 • Five in 2017 • Two in 2018 • Four in 2019
Recommendations	The incident assessment is ongoing and extremely complex due to the ongoing report cases as detailed in HIIORT updates to HAI Policy Unit (28th January 2020). • ARHAI Group will set up a dedicated team to coordinate the NHSGGC support including the situation assessment • HFS will support HPS in the review of ventilation in particular assessing NHSGGC response to the external validation review • Current independent review planned of the haematology patients involved in previously reported HAI Policy Unit may wish to consider extending this review to the PICU patient population in the first instance • Meeting arranged with NHSGGC to fully understand the environment sampling results in relation to clinical results • HPS to review updated SPC for PICU when provided • HPS to review updated detailed patient timeline when provided • HPS to consider analysis of all Gram Negative invasive infections in the high risk patient population across RCH • HPS to meet with Consultant Microbiologists NHSGC to explore the significance of environment and drain sampling • HPS to provide a situation assessment summary report to HAI Policy Unit on completion of investigation. In the interim regular updates will be provided.

Appendix 1

HIIATs PICU – RHC

Date reported	HIIAT Log	HIIAT	Ward	Infection category	Organism
2015 – none reported					
2016					
23/9/2016	G16.59	Green	RHC/PICU	BSI	*Pseudomonas aeruginosa*
2017					
6/2/2017	G17.010	Green	RHC/ PICU	Colonisation	*Serratia marcescens*
10/3/2017	O17.10	Amber	RHC/ PICU	BSI	*Serratia marcescens*
2/8/2017	G17.068	Green	RHC/PICU	BSI	*Pseudomonas aeruginosa*
15/11/2017	G17.104	Green	RHC/PICU	SSI	Acinetobacter baumannii
1/12/2017	G17.115	Green	RHC/PICU	SSI	Acinetobacter baumannii
2018					
23/1/2018	O18.10	Amber	QEUH/PICU	Mixed/various	*Pseudomonas aeruginosa*
29/6/2018	G18.081	Green	RHC/PICU	Colonisation	*Acinetobacter baumannii*
2019					
23/9/2019	O19.32	Amber	PICU	Respiratory	*Bordetella pertussis*
*05/11/2019	G19.132	Green	PICU	Colonisation	*Acinetobacter baumanii*
*19/11/2019	G19.136	Green	PICU	Colonisation	*Pseudomonas aeruginosa*
*28/11/2019	O19.44	Amber	PICU	BSI	*Serratia marcescens*

***three incidents now being investigated and reported as one**

Health Protection Scotland

NHS National Services Scotland

Health Protection Scotland, ARHAI Group

Ventilation Assessment
PICU
Royal Hospital for Children
NHS Greater Glasgow and Clyde

On behalf of Scottish Government HAI Policy Unit
February 2020

Situation	NHS Greater Glasgow and Clyde (NHSGGC) are currently investigating and managing a cluster of environmental Gram Negative infections within the Paediatric Intensive Care Unit (PICU), also known as Ward 1D, at the Royal Hospital for Children (RHC). The National Support Framework (http://www.nipcm.scot.nhs.uk/documents/the-national-support-framework-2017//) was invoked by the Scottish Government HAI/AMR Policy Unit to request Health Protection Scotland (HPS) undertake a review of the incident.
Background	The RHC is a 256 bedded childrens hospital which was handed over to the Board on 26th January 2015 with migration of patients occurring between 10th and 14th June 2015 from the previous Yorkhill site. The RHC was fully occupied from 15th June 2015. Since opening there have been a number of separate incidents where environmental Gram Negative infections have been investigated relating to haemato oncology patient population. PICU is a 22 bedded area (commissioned for 19 beds) within the main RCH on the Queen Elizabeth University Hospital (QUEH) site. As part of the National Support Framework an assessment of the environment will be carried out including the ventilation system within PICU. NHSGGC were requested to share evidence of ventilation validation with HPS. The evidence provided as been reviewed by HPS supported by Health Facilities Scotland (HFS).

Assessment	An initial review the documentation provided by NHSGG includes: • QUEEN ELIZABETH UNIVERSITY HOSPITAL ISOLATION ROOMS SHPN 04 Supplement 1 CRITICAL VENTILATION ANNUAL VERIFICATION & INSPECTION RHC Ward PICU Room 12, March 2019. H&V Commissioning Services Ltd. • QUEEN ELIZABETH UNIVERSITY HOSPITAL ISOLATION ROOMS SHPN 04 Supplement 1 CRITICAL VENTILATION ANNUAL VERIFICATION & INSPECTION RHC Ward - PICU Room 17, March 2019. H&V Commissioning Services Ltd. • QUEEN ELIZABETH UNIVERSITY HOSPITAL ISOLATION ROOMS SHPN 04 Supplement 1 CRITICAL VENTILATION ANNUAL VERIFICATION & INSPECTION RHC Ward - PICU Room 18, March 2019. H&V Commissioning Services Ltd. • QUEEN ELIZABETH UNIVERSITY HOSPITAL NEGATIVE PRESSURE ISOLATION ROOM SHPN 4 Supplement 1 CRITICAL VENTILATION VALIDATION & INSPECTION QEUH – RHC PICU Bedroom 5 – Negative Isolation Room, April 2019. H&V Commissioning Services Ltd. • CRITICAL VENTILATION ANNUAL VERIFICATION & INSPECTION QEUH – PICU (Paediatric Intensive Care Unit) Beds 1-4, April 2019. Correct Air Solutions Ltd. • Derogation from Scottish Health Technical Memorandum (SHTM), September 2019. NHS Greater Glasgow & Clyde. • CRITICAL VENTILATION ANNUAL VERIFICATION & INSPECTION QEUH – PICU (Paediatric Intensive Care Unit) Beds 13-16, November 2019. Correct Air Solutions Ltd. Following review of the documents provided by NHSGGC NSS have requested further information from NHSGGC (by 13th February 2020): 1 From the documentation provided there is no evidence of validation or design data prior to April 2019 for PICU a. Is this correct? b. What was the original design solution for PICU? 2 NHSGGC shared a PICU Ventilation Options paper dated August 2019 a. What triggered this paper being commissioned? b. What option if any has been/will be implemented? 3 A derogation SBAR was shared a. Can NHSGGC provide some background as to the rationale for these works being done? b. The derogation paper suggests cross contamination between different cohorts – can NHSGGC provide a more detailed explanation? c. Is the paper based on what is achievable from the existing

	ventilation system? 4 Repeat validation appears to have been carried out in November 2019 for only beds 13-16 a. Is this correct? b. Can NHSGGC provide further detail on the non compliance?
Recommendations	Further assessment is carried out by NSS once NHSGGC have provided additional information requested. Updated ventilation SBAR to be provided to the HAIPU 14th February 2020.

ARHAI Scotland

Antimicrobial Resistance and Healthcare Associated Infection

NHS National Services Scotland

Author: Susie Dodd, Nurse Consultant Infection Control Date of Issue: September 2020	
Situation	Evidence of continued circulation within Scotland of a single strain of K2 capsular type extended-spectrum beta-lactamase (ESBL) *K. pneumoniae* responsible for a multi-hospital outbreak across three NHS boards
Background	*Klebsiella* spp. are a common cause of multidrug-resistant Gram-negative bacteria outbreaks, and are particularly associated with the emergence of the ESBL enzymes. Infections in hospitalised patients with ESBL *Klebsiella* spp. are a public health concern due to poorer clinical outcomes and limited antibiotic options. In January 2020, epidemiological support from Health Protection Scotland (HPS) was requested by NHS Tayside (TY) for the characterisation of an outbreak of ESBL *K. pneumoniae* of a particular K2 capsule strain with shared variable number tandem repeat (VNTR) typing. Typing was carried out at the Antimicrobial Resistance and Healthcare Associated Infections (AMRHAI) Reference Unit, Colindale, Public Health England (PHE), who subsequently informed NHS Tayside that they had identified strains of the same VNTR type in two other Scottish NHS boards – Ayrshire & Arran (AA) and Greater Glasgow & Clyde (GCC). AMRHAI reported that 69 confirmed cases of the same VNTR type had been typed between the three NHS boards since 2017. A national Incident Management Team (IMT) involving the three NHS boards and chaired by HPS was held in February 2020. As part of wider investigations, a case definition was developed to identify epidemiological links, other potential cases, and any incidents that may have been missed due to lack of VNTR typing.
Assessment	The case definition for inclusion in this epidemiological investigation was: • Confirmed case: A patient receiving care within any of the three NHS boards with a new isolate of the K2 strain of an ESBL-producing *K. pneumoniae* (typed by the Reference Laboratory) identified between January 2017 and February 2020. • Possible case: A patient receiving care within any of the three NHS boards with an ESBL-producing *K. pneumoniae* resistant to ceftriaxone/cefotaxime, ceftazidime, ciprofloxacin, gentamicin, and trimethoprim, identified between January 2017 and February 2020. A total of 344 isolates of ESBL-producing *K. pneumoniae* met the case definition. 57 isolates (16.6%) were considered confirmed cases as a result of VNTR typing (the “outbreak strain”), whereas 287 (83.4%) were considered possible cases due to their antibiogram results (Figure 1). Among the three boards, 8.0% (n=4/50) of

cases were confirmed in NHS AA, with 11.7% (n=23/196), and 30.6% (n=30/98) in NHS GGC and TY, respectively (Figure 2).

Figure 1: Epidemic curve of all cases (confirmed and possible) of ESBL *K. pneumoniae* in NHS AA, GGC and TY by date first positive sample was obtained, January 2017 to February 2020.

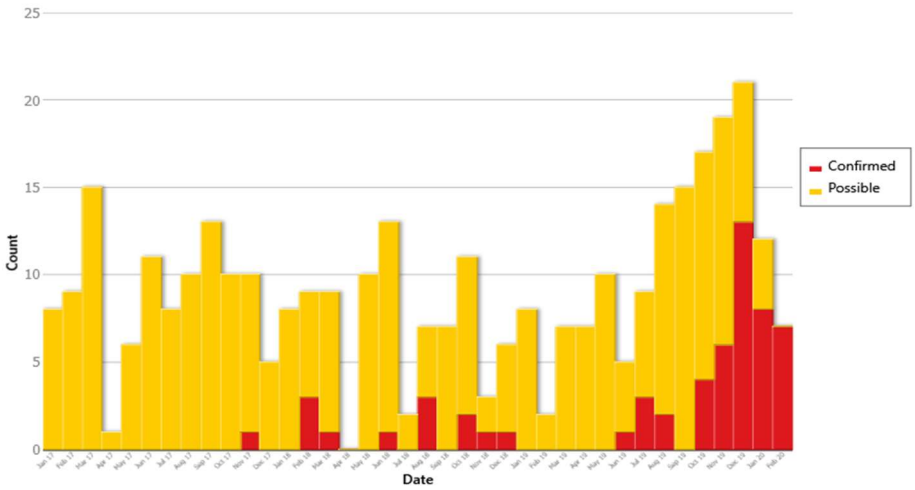
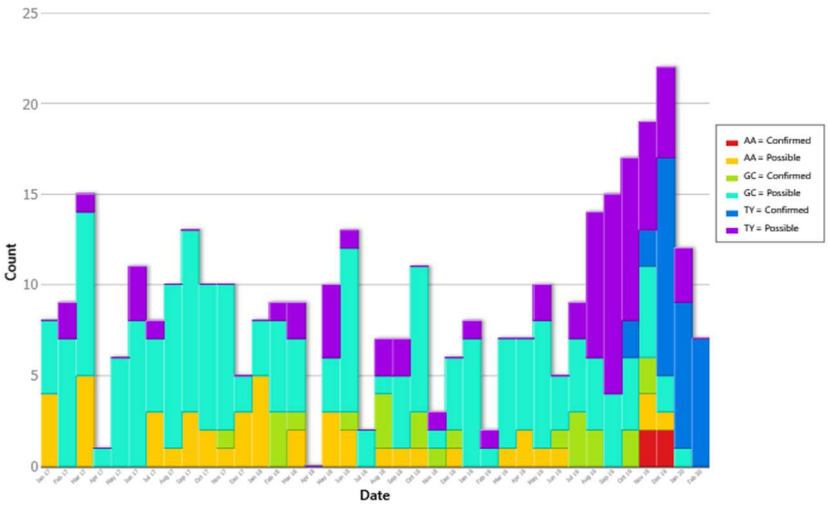


Figure 2 shows that NHS AA had sporadic though declining cases over the time period, with 22 in 2017, 16 in 2018 and 12 in 2019. NHS AA confirmed cases occurred in November and December of 2019. In NHS GGC, cases were relatively steady of the same period: 77 in 2017, 56 in 2018, and 62 in 2019. The first confirmed case in NHS GGC was November 2017, with sporadic reporting thereafter. NHS Tayside saw an increase from 7 in 2017, to 14 in 2018 and 60 in 2019 (most of the confirmed cases occurred towards the end of 2019 (n=15)). In the first two months of 2020, NHS TY reported 18 cases (15 confirmed) compared to one possible case in GGC and none in AA.

Figure 2: Epidemic curve of all cases (confirmed and possible) of ESBL *K. pneumoniae* in each NHS board by date first positive sample was obtained, January 2017 to February 2020.



Most of the cases had the first positive sample obtained while admitted to hospital (70.3%), and around a third were GP samples (27.9%) (Figure 3).

Figure 3: Distribution of cases at the time the first positive sample was obtained, January 2017 to February 2020.

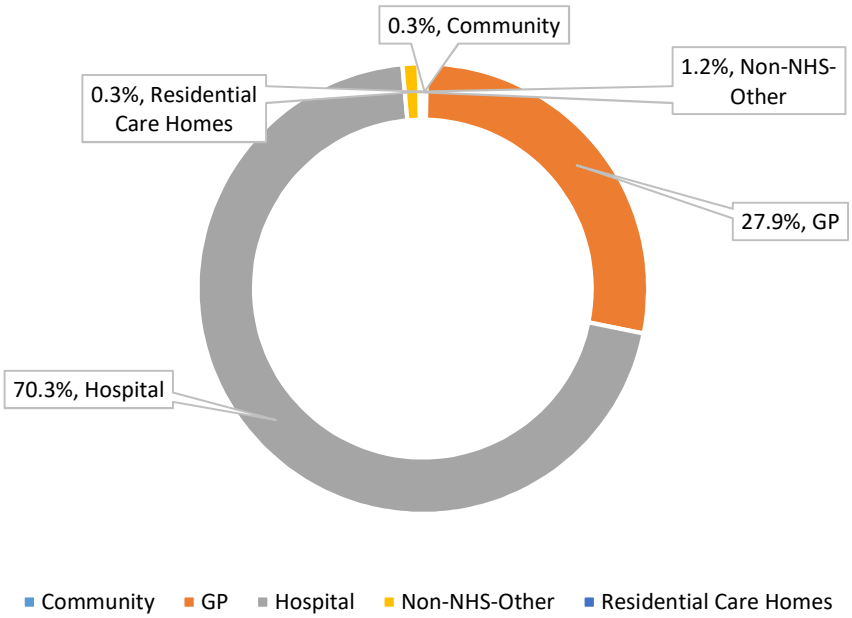


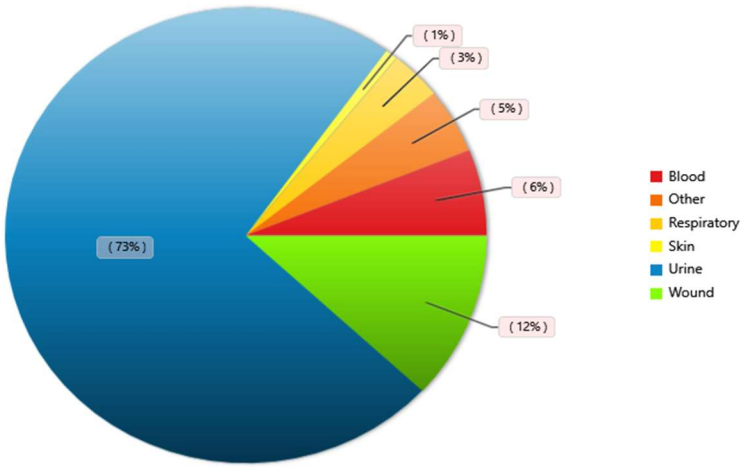
Table 1 describes the 344 cases by age and sex at the time the first positive sample was obtained. There were more female cases (n=176, 51.1%) than male cases (n=168, 48.7%). The overall median age was 70 years (interquartile range (IQR): 57 to 80). The median age in females was 73 years compared to 68 years in males. The majority of cases were aged 50 years and older (n=289, 84.0%) with 25.6% of cases aged 80 years and older (n=88).

Table 1: Distribution of all cases (possible and confirmed) in NHS AA, GGC and TY by age and sex at the time the first positive sample was obtained (n=345), January 2017 to February 2020.

Age group	Female		Male		Total	
	N	%	N	%	N	%
0-10	3	1.7	2	1.2	5	1.4
10-20	1	0.6	4	2.4	5	1.4
20-29	6	3.4	3	1.8	9	2.6
30-39	4	2.3	13	7.7	17	4.9
40-49	7	4.0	12	7.1	19	5.5
50-59	21	11.9	26	15.5	47	13.6
60-69	30	17.0	37	22.0	67	19.5
70-79	49	27.7	38	22.6	87	25.2
80-89	44	24.9	29	17.3	73	21.2
90+	11	6.2	4	2.4	15	4.3
TOTAL	**176**	**100%**	**168**	**100%**	**344**	**100%**

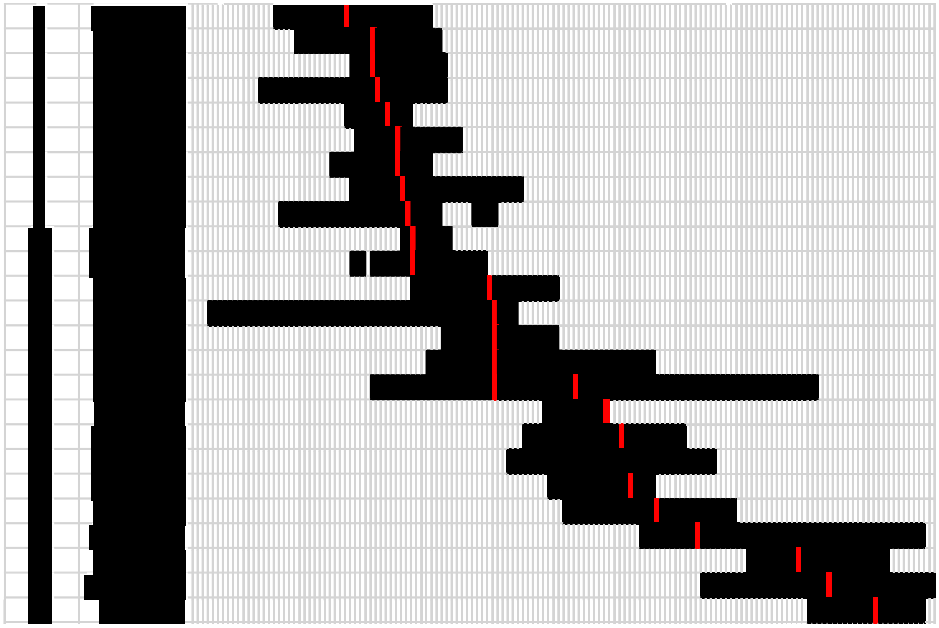
Figure 4 describes the distribution of body sites from which ESBL *K. pneumoniae* were isolated. The majority of clinical isolates were from urine (n=251, 73.0%). The remaining body sites were wound (n=41, 11.9%), blood (n=21, 6.1%), respiratory (n=12, 3.5%) and skin (n=3, 0.9%).

Figure 4: Distribution of body sites from which ESBL *K. pneumoniae* was isolated, January 2017 to February 2020.



Data linkage using the Scottish Morbidity Records 01 (SMR01) was used to determine patient histories and transfers between hospitals. For this analysis, 8 cases were from AA, 31 cases from GGC and 28 from TY.

[redacted]



[redacted]

	This assessment has shown that a single strain of K2 capsular type ESBL *K. pneumoniae* has been responsible for several clusters within three NHS boards since 2017. Analysis using data linkage has identified epidemiological links that suggests transfer of cases between boards based on shared types of clinical procedures. Wider investigations based on the antibiogram has also provided some evidence to suggest further cases that may not have been included in the initial outbreaks due to lack of typing data. This should be interpreted with caution as shared antibiograms are not in of themselves unequivocal indicators of relatedness. It is important to supplement any outbreak investigation with more discriminatory typing methods such as pulsed-field gel electrophoresis (PFGE) or VNTR typing. Conversely, isolates not included in this investigation, on account of not sharing the same antibiogram but sharing the same VNTR pattern, may have been missed. Infection prevention and control measures such as reinforced Standard Infection Control Precautions (SICPs), Transmission Based Precautions (TBPs), educational programmes, antimicrobial stewardship and enhanced cleaning, were implemented. As no further cases of the outbreak strain were identified, the multi-hospital outbreak was declared over in March 2020. However, sporadic cases of K2 capsular type ESBL *K. pneumoniae* with similar antibiograms continue to be picked up by laboratories within these NHS boards and across Scotland.
Recommendation	Given the continued identification of ESBL *K. pneumoniae* with similar antibiograms, and the potential to cause multi-hospital outbreaks across NHS boards, the following recommendations are suggested: • ARHAI to consider addition of ESBL K.pneumoniae to Appendix 13 of the National Infection Prevention and Control Manual as an alert organism alerting NHS boards of the need for a robust alert organism local surveillance system in place to monitor and report levels of ESBL K.pneumoniae at ward and hospital level. • NHS boards to ensure a reporting system is in place that will measure and report cleaning and maintenance of the healthcare environment to prevent reservoirs of infection. • NHS boards to ensure management and prevention of ESBL *K. pneumoniae* cases by consistently applying the standard infection control and transmission based precautions in the National Infection Control Manual to reduce the risk of onward transmission and HAI. • NHS boards to facilitate the ability to investigate outbreaks and assess patient management by improving the recording of symptoms, rationale for taking clinical samples (including their results), and indications for treatment. • ARHAI, in collaboration with the Scottish Microbiology and Virology Network, to inform the wider service of this issue and to encourage the use of more discriminatory methods such as VNTR typing, to facilitate national monitoring of this strain and rapid implementation of infection prevention and control methods.

Assessment of NHS Greater Glasgow and Clyde reporting of Healthcare Infection Incidents at QUEH and RCH Hospitals.

Prepared for NHS Greater Glasgow and Clyde and Queen Elizabeth University Hospital Oversight Board

September 2020

Situation

The Oversight Board requested Antimicrobial Resistance & Healthcare Associated Infection (ARHAI) Scotland undertake an assessment of NHS Greater Glasgow and Clyde (NHS GGC) reporting of Healthcare Infection Incidents related to the Queen Elizabeth University Hospital (QEUH) site. The QUEH site includes both the QEUH and the Royal Childrens Hospital (RCH).

The review will assist the QEUH Oversight Board to identify targeted pieces of work that might be needed to conclude the QEUH Oversight Board evaluation.

Background

The National Infection Prevention & Control Manual http://www.nipcm.scot.nhs.uk/chapter-3-healthcare-infection-incidents-outbreaks-and-data-exceedance/#a1744 sets out the requirements for NHS Boards to assess all healthcare infection incident using the Healthcare Infection Incident Assessment Tool (HIIAT). An early and effective response to an actual or potential healthcare infection incident, outbreak or data exceedance is crucial. The local Board IPCT and HPT responsible for managing incidents should be aware of and refer to the national minimum list of alert organisms/conditions. See Appendix 13.

Within hospital settings the Infection Prevention and Control Team (IPCT) normally take the lead in investigating and managing any infection related incidents with support from local Health Protection Team (HPT). Every healthcare infection incident i.e. all outbreaks and incidents (including decontamination incidents or near misses) in any healthcare setting (that is, the NHS, independent contractors providing NHS services and private providers of healthcare) should be assessed using the HIIAT.

The HIIAT has two parts/functions:

Part 1: Assesses impact of a healthcare infection incident/outbreak on patients, services and public health.

Part 2: Supports a single channel of infection incident/outbreak assessment and communication both internally within a NHS Board and externally to ARHAI Scotland (formally part of HPS) and Scottish Government Healthcare Associated Infection Policy Unit (HAIPU).

Assessment

Incidents reported by NHS GGC were identified from the Antimicrobial Resistance and Healthcare Associated infection (ARHAI) Infection Control Team (ICT) Access database Incident log. Figures used for this analysis are from 1st April 2016, when reporting of HIIAT greens to ARHAI Scotland became a mandatory requirement, to 31st August 2020. All COVID-19 incidents currently on the log from this year have been excluded.

A total of 191 incidents were reported by NHS GGC from 1st April 2016 to 31st August 2020 of which 77.0% (n=147) were 'HIIAT Green' (Table 1). Those reported by NHS GGC QEUH accounted for 56 (29.3%) with the first 'HIIAT Red' being reported by NHS GGC QEUH in 2018 (Table 2). Those reported by NHS GGC RHC accounted for 51 (26.7%) with the first 'HIIAT Red' being reported by NHS GGC RHC in 2017 (Table 2).

Table 1: NHS GGC incidents by HIIAT, 1st April 2016 to 31st August 2020

OutbreakType	HIIAT	2016	2017	2018	2019	2020	Grand Total
HIIAT Greens	HIIAT Green	17	42	39	35	2	135
Main Outbreak Log	HIIAT Red	2	8	4	5	2	21
	HIIAT Amber	4	6	6	4	3	23
	HIIAT Green	3				7	10
Grand Total		26	56	49	44	14	189

Table 2: Incident type by NHS GGC hospital, 1st April 2016 to 31st August 2020

OutbreakType	HIIAT	Hospital	2016	2017	2018	2019	2020	Grand Total
HIIAT Greens	HIIAT Green	Beatson West of Scotland Cancer Centre	1	1	4		1	7
		Gartnavel General				1		1
		Glasgow Royal Infirmary	3	5	4	8	1	21
		Inverclyde Royal Hospital		1	1			2
		Leverndale Hospital			1			1
		Multiple Sites			1			1
		Queen Elizabeth University Hospital	5	14	13	8		40
		Royal Alexandra Hospital	4	3	2	7		16
		Royal Hospital for Children	3	13	10	9		35
		Stobhill Hospital			1			1
		The Princess Royal Maternity Unit	1			1		2
		Unknown		2				2
		West Glasgow		3	2	1		6
Main Outbreak Log	HIIAT Red	Beatson West of Scotland Cancer Centre	1					1
		Glasgow Royal Infirmary		3	1		1	5
		Lightburn Hospital	1					1
		Multiple Sites		1		1		2
		Queen Elizabeth University Hospital			1	3	1	5
		Royal Alexandra Hospital				1		1
		Royal Hospital for Children		3	2			5
		West Glasgow		1				1
	HIIAT Amber	Glasgow Royal Infirmary		4	3			7
		Multiple Sites	1					1
		Queen Elizabeth University Hospital		1	2	1	2	6
		Royal Alexandra Hospital	1					1
		Royal Hospital for Children	2	1	1	2	1	7
		Stobhill Hospital				1		1
	HIIAT Green	Multiple Sites	1					1
		Queen Elizabeth University Hospital	1				3	4
		Royal Alexandra Hospital					1	1
		Royal Hospital for Children	1				3	4
Grand Total			26	56	49	44	14	189

A variety of specialities have been reported for NHS GGC QEUH and NHS GGC RHC incidents (Table 3) however 80 (74.8%) incidents do not have this information recorded. Minimum data set is required for the reporting of Green incidents unlike Amber and Red where a HIIORT template is required to be completed therefore intelligence held by ARHAI Scotland for Green incidents is not as complete as Amber and Red.

Incidents reported as Green are provided to ARHAI Scotland as information only with no escalation to Scottish government HAIPU. All Green incidents are reviewed by Senior Nurse Infection Control within ARHAI and further information sought from the reporting NHS Board where the assessment and scoring of the incident appears inconsistent with the HIIAT tool guidance. A number of Green incidents reported by NHSGGC have required further discussion to establish the boards assessment particularly when considering recurring themes within the QUEH site.

Table 3: Incident type by location/speciality for NHS GGC QEUH and NHS GGC RHC, 1st April 2016 to 31st August 2020

OutbreakType	HIIAT	Type of location / specialty	2016	2017	2018	2019	2020	Grand Total
HIIAT Greens	HIIAT Green	Null	8	27	23	17	1	76
Main Outbreak Log	HIIAT Red	Null			1			1
		haemato oncology		2				2
		ITU				1		1
		Langlands Building					1	1
		oncology		1				1
		Paediatric Haemato-oncology			2			2
		surgical				1		1
		Temporary paediatric haemato-oncology ward				1		1
	HIIAT Amber	critical care		1				1
		Critical care unit (ITU)					1	1
		ICU				1		1
		mixed		1				1
		Neurosurgical					1	1
		NICU	1					1
		Paediatric Haemato-oncology			1			1
		Paediatric Intensive care				1		1
		Paediatric ITU			1			1
		Paediatric Oncology					1	1
		Paeds	1					1
		Renal				1		1
		Spinal injuries			1			1
	HIIAT Green	Null	1				2	3
		Bone Marrow Transplant Ward					1	1
		Maternity	1					1
		NICU					2	2
		NICU and SCBU					1	1
Grand Total			12	32	29	23	11	107

A range of infection types have been reported for NHS GGC RHC incidents (Figure 1). 'HIIAT Red' incidents reported by NHS GGC QEUH and NHS GGC RHC between 1st April 2016 to 31st August 2020 (n=10) were associated with bloodstream infection, gastrointestinal infection, respiratory, surgical site infection and mixed source.

Figure 1: Incident type by infection category for NHS GGC QEUH and NHS GGC RHC, 1st April 2016 to 31st August 2020 (n= 107)

Recommendation

The reporting of healthcare incidents although supported by a number of guidance documents within the National Infection Prevention & Control Manual relies on NHS Boards recognising and reporting all infection related incidents in a timely manner. ARHAI Scotland undertook a standardisation exercise looking at example incidents and working with NHS Boards to establish how they would assess the incidents. It was recognised that the HIIAT assessment

relies on individual review and the assessment can be subjective, the exercise resulted in some variation between different boards assessments. The HIIAT assessment does not explicitly take into account any previous incidents within the same healthcare site. There have been occasions when ARHAI Scotland have requested the board reassess an incident taking into account all previous incidents however the reporting Board often choose not to change their initial assessment.

NHS Boards should be encouraged to report all infection related incidents in an open and transparent manner.

- ARHAI Scotland should further develop the HIIAT assessment and reporting tools to allow service, ARHAI Scotland and SG HAIPU to easily visualise all incidents within a healthcare facility over time.
- ARHAI Scotland to coordinate a working group through the NIPCM steering group to consider the HIIAT assessment including a standardised scoring system to provide a more robust risk assessment of infection related incidents within care systems.
- NHS Boards and other organisations IMT should consider previous incidents and any possible links when assessing all new infection related incidents.
- Education tools should be developed to assist all staff responsible for assessing and reporting infection related incidents.
- Scottish Government should consider the communication and escalation process for all incidents including Green HIIAT.

Paediatric Intensive Care Unit, Royal Children's Hospital NHS Greater Glasgow & Clyde: Ventilation: SBAR

Author: ARHAI Scotland and Health Facilities Scotland (HFS)

Publication date: April 2021

Situation

NHS Greater Glasgow & Clyde reported a number of infections with a potential environmental link within the paediatric intensive care unit (PICU), Royal Hospital for Children (RHC) in NHS Greater Glasgow and Clyde (NHSGGC) a review of the wider controls applied within the unit were undertaken by National Antimicrobial resistance and Healthcare Associated Infection Scotland (ARHAI) and Health Facilities Scotland (HFS). The ventilation system within PICU was reviewed as part of this work.

Background

In February 2020 NHSGGC reported a number of infections potentially linked to the environment within PICU, RHC. Given the background of environmental infections reported within other areas of the hospital (including PICU) Scottish Government invoked the National Support Framework for GGC incident: Gram-negatives within Ward 1D (PICU) at Royal Hospital for Children. A full review of surveillance data and Infection Prevention & Control was led by Dr Marion Bain and the findings and action plan submitted to HAI Policy Unit within Scottish Government. As part of the wider review NHSGGC were requested to provide information relating to the commissioning and maintenance of the ventilation system within PICU.

National ARHAI Scotland worked alongside HFS to support NHSGGC in the review of the PICU ventilation system.

This SBAR is the summary of the ventilation review.

Assessment

The initial information requested from NHSGGC were:

1. Supporting evidence of validation or design data prior to April 2019 for PICU to be shared, including the original design solution.

2. The background to the NHSGGC PICU Ventilation Options Paper dated August 2019, including why this paper was commissioned and what if any option were NHSGGC implementing?

3. The original design solution for PICU and any parts of the ventilation within PICU subject to a derogation. Where derogations had been made rationale and detail of assessment requested.

NHSGGC provided HFS with an SBAR detailing the derogations undertaken. Following a series of meetings and communications it was noted that the ventilation solution for the PICU did not meet the guidance outlined in SHTM 03-01. The ventilation in the wards had been validated against a “derogation” from NHSGGC which suggested a different ventilation solution was appropriate. NHSGGC were requested to consider the methodology outlined in the derogation, with the main concern highlighted by HFS being the protective pressurisation and air change rates of these wards.

NHSGGC provided information on the revised performance of the PICU wards which were taken after making adjustments to the relevant air handling plant and minor alterations to the ventilation diffusers in the wards themselves. The documentation shared with HFS showed that the four bed wards now appear to achieve the guidance recommendations (i.e. plus 10 Pascal (Pa) to the corridor and 10 air changes per hour (ACH)). No further data has been received for the two single rooms to demonstrate their ventilation performance following the rebalancing.

The ventilation rates in the transitional corridors remain lower than recommendations in SHTM 03-01 however it would appear that NHSGGC have increased the air change rate and pressurisation from those originally observed by adjusting the plant. Any further increase would require significant and major disruption to the ward and hospital in general to accommodate additional plant and ductwork.

Recommendations

- NHSGGC confirm the validation results for the single bed wards in PICU.

- NHSGGC consider options for increasing the dilution ventilation rate in the transitional corridors and assess any risk to patients as a result of keeping the solution as is currently implemented.
- NHSGGC undertake annual validation/verification checks on all ventilation systems within PICU as per SHTM 03-01 and results communicated to NHSGGC Infection Control & Prevention Committee.
- Any deviation from SHTM 03-01 should be recorded and noted on the corporate risk register together with appropriate mitigations in place.
- IPCT should continuously monitor alert organism in line with appendix 13 NIPCM within this area.

Bundle of documents for the Oral hearing commencing on 12 June 2023

in relation to the Queen Elizabeth University Hospital and the Royal Hospital for Children, Glasgow

Bundle 3 – NHS National Services Scotland: Situation, Background, Assessment, Recommendation (SBAR) Documentation

A43273121