



**Summary of Incident and Findings of the NHS Greater
Glasgow and Clyde: Queen Elizabeth University
Hospital/Royal Hospital for Children water
contamination incident and recommendations for
NHSScotland**

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Contents

Executive summary	3
Background.....	4
Summary of clinical cases associated with this incident	7
Summary of initial findings	9
Current management of situation/Control measures	12
Hypothesis	14
Summary	17
Recommendations	18
Appendix : 1 Timeline of cases	20
References	21
Glossary.....	23

Executive summary

NHS Greater Glasgow and Clyde (NHSGGC) are currently 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.

Wards 2A/2B 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 received by the child was prepared. *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 26th September 2018, 23 cases of blood stream infections (11 different organisms) with organisms potentially linked to water contamination were identified. As a result further testing of the water supply was undertaken across both hospital sites early in the investigation. This testing identified widespread contamination of the water system. Control measures implemented included sanitisation of the water supply to ward 2A, installation of the use of point of use filters in wash hand basins and showers in ward 2A/B and other areas where patients were considered high risk. Drain decontamination was undertaken and on 26th September 2018 wards 2A/B were closed and patients decanted to ward 6A QEUH and 4B QEUH. There have been no new linked cases identified since the decant of the patients.

NHSGGC requested support from Health Protection Scotland (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 a summary of the findings from this ongoing investigation for the period of 29th January 2018 – 26th September 2018. Further technical work is being undertaken for NHSGGC by Health Facilities Scotland (HFS).

Background

Health Protection Scotland

HPS plan and deliver effective and specialist national services which co-ordinate, strengthen and support activities aimed at protecting the people of Scotland from infectious and environmental hazards.

They do this by providing advice, support and information to health professionals, national and local government, the general public and a number of other bodies that play a part in protecting health.

HPS is a division of NHS National Services Scotland which works at the very heart of the health service across Scotland, delivering services critical to frontline patient care and supporting the efficient and effective operation of NHS Scotland. The specialist group involved in supporting NHSGGC in this investigation is the antimicrobial resistance and healthcare associated infection (ARHAI) group. The lead from HPS in this investigation and author of this report is a Consultant Nurse in Infection Prevention and Control with a specialist qualification in water and ventilation and is also the national HAI built environment and decontamination lead. HPS have been supporting NHSGGC with this incident since 16th March 2018. This report has been produced with full support from colleagues across NSS.

National Support Framework

The National Support Framework¹ is a structure that sets out the roles and responsibilities of organisations in the event that a healthcare infection outbreak/incident, is deemed to require additional expert support. The National Support Framework may be invoked by the Scottish Government HAI/AMR Policy Unit or by the NHS Board to optimise patient safety during or following any healthcare incident/outbreak(s)/data exceedance or Healthcare Environment Inspectorate (HEI) visit/report. Scottish Government invoked the national support framework¹ on 20th March 2018

NHS Greater Glasgow and Clyde

NHSGGC is the largest health board in Scotland serving a population of approximately 1.2 million people and employ circa 38,000 staff. The main hospital sites covered by this NHS Board are:

- Inverclyde hospitals campus
- Royal Alexandra campus
- Gartnavel campus
- West Glasgow ambulatory care Campus
- Glasgow Royal Campus
- New Victoria Hospital
- Stobhill campus
- Vale of Leven
- Queen Elizabeth University Hospitals Campus

Queen Elizabeth University Hospital (QEUH)/Royal Hospital for Children (RHC)

NHS Greater Glasgow and Clyde's (NHSGGC) Queen Elizabeth University hospital (QEUH) is a 1109 bedded hospital with 100% ensuite single side room. Construction commenced on the £842 million hospital in 2011 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. The QEUH/RHC is Scotland's largest hospital and replaced a number of existing hospitals from the NHSGGC area including:

- Southern General Hospital
- Victoria Infirmary
- Mansionhouse Unit
- Western Infirmary
- Royal Hospital for Sick Children (Yorkhill)

Introduction

NHS Greater Glasgow and Clyde (NHSGGC) are currently investigating and managing a contaminated water system across the Queen Elizabeth University Hospital (QEUH) and Royal Hospital for Children (RHC) with 23 probable linked cases of bloodstream infections associated with wards 2A /2B RHC. NHSGGC requested support from HPS with this incident on 16th March 2018 and Scottish Government invoked the national support framework¹ on 20th March 2018 which requires HPS to lead an investigation and provide NHS board support. It is recognised that this investigation and remedial action is still underway and may be ongoing for a considerable period, therefore this report is a summary of the findings from this investigation and includes cases and findings for the period 29th January – 26th September 2018.

An initial report was produced by HPS and submitted to Scottish Government (SG) and NHSGGC on 31st May 2018. Due to the ongoing and complex nature of this incident and investigation a further report was requested. This report is a summary overview of this investigation however due to the large volume of data and complexities associated with this incident further technical work is being undertaken by HFS. HPS worked with the support of HFS as the technical engineering experts to support this investigation and report production. In addition the HAI Policy Unit Scottish Government (HAIPU) has requested a separate detailed review of wards 2A/B to be undertaken. This is currently underway and will form a separate report for HAIPU and NHSGGC.

Summary of clinical cases associated with this incident

Case definition

The case definition in place since January 2018 is:

“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 Schiehallion, and houses the National Bone Marrow Transplant Unit and teenage cancer trust. Ward 2B is the day care component of ward 2A. In total there have been 23 cases identified during the period 29th January and 26th September 2018.

2016-2017

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. Typing by Colindale reference laboratory confirmed the isolate from the washhand basin and the patient were the same. The wash hand basin was subsequently removed as a result. A further single case of *Cupriavidus pauculus* was identified in September 2017. NHSGGC reported that a second hand hygiene sink was found to be positive but following assessment was unable to be removed. Silver hydrogen peroxide treatment was undertaken and repeat testing resulted in zero total viable counts from this outlet.

2018

On 29th January 2018 *Cupriavidus pauculus* was again identified from a bloodstream infection (BSI) in a patient in ward 2A. Following identification of this case a series of investigations were undertaken including water sampling from outlets within the ward area. On 21st February *Pseudomonas fluorescens* was identified from a BSI and between 11th and 16th March 2018, 3 cases of *Stenotrophomonas maltophilia* were identified from patients in ward 2A. On 7th April a further case of *Stenotrophomonas maltophilia* was identified. *Cupriavidus*, *pseudomonas* and *stenotrophomonas* (amongst other gram negative bacillus and fungi) were identified from water samples obtained within wards 2A/B and therefore all cases considered to be linked to the water system. No further cases were reported until April, when between April and June, a further 10 cases were reported: 5 *Enterobacter cloacae*, 3 mixed gram negative bacilli, 2 *Stenotrophomonas maltophilia*. This cluster of mixed organisms, which were present from drain samples prompted the investigation in to the drains within ward 2A/B. Following drain sanitisation and environmental decontamination using hydrogen peroxide vapour, no further cases were reported until 2nd August and between the period 2nd August and 20th September 6 further cases were identified: 1 *Chryseomonas indologenes*/*Stenotrophomonas maltophilia*, 1 *Serratia marsescens*, 1 *Klebsiella oxytoca*, 2 *Stenotrophomonas maltophilia*, 1 *Enterobacter cloacae*. This latest cluster resulted in immediate further drain decontamination and a temporary decant facility for wards 2A/B being identified, with the patients transferred to wards 6A and 4B on 26th September to allow for investigative and remedial works to be undertaken in wards 2A/B.

In total there have been 23 patient cases identified. A number of patients have multiple organisms so the organism total is greater than the case number.

The organisms linked to cases include:

- *Cupriavidus pauculus* (1)
- *Pseudomonas fluorescens* (1)
- *Pseudomonas aeruginosa* (3)
- *Stenotrophomonas maltophilia* (12)
- *Acinetobacter ursingii* (2)
- *Enterobacter cloacae* (7)
- *Klebsiella oxytoca* (1)
- *Serratia marcescens* (1)
- *Pseudomonas putida* (1)
- *Pantoea sp* (1)
- *Klebsiella pneumonia* (1)
- *Chryseomonas indologenes*(1)

In addition to the organisms detailed above there is evidence of fungal growth in the water system however there have been no associated clinical cases reported.

A timeline of cases is detailed in Appendix 1. This incident has resulted in a number of children requiring additional intervention and some delays in chemotherapy treatment, however, there has been no associated mortality. There have been no associated cases since the temporary closure of wards 2A/B and the decant of the patients to ward 6A QEUH on 26th September 2018.

The clinical component of this incident is considered as occurring within two phases:

- Phase one relates to the water contamination and the clinical cases associated at that time relating to the water system. Following installation of point of use filters, the water system was acknowledged as being of suitable quality for use by patients and staff. Whilst work was ongoing to investigate and manage the water contamination incident the clinical component of this phase was considered over with a debrief held on 15th May 2018
- Phase two relates to the environmental contamination and subsequent associated clinical cases occurring as a result of the contaminated drains and the impact caused by the fitting of point of use filters. Phase two is currently ongoing and will remain open until wards 2A/B have re-opened

Summary of initial findings

Following identification of the potentially contaminated water system in wards 2A/B and the resultant possible linked cases in March 2018, NHSGGC considered the decant of these 2 wards to allow for a full investigation of the source of water contamination in wards 2A/B and consider remedial action. At that time ward 4B QEUH was being prepared for the transfer of adult BMT patients from the Beatson oncology unit. Water sampling was undertaken in this ward prior to decant as a precautionary measure. Results identified the presence of *Cupriavidus pauculus* (and other gram negative bacilli) in water outlets within this ward and was the initial suggestion that there may be widespread contamination of the water system that serves both QEUH and RHC. Further testing across the site provided confirmation of this, with positive samples being identified in a number of areas across both sites at both outlet level and within the water system in the basement level (risers). Within the same timeframe staff within wards 2A/B also reported they had witnessed “black effluent” around the rim of the drain in some wash hand basins. Following visual inspection and laboratory testing, this was considered to be biofilm and sampling identified significant contamination of the drains with microorganisms and fungi. Drain contamination is not unexpected however the level of biofilm evident was not in keeping with a water system of less than four years old.

In an attempt to establish the extent of the water system contamination and any causative factor NHSGGC, supported by HFS and HPS initiated a detailed investigation into the contaminated water system within QEUH/RHC. Support was also requested from a number of external companies experienced in water incident management: These included Leegionella, Public Health England (PHE), water solutions group and Makin & Makin. The detailed investigations led by NHSGGC and supported by HFS/HPS included reviewing commissioning, installation and maintenance records provided by the contractor. This proved to be challenging due to the archiving of data and there were very few members of the initial project team available who are technically qualified to retrieve data and provide verbal clarification. The detailed findings from these records are included within the technical review.

Results from ongoing water testing were reviewed on a weekly basis and highlighted there was evidence of regressional seeding of contamination which supported NHSGGCs view that a whole system remedial approach was required.

Commissioning and design of the hospital water system

As part of the normal water system commissioning water samples were obtained. 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.

In response to the high levels of TVCs found as part of the pre handover commissioning sanitisation of the water supply was undertaken by the contractor, 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.

Design and installation of taps and clinical wash hand basins

The design and construct of wash hand basins, showers and taps in these hospitals were agreed with NHSGGC in line with the Scottish Health Technical Memorandum (SHTM) in place at the point the hospitals were designed (commencing 2009), this included the installation of taps with flow regulators. HFS and HPS were involved in this decision making process as were NHSGGC Infection Control team. The SHTM (SHTM 04-01)² was revised in 2015 and no longer supports the use of flow regulators in clinical wash hand basins.

Biofilm formation in flow regulators has been identified in a previously published outbreak.³ The manufacturers of the taps/flow regulators in place across the QEUH/RHC recommend regular removal of the flow regulators for cleaning/decontamination however do not offer more specific guidance on frequency of decontamination of the flow regulators. The flow regulators in use have a number of components and potentially create ideal conditions for the development of biofilm.

NHSGGC provided an external company (Intertek) with some flow regulators to carry out microbiological testing. This confirmed that flow regulators have the ability to harbour a significant number of micro-organisms with the presence of biofilm being detected on all flow regulators tested and 50% showing high levels of contamination. It is also worthy of note that biofilm was present on some flow regulators which was not immediately obvious on visual inspection.

The taps in place across all clinical wash hand basins in both hospitals are also reported to be non compatible with silver hydrogen peroxide, a product which was 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. A tap was deconstructed by NHSGGC and examined for the presence of biofilm, in addition to microbiological sampling. Several components of the tap exhibited microbiological contamination.

The presence of high levels of gram negative bacteria and fungus in the water system may indicate that temperature control required has not always been achieved. Temperature control is included as part of the wider technical review being undertaken for NHSGGC by HFS.

Other aspects discussed in the detailed technical review include:

- Flushing
- Contract/project team
- Roles/responsibilities
- Design and construction
- Guidance and specifications
- Specification of water system
- Flexible hoses
- System description

- Pipe work
- Post handover and maintenance

There are a number of local and national recommendations within this review for both NHSGGC and Nationally. The key NHSGGC and National recommendations from the technical review are included within the recommendation section of this report.

Infection Control at design commissioning and handover

HAI-SCRIBE

Healthcare Associated Infection System for Controlling Risk in the Built Environment (HAI-SCRIBE) ⁴, reference has been designed as an effective tool for the identification and assessment of potential hazards in the built environment and the management of these risks. HAI-SCRIBE (2007) was in place during the construction and handover of both buildings.

Implementation of HAI-SCRIBE should be the responsibility of a multidisciplinary team of specialists with appropriate skills.

Compliance with HAI-SCRIBE requires an accurate record of the process of hazard assessment and risk management which is essential 'due diligence' information.

Evidence has been reviewed in relation to the infection control sign-off of results and the system at commissioning/handover. Whilst there is evidence of involvement with initial results and sanitisation there is no evidence of ongoing input or sign off from the Infection Prevention and Control Team (IPCT). It is noted that there is lack of clarity in current national guidance relating to roles and responsibilities of the IPCT in the commissioning, design and handover of new or refurbished builds. Water was first placed on the Infection prevention and control (IPCT) risk register in 2018. The IPC risk register is reviewed on an annual basis with risks considered and prioritised using a risk scoring system. Water safety was added to the risk register in 2018 in response to the emerging evidence of potential issues associated with this incident. Prior to 2018 water safety did not feature in the IPC risk priorities when scored.

NHSGGC employed a robust approach to the design stage of the hospital project by means of a dedicated Infection Prevention and Control Nurse (IPCN) seconded as part of the project team to support the IPCT aspect of the design stage, commissioning and handover stage.

Whilst there was dedicated resource allocated to the project team, there is no documented evidence of NHSGGC Infection Prevention and Control Team involvement in the commissioning or handover process of the project. However NHSGGC has provided a statement from the Lead Infection Control doctor at the time to confirm that they were involved in reviewing some aspects of the initial water testing methodology and the results for QEUH and RHC during commissioning and handover. The Lead ICD has confirmed being involved in:

- Quality assurance of the water testing methodology used by the commissioning engineers.
- Liaising with Facilities Colleagues in reviewing the water testing results supplied by the commissioning engineers.

- Recommending further actions (dosing), for a small number of outlets with TVCs above the acceptable limits.

In addition to a nurse consultant being seconded as a dedicated resource to the project team with involvement in design, commissioning and handover, the project team were supported by the IPCT. This support included regular review of the new builds hospital project at the infection control committee and senior IPC meetings. NHSGGC reported that both the infection control manager and associate director of nursing (infection control) liaised regularly with the project associate nurse director and ensured the numerous commissioning groups established were supported by a member of the IPCT. In addition all wards were reviewed by a member of the IPCT prior to occupation by patients.

Current management of situation/Control measures

In addition to holding regular incident management IMT meetings (IMT) NHSGGC established a multi disciplinary water technical group which is a sub group of the incident management team. This group is supported by HFS, HPS, with monthly representation from water solutions group and Makin & Makin.

A number of control measures have been instigated during this incident and in particular in wards 2A/B. These included parent and staff education sessions, daily visits to the ward from members of the infection prevention and control team (IPCT), increased domestic hours, environmental monitoring by means of audit, including Standard infection control precautions (SICPs) audits.

Limiting access to water

In the initial investigation the use of water within wards 2A/B was limited with portable wash hand basins being supplied for hand washing. Patients were requested not to use wash hand basins or showers and wipes were provide as an alternative. Drinking water was provided by means of bottled water. Access to water was re-established once point of use filters were in place in showers and wash hand basins/sinks. BMT patients continue to receive sterile water.

Point of Use filters.

Following the identification that the water contamination was widespread across both RHC and QEUH an additional control measure of point of use (POU) filters for high risk areas was implemented to ensure a safe water supply at the point of use. In addition if a high risk patient was being nursed in an area deemed to be of low risk, a point of use filter was fitted to water outlets in their room. 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 considered 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^{5,6} or pathogen counts within tested water samples.⁷

Once the POU filters were in place the restrictions on access to water within wards 2A/B was removed and patients were able to access washhand basins and showers. It was noted that following the fitting of the POU filters there was a greater splash evident from the wash hand basins as the point of entry of the water from the outlet was closer the basin. This splash was noted more from clinical wash hand basins than ensuite wash hand basins and trough sinks.

Drain Sanitisation

Following the identification of the second phase of cases associated with this incident and the hypothesis that the cases may be related to drain contamination, the drains were inspected by the IPCT. Once the drains were identified as being visibly contaminated with what was thought to be biofilm, a programme of drain sanitisation was undertaken across high risk areas commencing with wards 2A/B.

Environmental decontamination

Prior to and following completion of the first drain decontamination process in wards 2A/B, a terminal clean of all areas using hydrogen peroxide vapour was carried out.

Water treatment

It is well recognised that drinking water distribution systems contain a diverse range of microorganisms.⁸⁻¹⁰ 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.¹¹

There were a number of options explored for longer term water treatment by NHSGGC. These options included:

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.^{10,12,13} Various advantages and limitations associated with use of chlorine dioxide are known, with the most relevant summarised below.^{14,15}

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.¹⁶

UV light

A number of drinking-water treatment technologies are available which employ UV light radiation to inactivate microorganisms.¹⁵ As with chlorine dioxide, various advantages and limitations associated with use UV are known, with the most relevant summarised below.¹⁴⁻¹⁶

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.¹⁷ Copper silver ionisation was also considered however this was discounted due to pH levels.

Preferred solution

The NHSGGC preferred method of choice for water treatment was continual dosing chlorine dioxide. This was supported by HFS and HPS. Shock dosing of the system was considered and it was agreed that due to safety issues and the potential impact on both hospitals ability to function during the process, this was not the most appropriate approach. It was also recognised that in the absence of initial shock dosing it may take up to two years for the process to be effective from tank to tap level. The procurement process is well underway and installation expected to commence November 2018.

Temporary closure of wards 2A/B

A recommendation was made by the IMT to pursue the temporary decant of wards 2A/B to allow investigative and remedial work to be undertaken. A number of options were explored resulting in the transfer of patients from wards 2A/B to ward 6A of the QEUH. Adult patients within ward 6A QEUH were transferred to Gartnavel General. Three rooms within the adult BMT (4B) were identified and allocated to the paediatric BMT unit. The patients were transferred on 26th September 2018. It is anticipated that the decant facility will remain in place until mid/late December.

Remedial work/Investigations wards 2A/B

The planned investigations/remedial works planned during the decant period include:

- Drain Survey
- Ventilation review
- Replacement of clinical wash hand basins
- Replacement of taps (with no flow regulator)
- Review of any little used water outlets with a view to remove
- Replacement of sections of pipework where biofilm noted
- Review of toilet cisterns and adaptation to reduce potential toilet plume effect.

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.

Secondary Hypothesis

It is recognised that in many situations control measures or actions taken in an attempt to minimise the risk of HAI there can be unintended consequences. In this scenario the secondary hypothesis is linked to the unintended consequence of the point of use filter use:

POU filters.

In an attempt to provide water of a safe microbiological quality NHSGGC applied point of use filters to all clinical and patient wash hand basins in high risk areas and areas where high risk patients were being treated. These filters meant the exit point of the water from the taps was closer to the washhand basin and as a result caused more splash which may also lead to disruption of any drain biofilm as well as potential environmental contamination. (Pictures 1, 2). At the time of fitting the filters, the issue of biofilm within the drains and the associated risk or the resultant splashing that was being caused had not been identified and therefore the subsequent increased risk of environmental contamination and potential exposure of the children was not recognised.



Picture 1



Picture 2

Additional potential considerations to minimise impact

Ensuite single side rooms/hand hygiene practice

Since 2008 it is recommended that all new build hospitals have 100% en suite single side rooms.¹⁸ As a result this has substantially increased the number of wash hand basins and therefore the frequency with which a wash hand basin is used and the water volume in each basin reduced when compared to multi occupancy wards with a single wash hand basin. Since the introduction and widespread use of alcohol gel, the need for hand washing as a first approach has greatly decreased, as alcohol gel may be used on hands that are not visibly soiled. This requires further exploration and consideration and review of flushing regimes and number of wash hand basins required.

Disposal to drain

A number of drain samples were sent to Intertek for analysis. A report has highlighted that in addition to the general presence of biofilm, there was biofilm noted around the aluminium spigots. There was also some occlusion reported as a result of adhesive and pooling noted between the back of the sink and the pipework. All aluminium spigots in wash hand basins in wards 2A/B were replaced with PVC spigots. In addition a number of foreign objects were identified within the drains. It was also reported that there was evidence of a yellow fluid present suggestive of urine being disposed to the drain. The biofilm has a mustard yellow colour and an odour of ammonia was detected. There was a small amount of yellow liquid in the base of the bowl trap which when removed and looked at in isolation also had an ammonia smell. Parents, families and clinicians are advised that hand wash basins are for hand washing only and additional activities such as fluids being disposed of to drain via a handwash basin should not occur. Staff are aware that this is not acceptable practice however the positioning of a wash hand basin in every ensuite single side room may encourage patients or visitors to expel fluids such as contents of a drink bottle. Items such as coffee, sweet drinks encourage the growth of

bio film and microorganisms within a drain. The large open horizontal drain may also encourage the accidental disposal of foreign items.

Summary

There have been no new reported cases since the decant of patients to ward 6A on 26th September 2018. The IMT will continue to meet regularly until the patients have been transferred back to wards 2A/B. The water subgroup will continue to meet until early/mid 2019 and will be supported by HFS/HPS. It has been evident to HPS that since the identification of this widespread incident and clinical impact on wards 2A/B, patient safety has been paramount with NHSGGC clinicians, facilities, IPCT and management team. A significant financial investment has been made to minimise ongoing risks including widespread use of point of use filters in addition to remedial work planned. A number of lessons can be taken from this incident for NHSGGC and NHSScotland as a whole in relation to water safety and commission, handover and maintenance of buildings. The national work and learning for NHSScotland will be driven via the HAI built environment steering group which is widely represented and chaired by the associate director of facilities (NHSGGC) and deputy chair is the lead ICD (NHSGGC).

Recommendations

A number of local and national recommendations have been made based on the investigation to date. This includes recommendations for NHSGGC which have been identified from a detailed HFS technical review. NHSGGC/HPS/HFS will produce an action plan based on the recommendations as follows:

1. NHSGGC

- To produce a detailed action plan addressing ALL points identified within the HFS technical review and should cover as a minimum:
 - Decontamination
 - The management of the water systems
 - All required rectification work
 - Management of recording systems
 - Routine and reactive maintenance schedules

2. All NHS Boards

- All NHS boards should ensure facilities teams are adequately resourced to ensure maintenance of all aspects of the water system are maintained in accordance with policies and guidance.
- All maintenance undertaken should be recorded and maintenance records should be reviewed regularly to ensure all aspects of the water system are maintained in accordance with policies and guidance

3. HPS/HFS

HPS (supported by HFS) to undertake an urgent national water review of all healthcare premises built since 2013 to provide assurance that a similar incident has not and is not likely to occur elsewhere.

HPS (supported by HFS) to establish a national expert group to:

- Review NHSScotland current approach to water safety including as a minimum:
 - Review NHSScotland current approach to water testing in healthcare settings.
 - Review NHSScotland current surveillance and reporting of potentially linked water related HAI cases.
 - Based on findings develop risk based guidance on water testing protocols, results interpretation roles and responsibilities and remedial steps to be considered.
- Give consideration to the development of a best practice built environment manual which will be evidence based and cover as a minimum current and emerging evidence

and the technical requirements from a clinical, patient safety and HAI perspective that will be adopted by all NHS boards. This will include as a minimum:

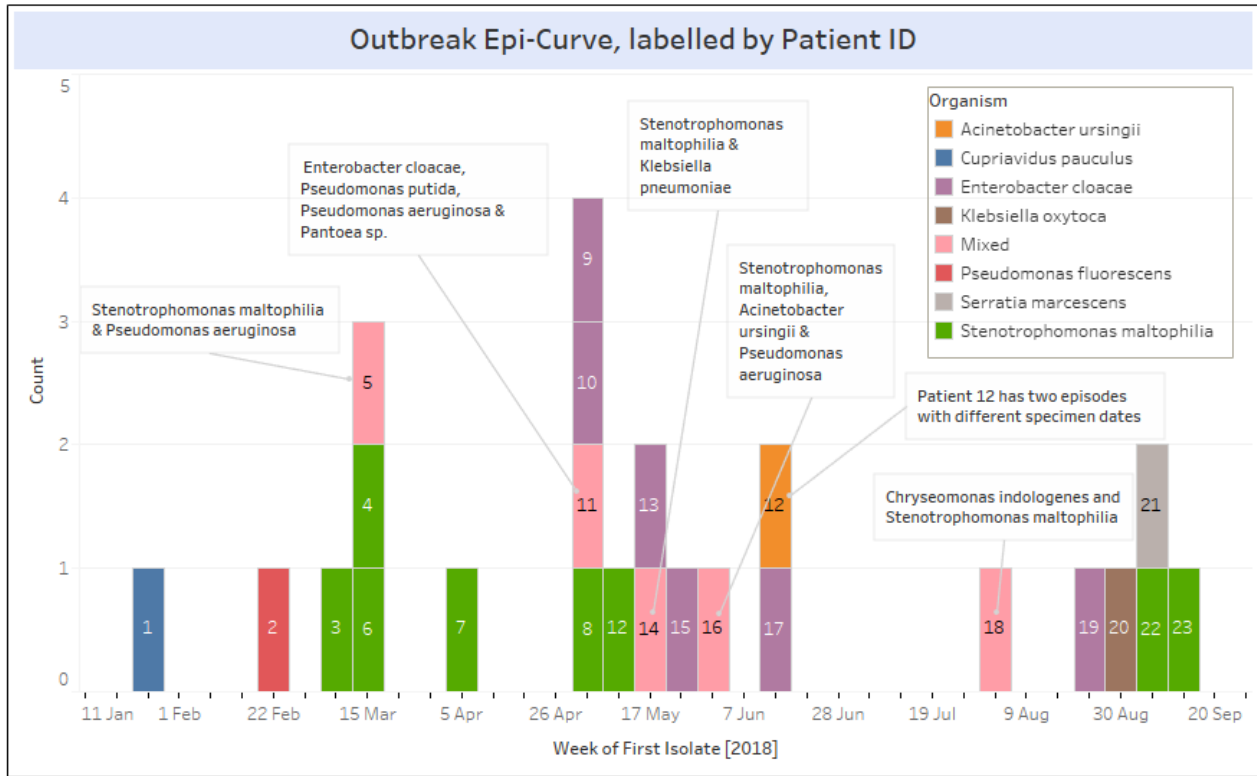
- Review existing national and international guidance relating to water safety.
 - Develop robust requirements/guidance for all aspects of water safety.
 - Develop robust handover requirements in relation to water systems.
 - Review of the role of the IPCT into the built environment, and produce clear guidance on roles and responsibilities.
 - Establish a risk based approach to water testing and any remedial action required, including roles and responsibilities that NHS boards will adopt.
 - Review the requirement for 100% ensuite single side rooms the number of clinical wash hand basins per patient/bed.
 - Review the use of flow regulators across NHS Scotland and identify and associated risks and recommend any remedial actions required.
- HPS/HFS will continue to provide support to NHSGGC relating to the current water incident and provide input into the weekly meetings until mid 2019 (and reviewed thereafter).
 - Further develop the existing Scottish expertise in the built environment programme (mainly water and ventilation) at national level.

HFS (supported by HPS) to:

- Review all relevant water technical guidance to ensure all aspects are covered within the guidance including as a minimum:
 - 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

Appendix : 1 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.



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Glossary

Alcohol gel	A gel, foam or liquid containing one or more types of alcohol that is rubbed into the hands to inactivate microorganisms and/or temporarily suppress their growth.
Aseptic Suite	An ultra clean environment within a department, (for example pharmacy) where sterile solutions are prepared such as chemotherapy under strict measures.
Bacteria	Microscopic organisms (germs).
Bib taps	A tap or stop cock which has a nozzle bent downwards.
Biofilm	Collective of one or more types of microorganisms, including bacteria, fungi and protists, that stick together and can become embedded on a surface.
Blood stream infection	The presence of bacteria in the bloodstream.
Chemotherapy	A cancer treatment where medication is used to kill cancer cells.
Chlorine dioxide	A chemical compound used for a variety of antimicrobial uses, including the disinfection of drinking water.
Clinical wash hand basins	A sink designated for hand washing in clinical areas
Cluster	A group of similar things located around the same location
Copper silver ionisation	A disinfection process where positively charged copper and silver ions are added into the water system. It is primarily used to control Legionella, the bacteria responsible for Legionnaires' disease.
Decant	Temporarily transferring people to another location.
Decontamination	Removing, or killing pathogens on an item or surface to make it safe for handling, re-use or disposal, by cleaning, disinfection and/or sterilisation.
Drain	A fixture that provides an exit-point for waste water or water that is to be re-circulated.
Ensuite single side room	A room with space for one patient and containing a bed; locker/wardrobe, clinical wash-hand basin, en-suite shower, WC and wash-hand basin.
Flexible hoses	A flexible hollow tube designed to carry fluids from one location to another and are used to connect taps to the water supply
Flow regulators	Point of use regulators designed to provide constant and maximum flow rates at taps and showers etc. irrespective of changes in demand or water pressure

Flushing	The process of cleaning or “scouring” the interior of water distribution mains (pipes) by sending a rapid flow of water through the mains.
Gram negative bacilli	Gram-negative bacteria are bacteria that do not retain the crystal violet stain used in the gram-staining method of bacterial differentiation; examples include E.coli, and Pseudomonas aeruginosa.
Hydrogen Peroxide Vapour	Vaporized hydrogen peroxide is an airborne disinfectant and infection control measure that can be used for room decontamination after patient use.
Ingress	The act of entering.
Microbiological sampling	Sampling for harmful bacteria, parasites, fungi and viruses including those in water, environment and equipment.
Micro-organism	Any living thing (organism) that is too small to be seen by the naked eye. Bacteria, viruses and some parasites are microorganisms.
Organism:	Any living thing that can grow and reproduce, such as a plant, animal, fungus or bacterium.
Parenteral nutrition:	The giving of special liquid feeding products to a person using an intravenous catheter and bypassing the normal digestion process of the stomach and bowel.
Pathogen:	Any disease-producing infectious agent
Point of use filters:	A device that incorporates an integral filter with a maximal pore size of 0.2 µm applied at the outlet, which removes bacteria from the water flow therefore protecting the end user from exposure to harmful waterborne pathogens.
Portable wash hand basins	A sink that is not connected to the mains water supply but connects to a water tank which is filled locally.
Regressional seeding	Where micro-organisms from contaminated water outlets/biofilm regress ‘back’ through the water system and seed other areas (pipes/tanks/outlets). The microorganisms embed themselves and multiply contaminating other areas of the system.
Sanitisation	Use of antimicrobial agent on objects, surfaces or living tissue to reduce the number of disease-causing organisms to non-threatening levels.
Shock dosing	The use of large quantities of chemicals to the water supply to break down organic waste and get rid of bacteria and contamination.
Silver hydrogen peroxide	A solution of stabilised silver in hydrogen peroxide that is used for surface and water decontamination.

Sterile water	Water free of all microorganisms – bacteria, viruses, fungi.
Terminal clean	Cleaning/decontamination of the environment following transfer/discharge of a patient, or when they are no longer considered infectious, to ensure the environment is safe for the next patient or for the same patient on return.
Thermal disinfection	The use of water and heat for the disinfection process for example washer-disinfectors.
Toilet plume effect	The dispersal of microscopic particles as a result of flushing a toilet.
Total viable counts	A quantitative estimate of the concentration of microorganisms such as bacteria, yeast or mould spores in a sample.
Trough sinks	A long, narrow basin designed for communal handwashing with water delivered at hand-washing temperature via mixer taps in conjunction with a thermostatic mixing valve. Usually used for surgical scrubbing.
UV light	A disinfection method that uses short-wavelength ultraviolet (UV-C) light to kill or inactivate microorganisms.
Water outlets	Any hole or opening where water is released for example taps, showerheads.
Water sampling	The analysing of the water supply for harmful bacteria, parasites, and viruses.
Water system	A system of engineered hydrolic and hydraulic components to supply water.
Spigots	A short cylindrical pipe which connects the Clinical Wash Hand basin to the main pipework.
Occlusion	Obstruction or blockage