SCOTTISH HOSPITALS INQUIRY

Bundle 8 – supplementary documents for the Oral hearing commencing on 12 June 2023

SCOTTISH HOSPITALS INQUIRY

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Protected Antibiotic Policy

Royal Hospital for Children (RHC)

BACKGROUND:

In 2019 the World Health Organisation published the antibiotic AWaRE classification database following recommendations from the WHO Expert Committee on Selection and Use of Essential Medicines. AWaRE classifies antibiotics in to three stewardship groups:

- ACCESS – This group includes antibiotics that have activity against a wide range of commonly encountered susceptible pathogens while also showing lower resistance potential than antibiotics in the other groups.

- WATCH - This group includes antibiotics that have higher resistance potential. Antibiotics in **Watch** group should be prioritized as key targets of stewardship programs and monitoring. Some Watch antibiotics are included as first- or second -choice empiric treatment options for specified infectious syndromes.

- RESERVE - This group includes antibiotics and antibiotic classes that should be reserved for treatment of confirmed or suspected infections due to multi-drug-resistant organisms. '**Reserve**' agents should be accessible, but their use should be tailored to highly specific patients and settings, when all alternatives have failed or are not suitable.

PURPOSE:

This purpose of this policy is to promote antimicrobial stewardship by reserving the use of specific antimicrobials for special circumstances (e.g resistant organisms), in line with WHO AWaRe recommendations and local epidemiology. The aim is to reduce the development of resistance and preserve the efficacy of these valuable agents for now and in the future.

SCOPE:

The policy is for use within all clinical areas at the Royal Hospital for Children, NHS Greater Glasgow & Clyde. Protected antimicrobials may only be used following approval from a Microbiologist or Infectious Diseases Consultant unless used in line with approved local guidelines as outlined below.

CLASSIFICATION AND PRESCRIBING OF PROTECTED ANTIBIOTICS

Antimicrobials MUST be prescribed:

- In accordance with locally approved guidelines
- In response to culture and sensitivity reports
- On the advice of an infection specialist (Microbiology/Infectious Disease)

For all antimicrobial prescribing the following must be recorded in the patient's medical notes AND on the drug Kardex:

- Indication for use
- Intended duration
- Review/stop date

For PROTECTED antimicrobials (WATCH Abx outside of approved use; all RESERVE antibiotics) the following also applies:

- Record the name and designation of the Infectious Disease Consultant or Microbiologist granting approval for use in the medical notes.
- A 'Protected Antimicrobial Form' should be completed by the requesting clinician where indicated (see below).

**Note: Where a protected antimicrobial is commenced out of standard Pharmacy operating hours, a limited supply will be available. Pharmacy must be contacted early the following working day to obtain further supply and avoid delay in treatment.*

The information collected within the 'Protected Antimicrobial Use Form' will be used to aid surveillance of antimicrobial use and facilitate the identification of areas where increased support with antimicrobial stewardship can be targeted.

Notes:

- NHS GGC local policy has re-classified some antibiotics under local treatment policy to further preserve use/allow access to approved patient groups.

- 'Protected' status have been presented in a 'red-amber-green' classification. Please note that this does NOT correlate to penicillin-allergy status.

- 'Reserve' antibiotics, with the exception of Meropenem, are not routinely stocked on all wards in RHC. Some 'watch' antibiotics are also not kept as ward stock. When a protected antimicrobial is prescribed please alert nursing staff IMMEDIATELY so that a supply can be obtained from Pharmacy. For out-of-hours access please check the Emergency Drug Cupboard (QEUH) in the first instance.

PROTECTED ANTIBIOTICS: RESERVE

Aztreonam (IV) **Linezolid** **Ceftazidime/avibactam** **Colomycin (IV)** **Daptomycin** **Fosfomycin** **Meropenem*** **Temocillin** **Tigecycline**	**RESTRICTED:** RECOMMENDATION/ APPROVAL required from Microbiology or Infectious Disease Consultant prior to initiating therapy* 'Protected Antimicrobial Use' form mandatory for all meropenem and nitrofurantoin (liquid) **Micro/ID approval not required where meropenem is used as second line therapy for Haematology/oncology patients in line with approved NHS GGC guidelines. A PAU form is still required for surveillance purposes.*

PROTECTED ANTIBIOTICS: WATCH

Amikacin **Cefotaxime** **Cefuroxime** **Ceftriaxone** **Clarithromycin** **Ceftazidime** **Ciprofloxacin** **Colomycin (neb)** **Daptomycin** **Levofloxacin** **Nitrofurantoin (liquid)** **Piperacillin/Tazobactam** **Rifampicin** **Sodium Fusidate** **Teicoplanin** **Tobramycin** **Vancomycin**	**RESTRICTED:** Must be used in accordance with approved NHS GGC guidelines. RECOMMENDATION/ APPROVAL required from Microbiology or Infectious Disease Consultant prior to initiating therapy outside of NHS GGC approved guidelines 'Protected Antimicrobial Use' form not required

ACCESS ANTIBIOTICS: ADDITIONAL RESTRICTIONS NOT APPLICABLE

Amoxicilin **Azithromycin** **Benzylpenicillin** **Cefalexin** **Clindamycin** **Co-amoxiclav** **Co-trimoxazole** **Flucloxacillin** **Gentamicin** **Metronidazole** **Nitrofurantoin (tablets)** **Phenoxymethylpenicillin** **Trimethorprim**	**NOT RESTRICTED:** Recommended for use in accordance with NHS GGC guidelines. No approval/ 'Protected Antimicrobial Use' form required

PROTECTED ANTIMICROBIAL USE FORM – ROYAL HOSPITAL FOR CHILDREN

For all WATCH (out with NHS GGC guidelines) and all RESERVE antimicrobials please complete the following:

STEP 1: Check the protected antimicrobial policy for Protected status prior to prescribing

STEP 2: For all protected antimicrobials: Permitted indication YES / NO

Indication for use:

If prescribing for a non-permitted indication, please record the name and designation of the authorising specialist, and the date of authorisation: Date :

Name : Designation:

STEP 3: Complete patient details below

Name: CHI :

Consultant:

STEP 4: Complete details of the Protected Antimicrobial below

Antimicrobial: Start date: Route:

Dose (mg) : Dose frequency : Intended duration:

STEP 5: Complete prescriber details below & submit to Pharmacy

Name Designation Contact No.

Prescribe the Protected Antimicrobial on the medication chart, including review/stop date.

Review with culture/sensitivity results, response and suitability for IVOST regularly

Guidelines for the management of paediatric line-related sepsis

Objectives

This document aims to provide assistance with clinical management of probable or confirmed paediatric line-related sepsis in GG&C, including diagnosis, decisions regarding line salvage if necessary, and use of antimicrobial agents. The prevention of line related infections, and the use of line locks to prevent line infections, is outwith the scope of this guideline.

From the perspective of managing infections as well as to conserve valuable antibiotics and prevent resistance from developing, it is always ideal to remove infected lines or other prosthetic material. Line salvage therapy should only be considered when it is thought to be in the best interests of the patient and the benefits associated with this are thought to outweigh the risks. For example, in patients with multiple previous lines, limited ongoing options for vascular access, or a significant bleeding risk, one might have a lower threshold for considering line salvage. In all cases, the best decisions regarding line removal or salvage are made in the context of the wider multi-disciplinary team which should include a member of the vascular access team. These discussions may be informed by up to date imaging to assess available options for subsequent replacement of central venous access. Risks of line salvage therapy include ongoing or worsening sepsis due to continuing indwelling source of infection, and failure of salvage therapy or recurrence of infection.

It is always good practice to ensure individualised management plans tailored to each patient's unique needs and circumstances. These guidelines are purely to facilitate this process and are not a substitute for senior clinical review and discussion with an infection specialist where appropriate. Local departmental guidelines may already be in use to facilitate management of line related infections; these should be referred to and if in any doubt the most appropriate course of action should be discussed with an infection specialist.

This document does not provide a comprehensive account of the pathophysiology, potential sources or metastatic complications associated with individual organisms. Organisms not covered in this document, or line sepsis with mixed organisms, should also be discussed with an infection specialist.

"Infection specialist" refers to a specialist in clinical microbiology or infectious diseases.

+ Expand All

General approach to line infections

It is recognised that each patient and situation is unique. The following initial actions are recommended in patients with possible or probable line related sepsis:

1. Urgent senior clinical review
2. Blood cultures (preferably pre-antibiotic)
    - Paired line and peripheral blood cultures taken with clear labelling of the request forms
    - All lumens of multilumen lines should be sampled separately
    - If peripheral cultures are not obtainable, consideration should be given to arterial cultures
3. Review for other sources of infection – may require further investigations/imaging etc. Even with an underlying primary source of infection, the line may be secondarily infected.
4. Consultation of previous microbiology results – previous resistant or unusual infections may mean that empirical antimicrobials recommended in this guideline or in the therapeutics formulary are inappropriate and alternative regimes may be required. For haemato-oncology and other patients at high-risk of recurrent line infections there may be a condition specific guideline or an existing individualised line infection antibiotic plan which should be followed.
5. If in any doubt, early senior clinical review and discussion with an infection specialist should occur
6. It is generally against best infection specialist advice to salvage an infected line. However, an early decision regarding salvage, along with institution of lock and systemic antibiotic therapy (through the line to be salvaged) should be made. Where a lock cannot be used, systemic antibiotics should be administered through the line.
7. In a patient in whom line sepsis is suspected, and in whom there is a strong reason why line salvage is being considered, line locks and systemic antibiotics down the line should be used. In addition, due to the risk of metastatic septic complications and physiological instability, an early discussion with critical care services is warranted based on level of concern and the species of pathogen isolated. If continued use of the line results in ongoing signs of sepsis then the line should be removed.

8. In well patients, single positive cultures with Coagulase Negative Staphylococci might not be significant and these should be repeated prior to initiation of specific therapy.
9. Repeat line and peripheral cultures with tailoring of treatment (lock and systemic) to microbiology results are essential if line salvage is attempted. Discuss any antibiotic resistant organisms with an infection specialist. The line should ideally be removed if blood cultures remain positive at 72 hours post initiation of salvage therapy.
10. Line removal forms the mainstay of optimal management of these infections. When line sepsis is likely, line tips should be sent for culture and the results chased. If lines are removed but line sepsis is not likely, there is no clinical need to send line tips for culture. In problem situations or when problem organisms are cultured, renewed efforts should be made to remove the line. Certain situations may also prompt a search for other deep sources or metastatic complications (see tables 1 & 2 in section ***Problem situations and organisms*** below).
11. When line retention and salvage has been attempted using systemic and lock therapy for the recommended durations, line and peripheral cultures should be obtained 48 hours after stopping all antimicrobial therapy

Line rest

Line rest and rechallenge a few days later may allow more bacteria to grow within the line and risk severe septic showers on rechallenge. This might reduce the efficacy of salvage therapy. Removal of an infected line is always ideal when managing line infections, but if this is not possible then a decision to salvage should be made early and salvage therapy that includes line locks, instituted as soon as practicable, guided by senior clinical input. Line removal is indicated in patients who are severely unwell, haemodynamically unstable, or with signs of insertion site infection, severe exit site infection or tunnel infection. If line removal is still not possible then discuss the case urgently with senior clinicians, intensive care and infection specialists.

Line tips

Line tips should only be sent to microbiology for culture when there is a clinical suspicion of line sepsis. When these are sent, the results should be chased up by the responsible clinical team.

There is evidence that the following organisms, when cultured from a line tip but not blood cultures, MAY warrant clinical review, further investigations, consideration of a period of intravenous antimicrobial treatment, due to the association with deep sources or metastatic septic complications:

- *Staphylococcus aureus* or *lugdunensis* (typically 5-7 days IV treatment post line-removal)
- Candida species or other fungi/yeasts
- Gram-negative organisms

If in doubt, discuss with an infection specialist.

Lock therapy

Paediatric patients weighing less than 3kg should be discussed with the paediatric infectious diseases team prior to using locks.

Antimicrobial line locks deliver a high concentration of antimicrobial agent direct to the lumen of the line and remain in situ for a period of time before being aspirated and replaced. Line locks should be replaced at least every 24 hours. The line lock should be removed before infusion of the next dose of systemic antibiotic down the line, or, where applicable, other intravenous solution, or medication.

Line locks are an adjunct and not a replacement for systemic antimicrobials and are used as a final attempt at line salvage. For suspected bacterial line related infection, the initial choice of lock therapy suggested is taurolock. Lock therapy can then be guided by culture results and antimicrobial sensitivities. When using antibiotic locks, the choice of lock should ideally be a different class of antimicrobial from the agent used systemically. A number of different antibiotics can be used as a lock. Antibiotic locks not mentioned in this guideline may be considered under the guidance of microbiology and pharmacy based on the organism and antibiotic sensitivities.

For fungal/candidal infection and *Staphylococcus aureus/lugdunensis* infection, line removal is strongly recommended. Line salvage with antibacterial or antifungal locks should not be attempted unless in exceptional circumstances and should be discussed with an infection specialist first.

There may be instances where it is not possible to use antibiotic lock therapy, or locks cannot be instilled or changed with regularity, and these cases should be discussed with an infection specialist.

Lastly, the volume of lock instilled will vary according to the length and type of line: this cannot be defined in a protocol and must be individualised for the patient.

See Quick Reference Guideline section below for suggested antibiotic lock formulations and clinical management flowchart.

Blocked lines

Urokinase administration may be required if a line cannot be aspirated or is considered to be blocked. Further information on troubleshooting and general line-related care can be found at the vascular access device practice website on Staffnet (http://www.staffnet.ggc.scot.nhs.uk/Acute/Division%20Wide%20Services/Practice%20Development/GGC%20PD%20Calendar/Pages/default.aspx) *[NOTE: you must be connected to the NHSGGC network to view]*.

Replacing lines

If a line has been removed due to line sepsis and another line is required, this should ideally be placed in a different location. Guidewire exchange in insertion site infections is not appropriate as it can lead to bacteraemia and septic emboli.

Ideally, clearance of bacteraemia should be documented prior to replacing a line. This usually means a minimum of 48 hours of negative cultures.

Duration of antibiotic therapy post line-removal

This should be discussed with an infection specialist and may vary according to the organism and clinical circumstances. In patients with suspected deep foci of infection, such as endocarditis, septic thrombophlebitis, bony infection, or another deep or potentially infected nidus of infection or prosthesis, a more prolonged course of antibiotics may be required on discussion with the infection specialist

As a general guide:

- *Staphylococcus aureus* or candida species: Assuming the line has been removed, these organisms require at least 14 days of IV antimicrobial therapy from the date of the first negative blood culture at or after line removal, provided no deep sources or metastatic complications present
- Gram negative bacilli and enterococci: 7-14 days post line removal
- Coagulase-negative staphylococci: 5- 7 days post line removal depending on other comorbid factors, but may not require treatment at all

Line Sepsis and Antibiotic Lock Guidance for On Call Pharmacists and Clinicians – Quick Reference Guideline

- In order to avoid errors in preparation, it is suggested that a commercially pre-prepared preparation such as taurolock be used out of hours if required, and antibiotic locks be prepared during working hours after choice of antibiotic lock is agreed by an infection specialist.
- Maximum dwell time should be 24 hours.
- The concentration of lock suggested in different guidelines varies.
- If heparinised solutions are required to lock the line, consult with pharmacy prior to initiating antimicrobial lock therapy.
- The risk of accidentally flushing an antibiotic lock will depend on the volume and concentration flushed, and patient factors. If antimicrobial locks are accidentally flushed into a patient, get a senior clinical review and discuss with pharmacy.

Vancomycin (5mg/mL) and sodium chloride 0.9% antibiotic lock:

Method for preparation and administration

1. Reconstitute 500mg vial of Vancomycin with 10mL water for injection (to give concentration of 50mg/mL) – **draw up 1mL (50mg).**
2. Add 1mL (50mg) of Vancomycin to 9mL of sodium chloride 0.9% to give a final concentration of 5mg/mL Vancomycin and a total volume of 10mL.
3. Instil the required volume for size and type of central venous access device
4. ***Make sure that the line is not flushed during this time by labelling appropriately**Repeat the preceding steps as appropriate for each lumen.*

5. Aspirate the solution from the line prior to using the line or changing the lock
6. Document in patient's medical notes & get senior clinical review if unable to aspirate.

Gentamicin (5mg/mL) and sodium chloride 0.9% antibiotic lock:

Method of preparation and administration

1. Use Gentamicin 20mg/2ml injection, withdraw 2ml.
2. Add 2 mL of 0.9% Sodium Chloride to give a final concentration of Gentamicin 5mg/1mL and a total volume of 4 mL.
3. Instil the required volume for size and type of central venous access device
4. ****Make sure that the line is not flushed during this time by labelling appropriately**** ***Repeat the preceding steps as appropriate for each lumen.***
5. Aspirate the solution from each lumen prior to using the line or changing the lock
6. Document in patient's medical notes & get senior clinical review if unable to aspirate.

Ciprofloxacin (2mg/mL):

Method for preparation and administration

1. Use Ciprofloxacin infusion bag (concentration of 2mg/mL)
2. Instil the required volume for size and type of central venous access device
3. ***Make sure that the line is not flushed during this time by labelling appropriately** Repeat the preceding steps as appropriate for each lumen.***
4. Withdraw the volume added to each lumen prior to using the line or changing the lock
5. Document in patient's medical notes & get senior clinical review if unable to aspirate.

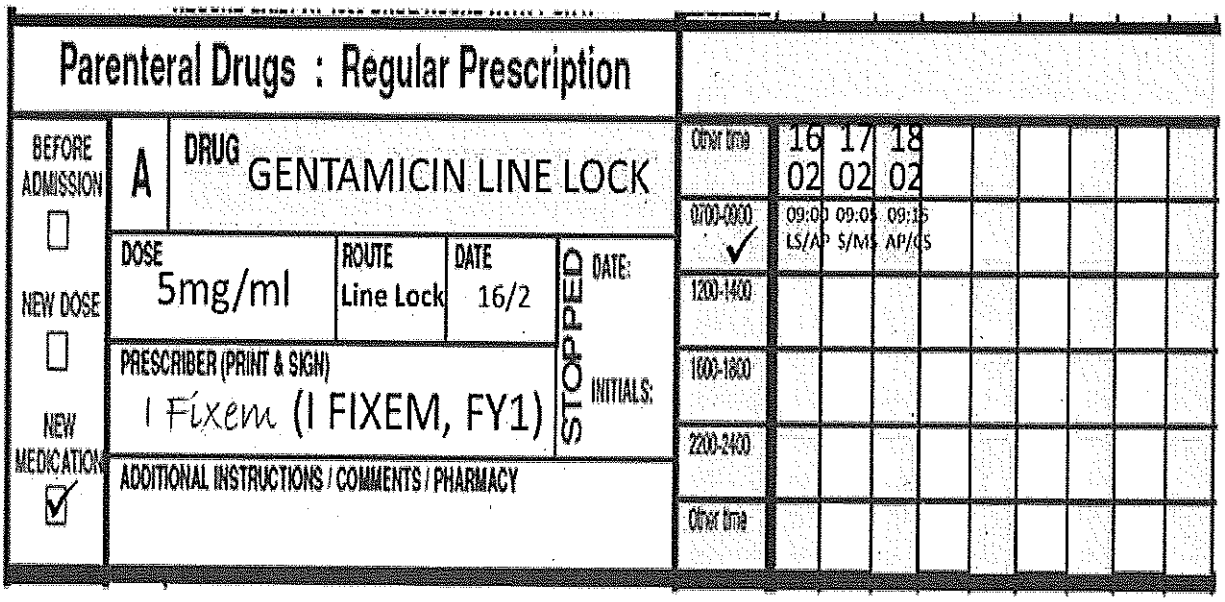
Taurolock

Instructions for use can be found at: https://www.taurolock.com/en/download/instructions-use (https://www.taurolock.com/en/download/instructions-use)

However, always check the actual instructions supplied with the product on the ward.

Prescription of locks and labelling of lumens:

Line locks should be prescribed on the Kardex as illustrated below.



Parenteral Drugs : Regular Prescription

BEFORE ADMISSION ☐ NEW DOSE ☐ NEW MEDICATION ☑

A DRUG GENTAMICIN LINE LOCK

DOSE 5mg/ml | ROUTE Line Lock | DATE 16/2

STOPPED DATE: INITIALS:

PRESCRIBER (PRINT & SIGN) I Fixem (I FIXEM, FY1)

ADDITIONAL INSTRUCTIONS / COMMENTS / PHARMACY

Other time	16/02	17/02	18/02
0700-0900 ✓	09:00 LS/AP	09:05 S/MS	09:15 AP/CS
1200-1400			
1600-1800			
2200-2400			
Other time			

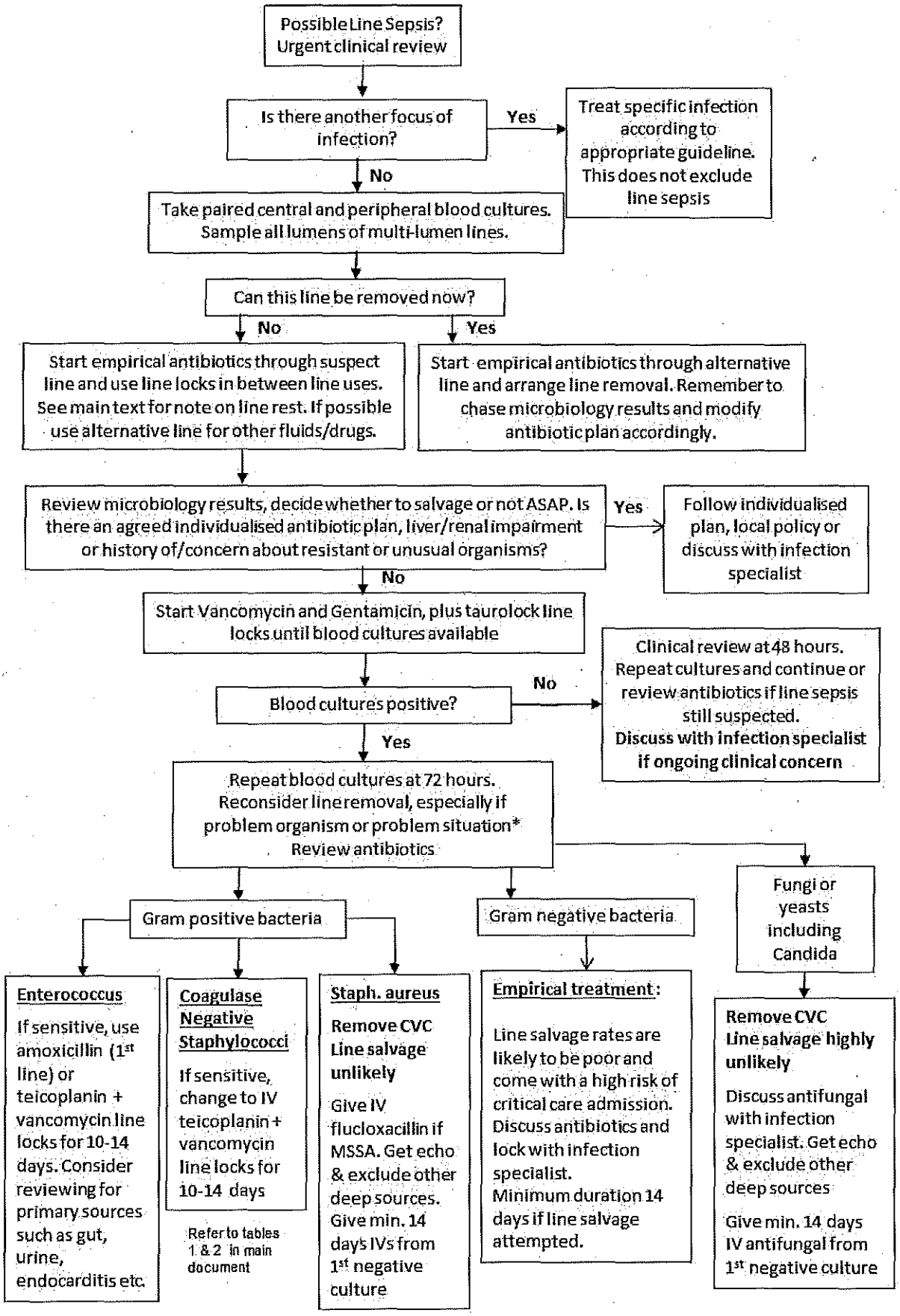
When salvaging a line, it is ideal to reserve the line purely for antimicrobial therapy (locks and systemic antibiotics) for the duration of salvage treatment. Peripheral access should be cited for any other IV therapies.

For multilumen lines where peripheral access is not available and the patient requires IV therapy of any description in addition to IV antibiotics, it may be necessary to lock different lumens on rotation.

For single lumen lines where peripheral access is not available, the lumen must be locked with antibiotic solution when not in use. Prior to using the line, the lock should be removed and discarded, and the line flushed. After using the line, fresh lock should be instilled until the next use, or 24 hours, whichever is first.

Lumens that are locked should be clearly labelled.

Flowchart



Problem situations and organisms

Line removal is strongly recommended in specific problem situations or in infections with problem organisms (Tables 1 and 2). If line removal is not deemed possible or is deemed unsafe, discuss with an infection specialist for individualised advice as a prolonged course of targeted antibiotic therapy along with specific line locks may be required. Unstable patients should be discussed early with an intensive care specialist.

Table 1: Problem Situations where line removal strongly recommended
Severe sepsis
Haemodynamic instability
Infectious Endocarditis or evidence of metastatic complications
Erythema or exudate due to suppurative thrombophlebitis
Persistent bacteraemia after 72 hours of antimicrobial therapy to which an organism is susceptible
Evidence of tunnel infection
Evidence of insertion site infection or severe exit site infection

Table 2: Problem organisms
<u>Highly virulent organisms:</u> • Fungi • *Staphylococcus aureus* or *lugdunensis* • *Pseudomonas aeruginosa*
<u>Organisms that may be less virulent but can be difficult to eradicate:</u> • Mycobacterium species • Bacillus species • Propionibacterium/Cutibacterium species • Micrococcus species

Environmental and multidrug resistant organisms:

- Multidrug resistant Gram-negative organisms
- Pseudomonas species
- Stenotrophomonas species
- Chryseomonas species
- Chryseobacterium species
- Acinetobacter species
- Elizabethkingia species
- Cupriavidus species
- Vancomycin or linezolid resistant Enterococci and other resistant Gram-positive organisms

References

Up to Date: Intravascular catheter-related infection: treatment (https://www.uptodate.com/contents/intravascular-catheter-related-infection-treatment?search=line%20sepsis&source=search_result&selectedTitle=1~93&usage_type=default&display_rank=1#H1778902482).

Mermel *et al.* Clinical practice guidelines for the diagnosis and management of intravascular catheter-related infection: 2009 update (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4039170/) by the Infectious Diseases Society of America. Clin Infec Dis 2009 49 (1): 1-45

Editorial Information

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Approved By: **Antibiotic Users Committee**

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Anti-Fungal Policy

1. INTRODUCTION

Invasive fungal infections (IFI) are an important cause of morbidity and mortality in patients with haematological malignancies, in particular those with prolonged and severe neutropenia. Treatment of invasive fungal infection with antifungal medicines is complicated in haemato-oncology patients due to the need for other potentially nephrotoxic or hepatotoxic medicines e.g. aminoglycosides, ciclosporin, tacrolimus and concomitant or potential nephrotoxic/hepatotoxic chemotherapy regimens.

2. RELATED DOCUMENTATION

2.1 IV/Oral drug kardexes

2.2 Drugs used in Haemopoietic Stem Cell Transplantation (CLIN-006)

3. AUTHORISED PERSONNEL/SPECIFIC STAFF COMPETENCIES

3.1 The diagnosis and management of fungal disease will be directed by the HSCT Clinical Team.

3.2 The Medical/Nursing team will be responsible for monitoring & investigation.

4. EQUIPMENT/MATERIALS

4.1 Blood culture bottles
4.2 Bacteriology swabs
4.3 Universal container
4.4 Stool sample container

5. PROCEDURE

5.1 High Risk Group:

Patients with the following risk factors are at high risk of developing IFI:

- Acute leukaemia
- Neutrophil count of <0.5 x 10^9/L for more than 2 weeks
- Patients receiving high dose steroids
- Recipients of allogeneic haematopoietic stem cell transplants
- GvHD
- Treatment with Fludarabine
- Treatment with Campath or ATG

- Previous fungal infection
- Fluconazole resistant colonisation
- Colonisation of more than one site plus neutropenia (neutrophils <1.0 x 10^9/L)
- Autograft where conditioning includes Total body irradiation

5.2 Diagnosis:

It is important that patients are regularly assessed for clinical features of IFI i.e:

- Daily physical examination
- Early radiological imaging following persistent pyrexia for more than 72-96 hours i.e. preferably before, but definitely within 48-72 hours of commencing antifungal therapy.
- In the first instance ultrasound of the liver and spleen. Consider early CT scanning of chest/sinuses if high clinical suspicion.

EORTC (European Organization for Research and Treatment of Cancer) criteria are helpful in determining the likelihood of proven/probable IFI

5.3 Monitoring of Renal Function:

Many antifungal medicines are nephrotoxic or hepatotoxic. Monitor serum creatinine daily and LFTs regularly during treatment.

5.4 Prophylaxis:

All haemopoietic stem cell transplant (HSCT) patients are commenced on IV Ambisome on the day of admission. It is prescribed on Mondays, Wednesdays and Fridays (dose: 2mg/kg/day). Selected oncology and haemato-oncology patients should also receive antifungal prophylaxis. In particular, children with relapsed acute lymphoblastic leukaemia (ALL), children undergoing induction therapy for acute lymphoblastic leukaemia and children receiving chemotherapy for acute myeloid leukaemia (AML) or lymphoma. Children with solid organ cancers should receive antifungal prophylaxis as recommended by individual protocols.

When engraftment is established and there are no signs of IFI Ambisome will be substituted with an oral azole, usually posaconazole. Anti-fungal prophylaxis should be discussed with senior members of the HSCT clinical team before being started. For doses see CLIN-006 SOP.

If not tolerating oral medicines or high risk for IFI:

- Ambisome 1mg/kg/day or 2mg/kg/day on Mondays, Wednesdays and Fridays.

If documented allergy to Ambisome:

- Caspofungin 50mg/m^2 on alternate days

5.5 Empirical/Possible IFI Therapy:

Patients eligible for **empirical therapy** should either:

- be in a high risk group with a pyrexia unresponsive to broad spectrum antibiotics for more than 96 hours

  or

- fulfill the **EORTC Criteria for Possible IFI** - 1 host factor and 1 clinical factor as per EORTC risk factor table (Appendix 1) for invasive fungal infection.

  Ambisome 3mg/kg/day (doses can be increased to 10mg/kg/day) in proven infections.

  If allergic to Ambisome or impaired renal function:

  Caspofungin: 70mg/m2 on D1, then 50mg/m2 once daily

5.6 Proven/Probable IFI Therapy:

- fulfill the **EORTC Criteria for Probable IFI** - 1 host factor, 1 clinical factor and 1 mycological factor as per EORTC risk factor table (Appendix 1) for invasive fungal infection.

  Treatment drugs and doses as for empirical therapy (see section 5.5)

  N.B: For individuals with evidence of intracerebral infection intravenous voriconazole is the drug of choice due to excellent penetration of the blood brain barrier

  Voriconazole (by intravenous infusion):

  - **Child 2-12 yrs (and child 12-15 years if body weight under 50 kg):** 9mg/kg every 12 hours for 2 doses then 8mg/kg every 12 hours (reduced in steps of 1mg/kg if not tolerated; increased in steps of 1mg/kg if inadequate response) for maximum period of 6 months.
  - **Child 15- 18 years (body weight over 50kg):** 6mg/kg every 12 hours for 2 doses then 4mg/kg every 12 hours (reduced to 3mg/kg if not tolerated) for maximum period of 6 months.

5.7 Alternative Agents:

Posaconazole can be used to treat invasive aspergillosis which is unresponsive to Ambisome, or in patients intolerant to Ambisome, voriconazole or fluconazole (see YMBT-CLIN-0006 SOP for dosing and side-effects).

5.8 Additional Agents:

The addition of the following agents to antifungal therapy can be considered depending on the patients' clinical condition**.**

G-CSF - Lenograstim 5mcg/kg equivalent dose, can be doubled to 10mcg/kg equivalent dose if required.

6. REFERENCES

6.1 **Prentice A, Glasmacher A, et al.** Guidelines on the management of invasive fungal infection during therapy for haematological malignancy (2007), *BCSH*

6.2 **Ben De Pauw, et al.** Revised Definitions of Invasive Fungal Disease from the European Organization for Research and Treatment of Cancer/Invasive Fungal Infections Cooperative Group and the National Institute of Allergy and Infectious Diseases Mycoses Study Group (EORTC/MSG) Consensus Group. *Clinical Infectious Diseases, Volume 46, Issue 12, 15 June 2008, Pages 1813–1821*

6.3 **J Peter Donnelly, et al.** Revision and Update of the Consensus Definitions of Invasive Fungal Disease from the European Organization for Research and Treatment of Cancer and the Mycoses Study Group Education and Research Consortium. *Clinical Infectious Diseases*, Volume 71, Issue 6, 15 September 2020, Pages 1367–1376

6.4 BNF for Children (2013-2014)

7. AUDIT AND REVIEW PROCESS

This SOP will be reviewed every two years.

8. FURTHER INFORMATION/EXCEPTIONS

For further information contact:

Haemopoietic Stem Cell Transplant Team on-call Consultant (via switchboard)

9. APPENDICES

Appendix 1: EORTC risk criteria for invasive fungal infection (adapted from J Peter Donnelly, et al, 2020.)

Appendix 1: EORTC risk criteria for invasive fungal infection (adapted from J Peter Donnelly, et al, 2020.)

Invasive Pulmonary Mold Disease	Invasive Pulmonary Mold Disease
Host factors	**Mycological evidence**
Recent history of neutropenia (<0.5 × 109 neutrophils/L [<500 neutrophils/mm3] for >10 days) temporally related to the onset of invasive fungal disease	Any mold, for example, Aspergillus, Fusarium, Scedosporium species or Mucorales recovered by culture from sputum, BAL, bronchial brush, or aspirate
Hematologic malignancy	Microscopical detection of fungal elements in sputum, BAL, bronchial brush, or aspirate indicating a mold
Receipt of an allogeneic stem cell transplant	Tracheobronchitis
Receipt of a solid organ transplant	Aspergillus recovered by culture of BAL or bronchial brush
Prolonged use of corticosteroids (excluding among patients with allergic bronchopulmonary aspergillosis) at a therapeutic dose of ≥0.3 mg/kg corticosteroids for ≥3 weeks in the past 60 days	Microscopic detection of fungal elements in BAL or bronchial brush indicating a mold
Treatment with other recognized T-cell immunosuppressants, such as calcineurin inhibitors, tumor necrosis factor-a blockers, lymphocyte-specific monoclonal antibodies, immunosuppressive nucleoside analogues during the past 90 days	Sino-nasal diseases
Treatment with recognized B-cell immunosuppressants, such as Bruton's tyrosine kinase inhibitors, eg, ibrutinib	Mold recovered by culture of sinus aspirate samples
Inherited severe immunodeficiency (such as chronic granulomatous disease, STAT 3 deficiency, or severe combined immunodeficiency)	Microscopic detection of fungal elements in sinus aspirate samples indicating a mold
Acute graft-versus-host disease grade III or IV involving the gut, lungs, or liver that is refractory to first-line treatment with steroids	Aspergillosis only
Clinical features	Galactomannan antigen
Pulmonary aspergillosis	Antigen detected in plasma, serum, BAL, or CSF
The presence of 1 of the following 4 patterns on CT:	Any 1 of the following:
Dense, well-circumscribed lesions(s) with or without a halo sign	Single serum or plasma: ≥1.0
Air crescent sign	BAL fluid: ≥1.0
Cavity	Single serum or plasma: ≥0.7 and BAL fluid ≥0.8
Wedge-shaped and segmental or lobar consolidation	CSF: ≥1.0
Other pulmonary mold diseases	Aspergillus PCR
As for pulmonary aspergillosis but also including a reverse halo sign	Any 1 of the following:
Tracheobronchitis	Plasma, serum, or whole blood 2 or more consecutive PCR tests positive
Tracheobronchial ulceration, nodule, pseudomembrane, plaque, or eschar seen on bronchoscopic analysis	BAL fluid 2 or more duplicate PCR tests positive
Sino-nasal diseases	At least 1 PCR test positive in plasma, serum, or whole blood and 1 PCR test positive in BAL fluid
Acute localized pain (including pain radiating to the eye)	Aspergillus species recovered by culture from sputum, BAL, bronchial brush, or aspirate
Nasal ulcer with black eschar	
Extension from the paranasal sinus across bony barriers, including into the orbit	
Central nervous system infection	
1 of the following 2 signs:	
Focal lesions on imaging	
Meningeal enhancement on magnetic resonance imaging or CT	

Schiehallion Haemato-oncology Unit (Ward 2A / 2B)
Royal Hospital for Children, Glasgow

NHS Greater Glasgow and Clyde

Candidiasis	Cryptococcus
Host factors	**Host factors**
Recent history of neutropenia <0.5 × 109 neutrophils/L (<500 neutrophils/mm3 for >10 days) temporally related to the onset of invasive fungal disease	Human immunodeficiency virus infection
Hematologic malignancy	Solid organ or stem cell transplant recipient
Receipt of an allogeneic stem cell transplant	Hematologic malignancy
Solid organ transplant recipient	Antibody deficiency (eg, common variable immunoglobulin deficiency)
Prolonged use of corticosteroids (excluding among patients with allergic bronchopulmonary aspergillosis) at a therapeutic dose of ≥0.3 mg/kg corticosteroids for ≥3 weeks in the past 60 days	Immunosuppressive therapy (including monoclonal antibodies)
Treatment with other recognized T-cell immunosuppressants, such as calcineurin inhibitors, tumor necrosis factor-a blockers, lymphocyte-specific monoclonal antibodies, immunosuppressive nucleoside analogues during the past 90 days	End-stage liver or renal disease
Inherited severe immunodeficiency (such as chronic granulomatous disease, STAT 3 deficiency, CARD9 deficiency, STAT-1 gain of function, or severe combined immunodeficiency)	Idiopathic CD4 lymphocytopenia
Acute graft-versus-host disease grade III or IV involving the gut, lungs, or liver that is refractory to first-line treatment with steroids	
Clinical features	**Clinical features**
At least 1 of the following 2 entities after an episode of candidemia within the previous 2 weeks:	Meningeal inflammation
Small, target-like abscesses in liver or spleen (bull's-eye lesions) or in the brain, or, meningeal enhancement	Radiological lesion consistent with cryptococcal disease
Progressive retinal exudates or vitreal opacities on ophthalmologic examination	
Mycological evidence	**Mycological evidence**
ß-D-glucan (Fungitell) ≥80 ng/L (pg/mL) detected in at least 2 consecutive serum samples provided that other etiologies have been excluded	Recovery of Cryptococcus from a specimen obtained from any nonsterile site
Positive T2Candidaa	

Haematology and Oncology Unit
Royal Hospital for Children, Glasgow

Management of Neutropenia & Fever - Antibiotic Policy

1. INTRODUCTION

Neutropenia is defined as a neutrophil count of <1 x 10^9/L and patients who are neutropenic are vulnerable to overwhelming infection. The frequency and severity of infective episodes correlates with the degree and duration of neutropenia and is particularly marked in children whose neutrophil count is below 0.5 x 10^9/l.

2. RELATED DOCUMENTATION

This policy should be read in conjunction with:

- The assessment, diagnosis and management of Neutropenic Sepsis, Best Practice Statement, publication date: September 2011 (see Point 6 – References).
- Guidelines for the management of paediatric line-related sepsis available via the Clinical Guidelines site - https://www.clinicalguidelines.scot.nhs.uk/nhsggc-paediatric-clinical-guidelines/nhsggc-guidelines/infectious-disease/guidelines-for-the-management-of-paediatric-line-related-sepsis/

3. AUTHORISED PERSONNEL / SPECIFIC STAFF COMPETENCIES

3.1 The diagnosis and management of febrile neutropenia will be directed by the Consultant/Associate Specialist or a senior member of the medical team.

3.2 The Medical/Nursing team will be responsible for admitting, assessing, investigating and administrating treatment, and monitoring response.

4. EQUIPMENT / MATERIALS

None.

5. PROCEDURE

5.1 FEBRILE NEUTROPENIA

CRITERIA FOR TREATMENT

- Any child with a single temperature of 38°C or above should receive intravenous antibiotics (in line with the national policy).
- Paracetamol should not be given until the decision to treat has been taken because it may mask a fever. Particular care should be exercised with HSCT patients who are neutropenic.

- Any child who deteriorates, looks unwell or rigors regardless of his/her temperature and neutrophil count should receive intravenous antibiotics. Fever may be suppressed by steroids, particularly Dexamethasone, and these children may become septic and deteriorate rapidly without exhibiting fever.
- A well child who is not neutropenic with an obvious focus of infection can receive treatment appropriate for that infection e.g. otitis media. Err on the side of caution and if in doubt **admit the child and give IV antibiotics.** Be particularly careful with possible/probable line-related infections because, although lines are most often colonised with coagulase negative staphylococci, they can be colonised with gram-negative organisms, and can result in gram-negative septicaemia and septic shock.
- It is always better to over rather than under treat these patients. **These children can deteriorate rapidly.**

IN A NEUTROPENIC PATIENT, THE OCCURRENCE OF FEVER MUST BE REGARDED AS AN EMERGENCY

- **The initial nursing assessment of the patient must happen within 15 minutes of the patient's arrival. Medical assessment and administration of antibiotics must happen within 60 minutes from the patient's arrival.**
- An **'ill'** child must be assessed immediately even in the absence of a fever. **A DELAY IN ADMINISTERING THE FIRST DOSE OF ANTIBIOTICS MAY PROVE FATAL** – and antibiotic administration must not be delayed for any reason (including shift changes, ward rounds, radiological examination, problems with venous access). **Blood cultures should be taken before giving the first dose of antibiotics.**

!!!! The first dose of antibiotics can precipitate septic shock

!!!!! Be prepared to resuscitate the patient

- Patients who are unwell or hypotensive should immediately receive resuscitation fluids and IV antibiotics, even if they are not pyrexial. Remember steroids can mask an inflammatory response.
- If a patient deteriorates after using/flushing his/her central line consideration should be given to siting a peripheral cannula and stopping using the line.
- All haematology/oncology patients admitted overnight who are ill, must be seen by the most experienced middle grade doctor on for hospital cover who should discuss the patient causing concern with the consultant haematologist/oncologist on-call.

HISTORY AND EXAMINATION

- **Keep the history brief**. The following will help predict the likely degree and duration of neutropenia and identify a potential focus that might guide antibiotic therapy. Note:
  - The diagnosis
  - The date and type of the last chemotherapy given
  - Any recent blood counts
  - The duration of fever
  - The presence of a central line (NB line associated sepsis)
  - The presence of bleeding
  - Any muscle, joint or abdominal pain
  - The presence of mucositis
  - Any local cause for fever
- **Examination: Ask yourself:**
  - Does the child require resuscitation?
  - Is the child septicaemic or shocked?
  - What is the temperature, HR, RR, BP, oxygen saturation and Capillary Refill Time (CRT)
  - Is there an obvious focus for infection?

INVESTIGATIONS

- Blood cultures (take a large volume)
- FBC and differential
- CRP
- U&Es
- LFTs and Coagulation screen: PT, APTT, Fibrinogen +/- d-dimers if unwell – every child does not require a coagulation screen
- Consider a CXR if respiratory signs or symptoms (this must not delay therapy)
- If upper respiratory symptoms are present, consider NPA

TREATMENT

- Resuscitate the child
- Give antibiotics
- Give blood products as indicated

MICROBIOLOGICAL CULTURES

Blood Cultures:

- Blood cultures should be taken from the central line, or where there is no central line, from a peripheral stab.
- The volume required is **5 - 10 mls** or a **minimum of 3-5 mls** from an infant. In the case of a double lumen long line, or two separate central lines, blood cultures should be taken **from each lumen**.

- Blood cultures should be repeated in the event of:
  - Clinical deterioration
  - Rigors
  - Persistent pyrexia after 24 and 48 hours and thereafter 48-72 hourly if the patient remains pyrexial
  - Prior to any antibiotic change
  - Recurrence of fever after period of apyrexia
- If blood cultures are initially positive, repeat cultures should be taken after 48 hrs to confirm the organism has been eradicated (in vitro sensitivities do not always correlate with in vivo sensitivity).
- In the case of a central line infection, which is often due to bacterial growth in a biofilm, it is advisable to repeat line cultures after stopping antibiotics to check that the organism has been eradicated.

Additional investigations should be performed:

- Swab of central line exit site(s)
- Consider:
  - Viral serology or culture / PCR if symptoms are suggestive of viral infection
  - Nose swab
  - Throat swab
  - Sputum culture
  - Urine culture
  - Stool culture
  - Swabs of any lesion or potential focus
- A chest X-ray may be indicated. Remember that in pneumocystits carinii pneumonia the chest may be clear to auscultation when there is hypoxia and marked radiological change.

5.2 Antibiotic Protocol for Neutropenic Patients

Antibiotic doses in this SOP are appropriate for empirical treatment or sensitive organisms only. For any organism categorised as 'I' (Susceptible – increased exposure), seek further advice on appropriate dose selection'.

First Line Therapy

- First line therapy in neutropenic patients is with Tazocin and Gentamicin in the absence of positive blood cultures which would indicate alternative antibiotics. Tazocin is a penicillin based antibiotic and penicillin allergy should be excluded. Patients known to be colonised with ESBL producing organisms should receive Meropenem instead of Tazocin (dosing schedule given under second line therapy).

Dosing regimen: **Tazocin (90mg/kg/dose 4 times a day) plus Gentamicin (7mg/kg/once daily)**

- Prescribe Tazocin according to pharmacy dose banding chart.
- Gentamicin requires caution in patients at risk of renal impairment. However, it is extremely unlikely that one single dose of gentamicin will do harm and a single dose should be given and levels measured before any subsequent doses.
- Please prescribe Tazocin according to pharmacy dose banding chart, which is available on ward 2a, 2b, A&E and CDU.
- Tazocin, as a single agent, is first line therapy for patients who are known not to be neutropenic or who are expected not to be neutropenic and considered at low risk for developing severe sepsis.
- Patients initially started on both Tazocin and Gentamicin can stop gentamicin if subsequently shown not to be neutropenic, if neither septic or shocked.

NB: Piperacillin increases the risk of toxicity when given with Methotrexate. For any patient imminently due IV Methotrexate or who is post Methotrexate and has not cleared to acceptable levels, prescribe Meropenem as first line empirical therapy.

- **Antibiotic cover for line-related infection:** Teicoplanin should be added to the initial therapy only if there is a proven or a very high suspicion of central line infection. Teicoplanin is preferable to vancomycin for patients receiving other nephrotoxic drugs and most haemato/oncology patients are on other nephrotoxic drugs. Factors suggesting line infection include:
  - Local Sepsis: Erythema at exit site or skin tunnel; pain over tunnel or on moving that arm/shoulder
  - Previously documented catheter related sepsis involving the current central venous line
  - Rigor or fever after flushing line (within 4 hours)
  - Blood culture positive for an organism associated with the related infection

  Vancomycin, rather than Teicoplanin should only be used in patients suspected to have a line related infection and who are scepticaemic.

<u>SECOND LINE THERAPY</u>

- Patients who remain pyrexial after 72 hours of empirical therapy should change to second line therapy. Second line therapy is with Meropenem and with or without Gentamicin.

  Dosing regimen: Meropenem (20mg/kg/dose three times a day) plus /minus Gentamicin (7mg/kg/once daily)

- Patients who remain pyrexial at 5 days and who are or have been persistently neutropenic with no evidence of line related infection should have **Ambisome** added. This should be discussed with the consultant responsible for the care of the patient.

<u>PENICILLIN ALLERGY</u>

- Serious allergy is one that causes an anaphylactic or urticarial reaction. 10% of patients with reactions to penicillin-based antibiotics will also have a reaction with cephalosporins.

- Patients who have had an allergic reaction classified as serious should receive **Ciprofloxacin & Vancomycin.**
- If ciprofloxacin has been given as prophylaxis, please discuss treatment with Consultant Microbiologist on call.

DURATION OF ANTIBIOTIC TREATMENT

This depends on the degree and duration of neutropenia and the organism cultured, but as a general rule:

- Patients who are blood culture negative; stop antibiotics after 48 hours of apyrexia if the patient is well and if the blood cultures are negative.
- Patients who are culture positive: this depends on the organism and the degree and duration of neutropenia. The child should be well and apyrexial and have a minimum of 7 days treatment including 48 hours of apyrexia. Preferably repeat blood cultures should be documented to have no growth. Discuss the duration of antibiotics with the microbiology consultant.
- Gentamicin should not be given for more than 7 days. If the child needs additional gram negative non-aminoglycoside antimicrobial cover, discuss with the microbiologist.

5.3. NON-NEUTROPENIC FEVER

- First line therapy for patients who are known not to be neutropenic or expected not to be neutropenic, and considered low risk for developing severe sepsis, should be single agent at Tazocin.
- Patients started on both Tazocin and Gentamicin should stop gentamicin if subsequently found not to be neutropenic, if neither septic nor shocked.

5.4. ANTIBIOTIC DOSES

For children aged 1-18 years:

TAZOCIN

- 90 mg/kg (max 4.5g) four times a day
- Vial size 2.25g, 4.5g
- Give by IV bolus over 3-5 mins
- Renal Impairment:
  - Dose adjustments required for GFR 50ml/min or less. Refer to Renal Drug Database

GENTAMICIN

- Gentamicin dosing in patients with normal renal function:
  - Gentamicin 7mg/kg/once daily (max 500mg/dose)
  - Give by IV infusion in 50 – 100ml Sodium Chloride 0.9% over 60 minutes
  - Prescribe dose for all patients at 12noon each day

- Measure level after 1st dose

  Trough: Plasma samples at 18-24 hrs post-dose (i.e. with morning bloods)
  Expected level <1mg/L

  NB in many patients the reported level will be <0.1mg/L, which is acceptable
- If trough level is >1mg/L, the dosing interval is normally increased by 12 hours. Please discuss further dosing with pharmacy/microbiology
- If trough level >2mg/L, patient is unsuitable for pulsed dosing regimen, and subsequent doses should be guided by levels
- If there is no change in dosage regimen or renal function, repeat trough levels every 4 days only

- Renal Impairment:
  - Use with caution. Dose reduction required for GFR 70ml/min or less
  - Initial dose - Gentamicin 5mg/kg
  - Trough levels as above
  - Prescribe as a single dose and consult pharmacy/microbiology for further dosage advice
- Managing patients admitted out of hours:
  - Patients admitted in the afternoon until 12 midnight:
    - Give 7mg/kg dose on admission
    - Trough samples with morning bloods
    - Prescribe at 12 noon the following day
  - Patients admitted between 12 midnight and 6am:
    - Give 7mg/kg dose on admission
    - Arrange with microbiology for emergency levels to be done at 12 noon that day
    - If trough level is reported at <2.5mg/L, give second dose as close as possible to midday
    - If trough level is >2.5mg/L, consult pharmacy/microbiology for further dosage advice
  - Patients admitted between 6am and 12noon:
    - Give 7mg/kg dose on admission
    - Trough levels the following day with morning bloods
    - Prescribe dose on following and subsequent days 2 hours later, until dosing time of 12 noon is achieved

NB: Do not forget to indicate on the microbiology request form the actual time the sample was taken – levels taken outwith the recommended times can still be interpreted, if an accurate sampling time is recorded.

CIPROFLOXACIN

- Ciprofloxacin may be used in children where the benefit is considered to outweigh any potential risk.
- **NB: Committee on Safety of Medicines (CSM) warning: Quinolone antibiotics may lower seizure threshold & may induce convulsions in patients with or without previous history.**
- Tendon damage is a rare side effect of quinolone antibiotics: if tendinitis is suspected, discontinue immediately.
- Dosing regimen for prophylaxis against gram negative organisms in patients undergoing HSCT is 10mg/kg bd (max 750mg/dose) (see below for maximum dosing). Children with Downs syndrome and ALL, and infants with ALL, also receive ciprofloxacin prophylaxis.
- Dosing regimen for treatment:
  - Intravenous: 1month – 18 years 10mg/kg three times a day (maximum dose of 400mg)
  - Oral: 20mg/kg bd (max 750mg/dose)
- Available preparations:
  - Tablets: 100mg, 250mg, 500mg, 750mg tablets;
  - Oral Suspension: 250mg/5ml
  - Premixed solution for IV infusion: 2mg/ml (50ml & 100ml bags available)
- Oral absorption is good but do not use with oral Mg, Ca, or Fe supplements as these affect absorption.
- Infuse undiluted IV over 30-60 minutes - flush with Sodium Chloride 0.9%.
- Renal Impairment:
  - Dose adjustments required for GFR 30ml/min or less. Refer to Renal Drug Database

VANCOMYCIN

- Dosing regimen: 15mg/kg three times daily. **(NB: To achieve optimal plasma profile it is vital to ensure doses are administered as close to an eight hour interval as possible).**
- Infuse over 1-2 hours in Sodium Chloride 0.9%.
- Measure trough level before the 3rd dose is given.
- Target trough: 15-20mg/L.
- Renal Impairment:
  - Use with caution. Dose reduction required for GFR 50ml/min or less

TEICOPLANIN

- 10mg/kg (max 400mg) every 12 hours for 3 doses then 10mg/kg (max 400mg) daily.
- Administration: Slow IV bolus or infusion over 30 mins diluted in Sodium Chloride.
- Renal impairment:
  - Dose adjustments required for GFR 80ml/min or less. Refer to Renal Drug Database
  - No monitoring required

AMBISOME

- Dosing regimen: dependent on clinical situation.
- 3 mg/kg/day with proven or highly suspicious fungal infection (doses of up to 5 mg/kg/day have been used for proven infections).
- 2mg/kg (M/W/F) anti-fungal prophylaxis in stem cell transplant patients and 1mg/kg (M/W/F) in other high-risk patients.
- Infuse in Glucose 5% ONLY at a concentration of 0.2-2.0 mg/ml. If dose ≥5mg/kg infuse over 2 hours otherwise 1 hour.
- Renal impairment:
  - No dose adjustments regardless of degree of renal impairment. Due to the size of AmBisome liposomes, there is no renal elimination

MEROPENEM

- Dosing regimen: 20 mg/kg three times a day (max 1g/dose).Can increase to 40 mg/kg in severe infections (max 2g/dose).
- Give as IV bolus over 5 minutes or infuse over 15-30 minutes (dilute 1g in at least 50 ml Sodium Chloride 0.9% or Glucose 5%).
- Renal impairment:
  - Dose adjustments required for GFR 50ml/min or less. Refer to Renal Drug Database

5.5. OPPORTUNISTIC CHEST INFECTIONS

GENERAL

- There are a variety of opportunistic lung infections that can occur in long-term immunosuppressed children that must be considered in a child with respiratory symptoms.
- Note the respiratory rate, any signs of respiratory distress and check pulse oximetry.
- Give supplemental oxygen therapy if required and arrange blood gases.

- Ask for ITU consult if the patient's condition, respiratory rate or oxygen requirements suggest that artificial ventilation may be necessary.
- Discuss these patients with the consultant on call for haematology/oncology.

MYCOPLASMA PNEUMONIAE

- This may present with a multitude of symptoms.
- The disease tends to have a prodrome (fevers, chills, headaches) and the cough may persist for several weeks.
- The chest x-ray may show diffuse patchy consolidation and the MCV may be raised due to cold agglutinins.
- Treatment is with IV **Clarithromycin** 7.5mg/kg per dose twice a day (max 500mg/dose). Consider using **Azithromycin** if patient is able to tolerate **oral** medications at following doses:

  Dose: over 6 months 10mg/kg once daily (max 500mg) for 3 days

Or	15-25kg	200mg once daily for 3 days
	26-35kg	300mg once daily for 3 days
	36-45kg	400mg once daily for 3 days
	>45kg	500mg once daily for 3 days

PNEUMOCYSTITS CARINII

- Signs of infection include tachypnoea, dry cough, dyspnoea on exertion and cyanosis. The chest is often clear on auscultation.
- Check pulse oximetry and blood gases as oxygen desaturation often precedes x-ray changes. CXR may show bilateral infiltrates, but can be similar to viral infection or fluid overload.
- Although pneumocystis is less common with the use of prophylactic Co-Trimoxazole, it still occurs. Exercise a high level of suspicion in children using alternatives to Co-Trimoxazole as PCP prophylaxis or in those with suspected poor compliance.
- Treatment is with **high dose intravenous Co-Trimoxazole 60mg/kg per dose twice a day.**
  - Give by IV infusion over 20-60 minutes. Dilute each 480mg ampoule in 75mls 5% Glucose.
  - In severe fluid restriction, Co-trimoxazole may be given undiluted via a central line only and over at least 60 minutes.
  - Consider the need for concomitant steroids, discuss with on call consultant.

NOTE: Adenovirus, Paraflu and RSV can be fatal in stem cell transplant patients. Any transplant patient who develops respiratory symptoms or distress should be discussed with the HSCT consultant.

- Renal impairment:
  - Dose adjustments required for GFR 30ml/min or less. Refer to Renal Drug Database

5.6. Supportive Care/Miscellaneous

Central Lines

- Central lines can be a source of infections with gram-negative and gram-positive organisms in neutropenic and non-neutropenic patients.
- If a patient becomes pyrexial or deteriorates after flushing or sampling a central line **add Teicoplanin**. Consider stopping using the line and inserting a cannula for antibiotics.

Antipyrexial Treatment

- Once cultures have been taken and antibiotics started it is acceptable to treat the fever with Paracetamol.
- **Do not** give **non-steroidal anti-inflammatories such as ibuprofen**. Non-steroidals are contraindicated because of their effect on platelet function.

Chemotherapy

Withhold oral chemotherapy for Acute Leukaemia patients. Refer to individual treatment protocol /guidelines for other haemato/oncology patients to establish if chemotherapy should be stopped temporarily in the neutropenic patient. **Note:** In certain protocols, chemotherapy is continued even in the presence of neutropenic fever. Discuss with consultant.

Examination

The child should be examined daily for signs of infection including sites such as the mouth, axillae, ears, perineum and central catheter site.

Constipation

- Must be avoided if possible. As well as causing distress, it may precipitate septicaemia through mucosal damage.
- Enemas, suppositories, rectal temperatures and rectal examinations should be avoided in neutropenic patients for the same reason. Ask about bowel function daily and consider laxatives as necessary.

Co-trimoxazole as PCP Prophylaxis

Continue prophylaxis co-trimoxazole whilst other antibiotics are being given unless the patient is receiving high dose co-trimoxazole intravenously or consultant thinks that co-trimoxazole should be temporarily discontinued to allow count recovery. Prophylaxis need not be given intravenously but can be temporarily withheld in patients who are nil by mouth.

MOUTH ULCERS

- All patients are advised on mouthcare.
- Swab for virology (herpes simplex) and bacteriology.
- Consider Aciclovir.

Aciclovir dosing:

Herpes Simplex:	Oral:	1-23months: 100-200mg x 5/day for 5 days
		2-17 years: 200-400mg x 5/day for 5 days (Use the higher dose in immunocompromised patients)
Varicella/Herpes zoster:	Oral:	1-23 months: 200mg x4/day for 5 days
		2-5yrs: 400mg x4/day for 5 days
		6-11yrs: 800mg x4/day for 5 days
		12-17yrs: 800mg x5/day for 5 days
	IV:	3mo – 12 years: 250-500mg/m^2 three times daily.
		12-18 years: 5-10mg/kg three times daily

  - **NB: Adequate hydration (normal maintenance, as per age and weight of the child) MUST be maintained during IV Aciclovir treatment. Monitor renal functions and fluid balance daily**

- Renal impairment:
  - IV - Dose adjustments required for GFR 50ml/min or less. Refer to Renal Drug Database
  - Oral-Dose adjustments required for GFR 25
  - ml/min or less. Refer to Renal Drug Database

DIARRHOEA

- Send stools for viruses, parasites, cryptosporidium and Clostridium difficile toxin.
- Metronidazole should be considered for mucositis or perianal infections

6. REFERENCES

6.1 Assessment, Diagnosis and Management of Neutropenic Sepsis - Best Practice Statement (publication date: September 2011) - www.gov.scot (put "neutropenic sepsis" into the search engine).

6.2 BNF – access via www.medicinescomplete.com

6.3 BNF for Children – access via www.medicinescomplete.com

6.4 www.renaldrugdatabase.com

7. AUDIT AND REVIEW PROCESS

This SOP will be reviewed in 24 months time.

8. FURTHER INFORMATION/EXCEPTIONS

None.

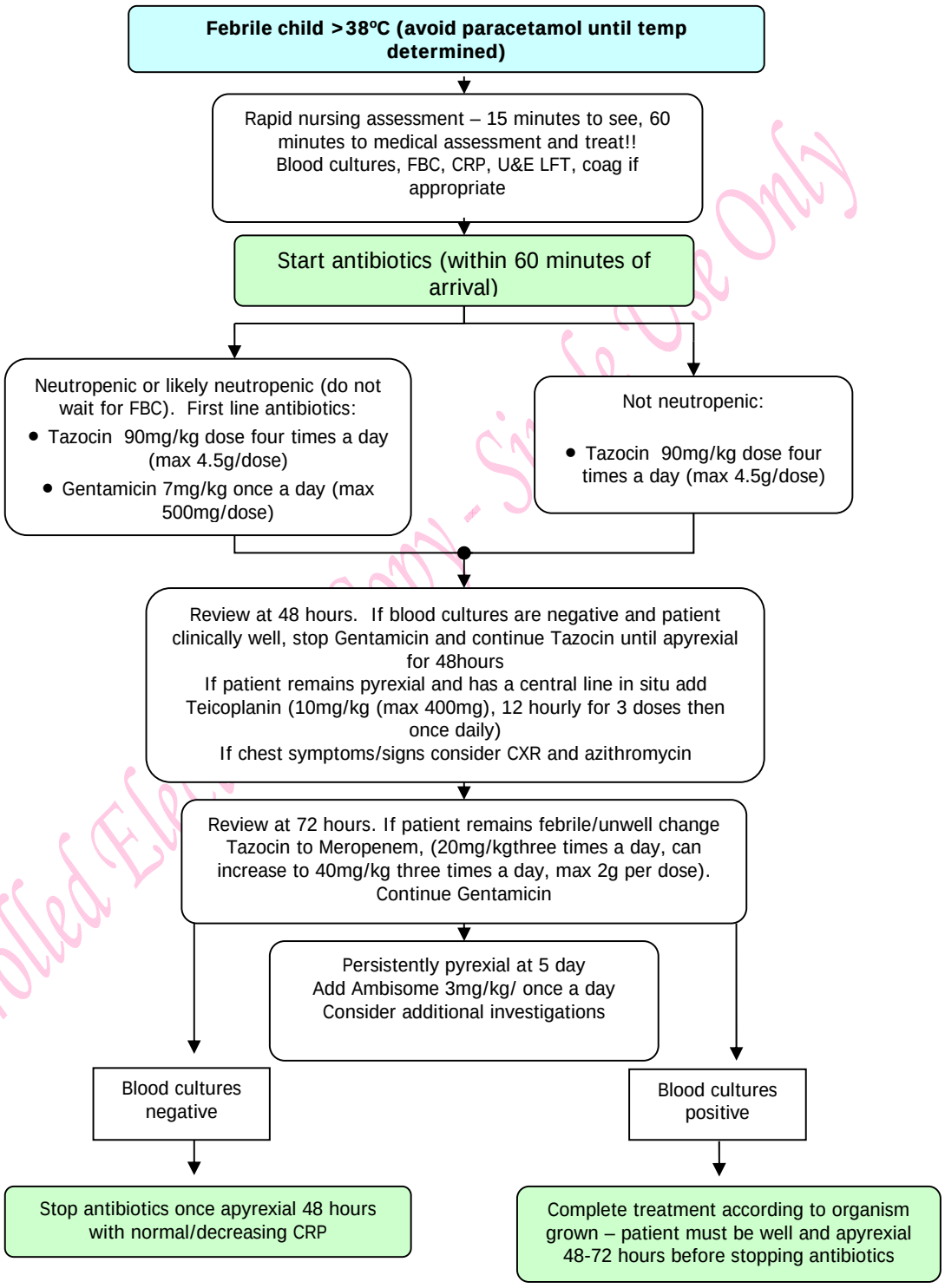
9. APPENDICES

Appendix 1: Criteria for Treatment

Haematology and Oncology Unit
Royal Hospital for Children, Glasgow

NHS Greater Glasgow and Clyde

Appendix 1: Criteria for Treatment



Schiehallion Haematology/Oncology Unit
Royal Hospital for Children, Glasgow

Prophylaxis against Gram Negative and Fungal Infections in Immunocompromised Babies, Children & Young People with a Central Venous Access Device (CVAD)

1. INTRODUCTION

Gram negative and fungal infections are a well-recognised cause of morbidity and mortality in immunocompromised babies, children and young people. Both fungi and Gram negative bacteria are recognised environmental organisms.

The campus of the Queen Elizabeth University Hospital and the Royal Hospital for Children, Glasgow have had documented, environmentally acquired, infections in immunocompromised patients.

Prophylaxing against environmental fungal infections is standard practice and there are well established criteria for this. The group considered previous local guidance on prophylaxis within paediatric haemato-oncology, the European Organisation for Research and Treatment of Cancer (EORTC) and Infectious Diseases Society of America (IDSA) guidance and the recent guidance from the Health Protection Surveillance centre in Ireland.

Prophylaxing against environmental Gram negative bacteria in children has a much smaller evidence base and there is no national or international consensus on whether or how this should be done. There is however published literature which shows the potential for using line locks to decrease the number of gram negative infections in children with cancer.

Standard technique in this document refers to turbulent push pause technique finishing with positive pressure.

2. RELATED DOCUMENTATION

2.1 GG&C Management of Line-related Sepsis in Adults and Children - Version 13

2.2 RHC-HAEM-ONC-011 - The Role of Phlebotomists

2.3 NHS GG&C Acute Division Intravenous Flush Policy 2015

2.4 Vascular Access Procedure and Practice Guideline 2019

3. AUTHORISED PERSONNEL/SPECIFIC STAFF COMPETENCIES

All medical staff, registered nurses, pharmacists, allied health professionals and phlebotomists need to be competent (appropriate to role) in the prescribing of, dispensing and administering prophylaxis.

4. EQUIPMENT/MATERIALS

4.1 TauroLock and TauroLock Hep 100 (Heparinised TauroLock 100iu/ml)
4.2 Sodium Chloride 0.9%
4.3 PPE
4.4 Syringes/Needles
4.5 Clinell wipes
4.6 Port Protector
4.7 Smartsites if require to be changed

5. PROCEDURE

5.1 GRAM NEGATIVE INFECTION PROPHYLAXIS:

General

All Central Venous Access Devices, Percutaneous Intravenous Catheters (PICs) Hickman Lines (Lines) and Port-a-Caths (Ports) should be locked as part of the Gram negative infection prophylaxis programme

Care and management of dialysis lines, ECMO, filter and exchange circuits are not covered in this SOP.

The maximum time permitted for a line lock to remain in situ is

ONE WEEK FOR HICKMAN LINES OR PIC LINES AND FOUR WEEKS FOR PORT – A -CATHS

Drug Storage

Two distinct TauroLock products will be kept as stock within the Haemato-oncology unit. Within the ward and day care areas, in order to minimise risk of incorrect drug selection, different storage conditions are in place for each product

- TauroLock (containing Taurolidine, Citrate 4%) 5ml ampoule
  For use in ***Hickman lines, PIC lines and Ports in regular use***
  Stored in clean utility areas and drug cupboards
- TauroLock Hep 100 (containing Taurolidine, Citrate 4%, Heparin 100iu/ml) 3ml ampoule
  For use in ***Ports only when removing the Gripper needle and locking the chamber(s)***
  Stored in ward controlled drug cupboard.

Other areas will demonstrate physically separate storage options for the two products and these locations will form a core part of the associated prophylaxis training package.

Prescribing

A current prescription is required for every patient receiving TauroLock or TauroLock Hep 100. Refer to Appendix 1 for appropriate lock volumes

During an inpatient admission, the appropriate product should be prescribed on an inpatient prescription chart.

When a patient is attending the day care unit, or outpatient department the appropriate prescription chart should be generated or the previous chart retrieved.

POONs attending patients at home who require a line flush and lock must retrieve the appropriate prescription chart before their home visit.

5.2 HICKMAN LINES OR PICS:

Inpatients

1. If the Hickman line or PIC will not be accessed for the duration of the inpatient stay, the following procedure should only be necessary to change line locks in situ prior to discharge from the ward if it has been in situ for the maximum permissible duration of 1 week.
2. Double lumen Hickman lines should have any lumen which is not being accessed locked as per procedure below. Both lumens must be locked prior to discharge.
3. Take a discard of 2.5-5ml from the CVAD to remove any previous lock solution, each time it is accessed.
4. Flush with 10 ml Sodium Chloride 0.9%, using standard technique, prior to line locking.
5. For Hickman lines or PICs which are being accessed intermittently (e.g. for blood samples, drug administration, fluids or chemotherapy), follow steps 3 and 4 above before and after each intervention as per standard procedure. The line should then be locked using ***TauroLock***, which will remain in situ until the lumen is next accessed.
6. Prior to discharge, ensure Hickman line or PIC is locked with ***TauroLock***, unless a different antibiotic lock has been requested by a consultant microbiologist.

Day Care Patients

1. If the Hickman line or PIC will not be accessed for the duration of the day care stay, check patient notes and Kardex to determine how long the current line lock has been in situ. The following procedure should only be necessary to change the line lock if the current lock has been in situ for the maximum permissible duration of 1 week.
2. Double lumen Hickman lines should have any lumen which is not being accessed locked as per procedure below. Both lumens must be locked prior to discharge.
3. Take a discard of 2.5-5ml from the CVAD to remove any previous lock solution, each time it is accessed.
4. Flush with 10 ml Sodium Chloride 0.9%, using standard technique, prior to line locking.
5. If the Hickman line or PIC is to be accessed on multiple occasions during the day care stay (e.g. for GFR estimations or PK studies), the line does NOT need to be locked every time it is accessed. The line should be flushed with 10ml Sodium Chloride 0.9% using standard technique following each intervention. The line should only be locked using ***TauroLock*** when the patient is ready to leave day care.

6. If the Hickman line or PIC is being accessed for blood samples which may subsequently lead to a requirement for further infusions or blood product support, the line should be locked with ***TauroLock*** pending results becoming available. If further intervention is required, follow steps 3 and 4 above before and after accessing the line. The line should then be locked with ***TauroLock*** when the patient is ready to leave day care
7. For Hickman lines or PICs which are being accessed intermittently (e.g. for drug administration, fluids or chemotherapy), follow steps 3 and 4 above before and after each intervention as per standard procedure. The line should then be locked using ***TauroLock*** which will remain in situ until the lumen is next accessed, and when the patient is ready to leave day care.
8. Prior to a patient leaving day care, ensure Hickman line or PIC is locked with ***TauroLock***, unless a different antibiotic lock has been requested by a consultant microbiologist.

Outpatient Clinic

1. If the Hickman line or PIC will not be accessed for the duration of the outpatient visit, check patient notes and Kardex to determine how long the current line lock has been in situ. The following procedure should only be necessary to change the line lock if the current lock has been in situ for the maximum permissible duration of 1 week.
2. Double lumen Hickman lines should have any lumen which is not being accessed locked as per procedure below. Both lumens must be locked prior to discharge.
3. Take a discard of 2.5-5ml from the CVAD to remove any previous lock solution, each time it is accessed.
4. Flush with 10 ml Sodium Chloride 0.9%, using standard technique, prior to line locking.
5. If the Hickman line or PIC is being accessed for blood samples which may subsequently lead to a requirement for further infusions or blood product support, the line should be locked with ***TauroLock*** pending results becoming available. If further intervention is required, the patients' care will transfer to the day care unit. Follow steps 3 and 4 above before and after accessing the line. The line should then be locked with ***TauroLock*** when the patient is ready to leave the day care unit.
6. For Hickman lines or PICs which are being accessed for chemotherapy, follow steps 3 and 4 above before and after drug administration as per standard procedure. The line should then be locked using ***TauroLock*** when the patient is ready to leave.

Home

1. Patients who are at home with Hickman lines or PICs in situ should have these flushed and re-locked once a week by a Paediatric Oncology Outreach Nurse. Double lumen Hickman lines should have both lumens locked.
2. POON must obtain the appropriate drug Kardex prior to each home visit
3. Take a discard of 2.5-5ml from the CVAD to remove any previous lock solution, each time it is accessed.

4. Flush with 10 ml Sodium Chloride 0.9%, using standard technique, prior to line locking.
5. The line should then be locked using ***TauroLock***.

5.3 PORT-A-CATHS (PORTS):

Inpatients

TAUROLOCK HEP 100 WILL ONLY BE REQUIRED WHEN REMOVING GRIPPER NEEDLE OR IF PATIENT IS BEING DISCHARGED WITH GRIPPER NEEDLE REMAINING IN SITU

1. If the Port is not be accessed for the duration of the inpatient stay, the following procedure should only be necessary to change the lock prior to discharge from the ward if the current lock has been in situ for the maximum permissible duration of 4 weeks.
2. Double chamber Ports should have any chamber which is not to be accessed locked as per procedure below. Both chambers must be locked prior to discharge.
3. Take a discard of 2.5-5ml from the CVAD to remove any previous lock solution, each time it is accessed.
4. Flush with 10ml Sodium Chloride 0.9%, using standard percussive techniques, prior to port locking.
5. For Ports which are being accessed intermittently (e.g. for blood samples, drug administration, fluids or chemotherapy), follow steps 3 and 4 above before and after each intervention as per standard procedure. The Port should then be locked using ***TauroLock***, which will remain in situ until the device is next accessed.
6. Prior to discharge, ensure Port is locked with ***TauroLock Hep 100*** before removing gripper needle, unless a different antibiotic lock has been requested by a consultant microbiologist. If the gripper needle is remaining in situ on discharge lock with ***TauroLock Hep 100.***

Day Care Patients

1. If the Port will not be accessed for the duration of the day care stay, check patient notes and Kardex to determine how long the current lock has been in situ. The following procedure should only be necessary to change the lock if the current lock has been in situ for the maximum permissible duration of 4 weeks, or this time period will have elapsed prior to their next home visit/ return to hospital.
2. Double chamber Ports should have any chamber which is not being accessed locked as per procedure below. Both chambers must be locked prior to discharge if the current lock has been in situ for the maximum permissible duration of 4 weeks.

3. Take a discard of 2.5-5ml from the CVAD to remove any previous lock solution, each time it is accessed.
4. Flush with 10 ml Sodium Chloride 0.9%, using standard technique, prior to port locking.
5. Ports accessed on multiple occasions for GFR estimations or PK studies, do NOT need to be locked every time it is accessed. The port should be flushed with 10ml Sodium Chloride 0.9% using standard technique following each intervention. This is to ensure the assays are not contaminated. The port should only be locked using ***TauroLock Hep 100*** when the patient is ready to leave day care.
6. If the Port is being accessed for blood samples which may subsequently lead to a requirement for further infusions or blood product support, the port should be locked with ***TauroLock Hep 100*** pending results becoming available. If further intervention is required, follow steps 3 and 4 above before and after accessing the port. The port should then be locked with ***TauroLock Hep 100*** when the patient is ready to leave day care
7. For Ports which are being accessed intermittently (e.g. for drug administration, fluids or chemotherapy), follow steps 3 and 4 above before and after each intervention as per standard procedure. The Port should then be locked using ***TauroLock***, which will remain in situ until the device is next accessed. When the patient is ready to leave day care, Port should be locked using ***TauroLock Hep 100***.
8. Prior to a patient leaving day care, ensure Port is locked with ***TauroLock Hep 100***, unless a different antibiotic lock has been requested by a consultant microbiologist.

Outpatient Clinic

1. If the Port will not be accessed for the duration of the outpatient visit, check patient notes and Kardex to determine how long the current lock has been in situ. It should only be necessary to change the lock if the current lock will have been in situ for the permitted maximum of 4 weeks prior to the next home or hospital visit.
2. Double chamber Ports should have any chamber which is not being accessed locked as per procedure below. Both chambers must be locked prior to discharge if the current lock has been in situ for the maximum permissible duration of 4 weeks.
3. Take a discard of 2.5-5ml from the CVAD to remove any previous lock solution, each time it is accessed.
4. Flush with 10 ml Sodium Chloride 0.9%, using standard technique, prior to port locking.

5. If the Port is being accessed for blood samples which may subsequently lead to a requirement for further infusions or blood product support, the port should be locked with ***TauroLock Hep 100*** pending results becoming available. If further intervention is required, the patients' care will be transferred to the day care unit. Follow steps 3 and 4 above before and after accessing the port. The port should then be locked with ***TauroLock Hep 100*** when the patient is ready to leave day care.
6. For Ports which are being accessed for chemotherapy, follow steps 3 and 4 above before and after drug administration as per standard procedure. The port should then be locked using ***TauroLock Hep 100*** when the patient is ready to leave.

Home

1. Patients who are at home with Ports in situ should have these flushed and re-locked every 4 weeks by a Paediatric Oncology Outreach Nurse. Double chamber ports should have both chambers locked. This needs to be appropriately documented
2. POON must obtain the appropriate drug Kardex prior to each home visit
3. Take a discard of 2.5-5ml from the CVAD to remove any previous lock solution, each time it is accessed.
4. Flush with 10 ml Sodium Chloride 0.9%, using standard percussive techniques, prior to port locking.
5. The port should then be locked using ***TauroLock Hep 100***

Management of Patients in other areas

All patients with lines locked with TauroLock or TauroLock Hep 100 should have their central venous access devices managed in accordance with this document.

5.4 FUNGAL PROPHYLAXIS:

Antifungal prophylaxis should be primarily directed to patents in high risk groups - prolonged neutropenia (low white cell count) for more than 2 weeks, high dose steroid use, allogeneic stem cell transplants (particularly if complicated by graft-versus-host disease) and bone marrow failure syndromes. Haematology or oncology consultants should risk assess individual patients and balance the utility and safety of anti-fungal prophylaxis against the perceived risk of invasive mould disease. Further advice on specific patients should be discussed with microbiology. These discussions should be clearly documented in the case record.

Drug Choice

Antifungal prophylaxis is based on a strategy of Posaconazole as first line, and AmBisome (liposomal Amphotericin) as second line. Caspofungin (plus Fluconazole) should only be used as a third choice when neither Posaconazole or AmBisome are tolerated.

Posaconazole	- Oral administration as tablets or liquid. Note that these are NOT equivalent, and the drug form must be stated clearly on the prescription - Pharmacy will advise on appropriate dosing - Requires therapeutic drug monitoring. First level 7-10 days after starting, then weekly after any dose change until target level is achieved - **DRUG INTERACTION WITH VINCA ALKALOIDS.** Azole antifungal drugs are predicted to increase exposure to Vinca alkaloids. All azole antifungals must be withheld for 48 hours before and after a dose of any Vinca alkaloid.
AmBisome (Liposomal Amphotericin	- Intravenous use only - Prophylactic dose: 2mg/kg on Monday, Wednesday and Friday only - Drug of choice only when oral Posaconazole is not tolerated or contraindicated
Caspofungin	- Intravenous use only - Discuss with patients' consultant and/or microbiology before switching prophylactic antifungal to Caspofungin

<u>High Risk Patient Groups</u>

Haematology:

- All stem cell transplant patients
- All AML patients throughout treatment
- All patients during Induction (until Dexamethasone wean complete) and Delayed Intensification Part I (Day 2 until Day 22)
- Bone Marrow Failure syndromes
- Lymphoma patients treated on the Inter-Ritux guideline during chemotherapy and periods of profound neutropenia
- Hodgkin's Lymphoma patients during treatment with steroids

Oncology:

- All High Risk Neuroblastoma patients
- All autologous stem cell transplant patients
- All ATRT patients
- Any patient on steroids

Any patient with a previously confirmed fungal infection should be prescribed antifungal prophylaxis for the duration of treatment where there is a risk of neutropenia. On completion of treatment, a plan for de-escalation of anti-fungal treatment will be discussed with the patients' consultant and microbiology.

Out-patient or day case patients should NOT receive fungal prophylaxis routinely unless they belong to the groups above.

The importance of ongoing surveillance and regular review of the clinical epidemiology of this vulnerable patient group is paramount. Regular review of these factors in conjunction with a consultant microbiologist taking account of environmental epidemiology is recommended, with subsequent review of prophylaxis if required.

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7. AUDIT AND REVIEW PROCESS

This SOP will be reviewed every two years.

8. FURTHER INFORMATION/EXCEPTIONS

None.

9. APPENDICES

Appendix 1: Lock Volumes

Appendix 1: Lock Volumes

TAUROLOCK	
Line type	**Lock volume**
PIC (any manufacturer, any size)	1.0ml
Single Lumen Hickman	1.0ml
Double Lumen Hickman	1.0ml in each lumen
Single Chamber Port	1.5ml
Double Chamber Port	1.5ml in each chamber

TAUROLOCK HEP 100 *****only when removing gripper needle*****	
Line type	**Lock volume**
Single Chamber Port	1.5ml
Double Chamber Port	1.5ml in each chamber

TAUROLOCK **in patients <5kg or under 6months old**	
Line type	**Lock volume**
PIC (any manufacturer, any size)	0.5ml
Single Lumen Hickman	0.5mls
Double Lumen Hickman	0.5ml in each lumen
Single Chamber Port	1.5ml
Double Chamber Port	0.5ml in each chamber

Full Incident Management Team Report

Incident Management	
Incident Management Team (IMT) lead:	Name and job title, Board: Dr Teresa Inkster, Lead ICD, NHSGGC
Agencies represented on IMT:	Health Protection Scotland Health Facilities Scotland
Date of first IMT meeting:	2nd March 2018
Date of last IMT meeting:	13th April 2018
Number of IMT meetings held:	9
Guidance used by IMT:	Chapters 2+ 3, National Manual
Please record any other points on IMT:	
Incident Detection and Initial Response	
Date of first notification of case(s):	5/2/18
Date incident detected:	1st March 2018
Description of how the incident was detected:	A patient in ward 2A , RHC presented with a Cupriavidus bacteraemia. This is a rare clinical isolate. A previous case linked to our aseptic unit had been detected in Feb 2016 and water testing had revealed positive results.
Description of the initial risk assessment response and communications:	Initial focus was on the aseptic unit and a PAG was held on 5/2/18. Following negative water results from there ,water testing was undertaken on ward 2A . Outlets from 2A tested positive. Due to an uncontrolled source, the incident was assessed as a RED on HIIAT on 1st March and reported to HPS. Due to the number of positive outlets in a high risk area chemical dosing was undertaken straight away with Silver Hydrogen Peroxide. Showers were placed out of use for patients and bottled water was provided for personal hygiene. Additional hand hygiene steps were implemented and bottled water provided for drinking.
Please note any other points on incident detection and initial response:	
Type of Incident	
Causative Organism :	Environmental Gram negatives and Fungi
Main presenting illness:	Bacteraemia
Main Primary Exposure(s):	Food

	Water Air General Environment Person to Person (type e.g. sexual, respiratory, contact) Other (please describe)
Source(s) of Exposure:	Contaminated water supply
Duration of Incident:	From: 1st March To: Ongoing
Please Note any Other Points on the Type of Incident:	Complex incident . Contaminated water supply . Long term preventative measures will take some time to implement. This report focuses on the acute incident and any learning from that.
Investigation	
Epidemiological Investigation	
Type(s) of Epidemiological Investigation:	Patient timelines Retrospective analysis of bacteraemias Ongoing analysis with HPS support looking at current cases, retrospective cases and national picture Review of epidemiology from Public Health Consultant Sampling of water, taps, showers, drains
Final Case Definitions:	1)Complex case definition . Started as a patient with Cupriavidus bacteraemia and evolved into bacteraemia due to any of the Gram negative bacteria identified in the water samples as being clinically significant. 2)Any patient with hospital acquired fungal infection
Number of Cases by Organism	1 Cupriavidus bacteraemia 5 Stenotrophomonas bacteraemia 1 Pseudomonas auerginosa – subsequently excluded following different identity of water isolate.
Clinical Status	Admitted:6 | ITU:1 | Deaths:0
First and Last Date of Onset by Definition:	1st case – 26/01/18; Blood culture Last case – 03/04/18; Blood culture (NB exposure to contaminated water took place before control measures were put in place.)
Epidemic Curve Appended?:	Yes/No No
Areas of Incident Occurrence:	Initially ward 2a then throughout RHC and QEUH
Mapping of Cases Appended?	Yes/No No

Primary Exposures Investigated:	Food Water Air General Environment Person to Person (type) Zoonotic Other (please describe)
Source(s) of Exposures:	Contaminated shower and tap water
Secondary Exposures Investigated:	
Other Risk Factors for Illness:	Immunosuppression
Underlying Medical Conditions:	Haematological malignancy, and solid tumours
Further Epidemiological Investigations Colindale, PHE, London Report Appended?:	Yes/No Yes
Key Findings:	One historical case (2016) of Cupriavidus bacteraemia linked to current incident by typing. Typing reveals at least 5 different strains of Cupriavidus in patients and water Different strains of Stenotrophomonas identified in patients and water Typing of historical isolates of other organisms from patient and water has revealed no link so far
Main Conclusions:	Possible all cases are linked to water as links in time/place/person we just haven't found the strain as yet. Typing continues
Please Note Any Further Points on the Epidemiological Investigations:	Was concern that Stenotrophomonas was being transmitted via patients via indirect contact route. Typing excludes this as different strains identified.
Laboratory Investigations	
Diagnostic Laboratories Involved:	Glasgow Royal Infirmary, QEUH microbiology labs
Reference Laboratory Involved:	Colindale, PHE, London
Causative Agent:	Cupriavidus pauculus, Stenotrophomonas maltophilia, other environmental Gram negatives, fungi
Strain/genotype of Micro-Organism:	Cupriavidus- strains 1-3 Stenotrophomonas – strains 1-4
Dates of First and Last Positive Results in Confirmed Cases by Laboratory:	1st case – 26/01/18; Blood culture Last case – 03/04/18; Blood culture

Key Findings:	Different strain types.
Main Conclusions:	Fairly typical to see several different species types in a water incident as conditions for one strain are conducive to other strains
Please Note any Further Points on the Laboratory Investigation:	Typing outstanding
Overall Summary from Investigation	
Key Findings:	Water testing revealed contamination of water supply within RHC and QEUH
Main Conclusions:	Hypothesis is that contamination took place during installation and has built up in the system creating thick biofilm

Control Measures	
Objectives:	Rapid control of water system and safe supply of water to patients
Prevention of Primary Exposure Dosing of system with Sanosil and Chlorine Patient showers taken out of use for immunocompromised patients across RHC/QEUH site Extra hand hygiene precautions put in place, additional alcohol gel step Bottled water for drinking Bottled water to brush teeth Sterile water for BMT patients Portable sinks to provide warm water for washing children on 2A and for parents use during periods of dosing Point of use filters fitted to hand wash basins and showers in all high risk wards. A small number of filters were fitted in all other inpatient areas so that immunocompromised patients could be cared for in any ward if necessary. Some other day wards/departments had filters fitted depending on patient group. Quality assurance checks carried out at time of fitting by estates staff . Ciproxin prophylaxis for high risk patient groups	
Criteria for Cessation of Main Control Measures	Fitting of point of use filters and sustained negative water testing from filtered outlets
Summary	
Compliance Issues	No compliance issues with IC precautions noted

Evaluation of Impact and Achievement of Objectives	Any further patient related bacteraemias
Main Conclusions	No further bacteraemias therefore control measures were deemed successful Filters are a short term measure only and long term preventative measures are crucial Long term measures will likely entail 1) Dosing with Chlorine Dioxide or Copper-Silver ionisation 2) Removal of mixer taps in high risk areas and replacement with more simple tap 3) Regular maintenance of tap flow straighteners in other areas 4) Use of filters long term in high risk areas In addition all sources of water in the hospitals will be reviewed

Communications	
Strategy	
Objectives:	Communication of incident
Audience(s):	Ward staff, relatives, senior management
Key Content: Assessed Risk to Health:	Yes
Key Content: Advice on Risk Reduction:	Yes
Main Spokesperson(s):	IMT via written info and core briefs
Method of assessing impact:	HIIAT tool
Communications Made: Service	
Public Health (Scotland):	HPS informed
Public Health (UK & Europe):	N/A
Scottish Government :	Informed via HPS
General Practice:	N/A
NHS 24:	N/A
Out of Hours & A&E:	N/A
Local Authorities:	Scottish water
Secondary Care:	N/A
Others:	Health facilities Scotland
Communications Made: Public	
Cases and Contacts:	Yes
Affected Communities:	Ward 2A
Local Media:	Yes

National Media:	Yes
Helpline:	No
Publicity and Specific Health Information:	No
Others:	
Summary	
Evaluation of Impact and Achievement of Objectives:	Concerns expressed re lack of Comms from clinicians
Main Conclusions:	Challenging incident with high anxiety. Difficult balance with releasing info and not causing undue alarm. To be discussed further in debrief

Antecedents of Outbreak	
What occurred to Precipitate the Outbreak? :	Contaminated water supply
Were there any System Failures which Contributed to this? :	Possible contamination at time of installation via pipework and outlets. Temperature control and maintenance may have been factors.
Were there any Organisational or Cultural Issues Contributing to these? :	Source of the contamination will be investigated as part of the ongoing SLWG.
What is the Likelihood of a Similar Event Occurring?	High, in a new build hospital
What Needs to be Done to Prevent this?	Learning from this incident communicated to other health boards and national guidance/recommendations developed as a result. Education of contractors ,plumbers, architects ,estates and infection control teams with respect to installation , handover of water systems and ongoing testing/maintenance

Learning from Experience	
Organisational Arrangements	*What worked well? :*
	What could be improved?:
Investigation	*What worked well? :*
	What could be improved?:

Control Measures	*What worked well? :*
	What could be improved?:
Communications	*What worked well? :*
	What could be improved?:
Please Identity any Updates to Guidance that Should be Considered as a Result of the Incident:	
Please Identify any Research that Should be Considered as a Result of the Incident:	
Please Identify any Workforce/ Education/ Development Priorities to Arise as a Result of the Incident:	

Recommended Actions Arising from the Incident

Recommended Action Should be set out as Objectives Using the 'SMART Approach' i.e. Specific, Measurable, Achievable, Realistic, Timed:

- **Specific –** Be Precise about the objective to be achieved.
- **Measurable –** Quantify the extent of the action.
- **Achievable –** Actions should not be an excessive burden on the owners.
- **Timed –** State the expected completion date.

Action No.	Description of Action	Action Owner	Complete by Date

Report Approval

For Completion by the Chair of the Incident Management Team

Name:	**Designation:**
Signature:	**Date:**
Email:	**Tel.:**

From: David Watson [redacted]
Sent: 24 May 2021 09:30
To: Clarkson, Kerr [redacted]
Cc: MacMillan, Melville [redacted]; Craig Guyer [redacted]; Mike Kinghorn [redacted]; NHS [redacted]
Subject: [ExternalToGGC]Water Supply Summary RHC, Old Mat & Neo Natal

Hi Kerr

As requested please find below a summary of the where water is supplied from in each of the RHC, Old Maternity and New Maternity (Neo-Natal)

RHC
The RHC is a shared water system with the Adults Hospital.

There are two separate mains water supplies into the RHC. One from Govan Road and one from Hardgate Road, which alternate on a timed basis with only one supply being live at any given time.

Both mains enter the building in the basement and run into the basement tank room where they supply 4 x "Raw Water" CWSTs. These in turn supply 3 x filtration units which then feed into the 4 x "Post Filter" tanks. The post filter tanks are treated with chlorine dioxide. These tanks supply two sets of booster pumps, one set supplying the Children's hospital and levels ground to 3 within the Adult hospital, with the other pump set supplying the adults hospital levels 4 – 11.

Old Maternity
The Mains supply is believed to enter the old maternity near the Security Night Entrance, though we haven't actually ever seen the actual supply as it enters. This mains is fed from the Hardgate Road mains water supply. The mains rises through the building to supply 2 x CWSTs in the 4th Floor tank room. The tanks then supply water to the maternity on a gravity system (i.e. no booster pumps). The CWSTs tanks are treated with Chlorine dioxide.

The 4th floor of the maternity is supplied directly from the mains supply (*Not* treated with chlorine dioxide) – the tanks which formerly supplied this area were removed a few years ago and system converted to mains.

New Maternity/Neo-Natal
The mains enters the building on the ground floor on the rear staircase, only accessible via a small hatch in stairwell. This mains is fed from the Hardgate Road mains water supply. The mains rises to feed a "Pre-Filter" tank in the 3rd floor plantroom, which then in turn supplies 2 x filtration units which then feed into 2 x "Post Filter" tanks.

The CWSTs then supply the water services within the New Maternity/Neo-Natal via a booster pump set.

No water within the New Maternity/Neo-Natal is treated with chlorine dioxide or other supplementary disinfectants.

I trust this is satisfactory but if you require any more information please do not hesitate to contact me.

Regards

David Watson
Director

Saturday, 30 November, 2019 (CC)

Various – Anas Sarwar parents meeting

NHS GREATER GLASGOW AND CLYDE RESPONSE

Statement by Jane Grant, Chief Executive, NHSGGC "I am truly sorry that parents remain concerned about safety issues and I am absolutely committed to ensuring families are provided with the information they need and deserve.

"The Chairman and I have already met with a number of families and they told us this direct engagement was extremely valuable. We continue to offer this opportunity to all 400 families involved with Ward 6A, including the 15 families represented by Mr Sarwar.

"I would once again encourage any parent who remains concerned about the quality of care their child has received to contact me directly to arrange a meeting.

"We want to work with parents to improve how we communicate with them and we are being supported in this by Professor Craig White who has been appointed by the Cabinet Secretary as point of liaison with families.

"The Cabinet Secretary has now announced the establishment of an Oversight Board, chaired by Professor Fiona McQueen, Chief Nursing Officer, to ensure appropriate governance is in place to increase public confidence in infection control and in our engagement with families.

"We welcome the additional support offered and are committed to working closely with the Scottish Government to implement any recommended additional changes and enhancements across infection control and associated engagement.

"Since the move to Ward 6A and 4B in September 2018, infection rates have been similar to other Scottish paediatric units.

“We have fully tested the water supply and ward surfaces in Ward 6A and also reviewed individual infections and found no links between individual infections and no source of infections in the ward.

“Families should be reassured that infection rates at present are within expected levels and the hospital is safe.

“The technical reports on the quality of the water supplies at the QEUH Campus mentioned by Mr Sarwar in the Scottish Parliament were not brought to the Senior Leadership Team’s attention until 2018.

“Once I had been made aware of these reports by Health Facilities Scotland as part of the work we had commissioned following an increase in the number of infections on Ward 2A/2B, I ensured that immediate steps and necessary action was taken to provide assurance about the safety of the water supply.

“I want to assure the families involved at that time that there was no attempt to ignore these reports once they were brought to my attention.

“I would, therefore, hope the families who have called for changes at the top of the organisation can accept that the current leadership team have made significant efforts to address the situation.

“Every member of the team has been entirely committed throughout this difficult period to ensuring the safety and quality of care of the children.

“This has not been easy given the challenges we inherited from the previous leadership team and we accept communications with the families could have been better but I remain convinced we have the right people to take the Royal Hospital for Children forward so that it fulfils its potential to be one of the leading children’s’ hospitals in the UK.”

ENDS

For further information either [redacted]

Dear Parent / Carer

Following our briefing to you last week we wanted to keep you up to date on the measures we have been taking to enhance the environment.

We have had a further meeting to review the measures that we have already taken and identify any further steps required.

Infection rates remain within expected levels for the patients treated on Ward 6A. However in light of the occurrence of rarer infections, we are continuing to take precautions, including monitoring infection control practices and procedures and the ward environment.

A programme of enhanced cleaning has been undertaken will continue going forward.

We have undertaken a range of audits of infection control practices within the ward all of which are of an extremely high standard.

Prophylactic antibiotics continue to be prescribed to patients on the ward.

We are also working closely with Health Protection and Health Facilities Scotland.

At this stage there still remains nothing to link the infections to the ward's infection control practices or the environment.

In order to facilitate further investigations, we continue to divert new admissions. Outpatients and day cases continue as normal.

We would also reiterate all the advice previously given and ask visitors for their assistance by continuing good hand hygiene practice when in the ward.

We would like to offer our thanks to all the parents for their continued support whilst these measures remain in place.

Please let a member of our clinical staff know if you wish to discuss anything further and we will arrange this with a member of senior medical, nursing and infection control teams.

Dear Parent / Carer

We are committed to keeping you informed of the ongoing work we are undertaking to enhance the environment on the ward and to reiterate our thanks and gratitude for your continued co-operation and support.

Our team investigating a number of unusual infections amongst patients continue to meet. The latest meeting was today, Friday 23rd August.

We have already made you aware of the extensive testing of all the water systems in the ward and that this testing has shown no source linking the ward environment to the infections.

Weekly audits of our infection control practices are ongoing and our infections control colleagues will continue to support staff on the ward to ensure these practices remain within accepted limits.

There will be some additional work being carried out in rooms across the ward next week by our facilities team. While this work is ongoing we will continue to divert a small number of admissions to other units. There is no change to our outpatients and day cases clinics. Where appropriate patients continue to be prescribed prophylactic antibiotics as a precautionary measure.

We are in regular contact with Health Protection Scotland and Health Facilities Scotland who have been offering support and advice.

We would also reiterate that parents and visitors continue to assist us by adhering to our advice on good hand hygiene practice when in the ward, and that our clinical, nursing and infection control staff are available to discuss anything further.

From: Bustillo, Sandra
To: Dell, Mark
Subject: Re: Update from 6A IMT
Date: 19 June 2019 18:26:15

I've discussed with Tom too.

Sandra

Sent from my iPhone

On 19 Jun 2019, at 18:22, Dell, Mark [redacted] wrote:

> Just spoke with Kevin. He's letting Jane and Jonathan know.
>
> Sent from my iPhone
>
> On 19 Jun 2019, at 18:21, Bustillo, Sandra [redacted] wrote:
>
> > Thanks Mark I got a copy of this too. Holding line appears ok. Will discuss further tomorrow.
> >
> > Sandra
> >
> > Sent from my iPhone
> >
> > On 19 Jun 2019, at 18:03, Dell, Mark [redacted] wrote:
> >
> > > Sitting with Jamie and he passed this on.
> > >
> > > Note sentence re presumed source…
> > >
> > > Mark Dell
> > > Senior Media Relations Officer
> > > NHS Greater Glasgow and Clyde
> > >
> > > [redacted]
> > >
> > > **From:** Redfern, Jamie
> > > **Sent:** 19 June 2019 17:54
> > > **To:** Dell, Mark [redacted]
> > > **Subject:** FW: Update from 6A IMT
> > > **Importance:** High
> > >
> > > **From:** INKSTER, Teresa [redacted]

Sent: 19 June 2019 17:02
To: Armstrong, Jennifer; Mcguire, Margaret; Hill, Kevin; Redfern, Jamie; Rodgers, Jennifer; Joannidis, Pamela; Devine, Sandra; Mathers, Alan
Subject: [ExternaltoGGC]Update from 6A IMT
Importance: High

Dear all

An IMT was held in ward 6A today to discuss two issues;

Gram negative bacteraemias

Five Gram negative bacteraemias meeting previous case definition since 13/4/09. All patients currently stable. Typing for 3/5 shows unique strains.

Water testing from 6A , no evidence of organisms found in blood cultures, drains on 6A clean

Patients have been to interventional radiology and theatres. Drain swabs from these areas positive for the same bacteria, typing awaited. Drain cleaning ongoing.

May represent normal background rates. No evidence of patient to patient transmission as different strains. Drains outwith ward 6A may be a source

Mycobacterium chelonae

Cutaneous infection with M Chelonae confirmed in a 6A patient this morning. [redacted]

Previous 6A patient in May 2018 had blood stream infection with M chelonae.

Rare infection , two patients in 2 years would be considered unusual

Recent water samples in 6A with filters off have tested positive for M chelonae .

Presumed source is areas outwith ward 6A without filters on where patients may have been .

Water sampling to be undertaken in these areas and filters to be fitted. Water testing with filters on in 6A to be undertaken to demonstrate filter efficacy. Organism known to concentrate in showerheads so these will be sampled also

Whole genome sequencing (typing) to be undertaken by St Andrews research lab

Comms

HIIAT - Amber, HPS and SG to be informed via HIIORT

Draft press lines . [redacted] , discussion re comms to family to take place with Prof Gibson early next week.

A further IMT will be held next week

Please get in touch if you have any questions

Kind regards
Teresa

Dr Teresa Inkster
Lead Infection Control Doctor NHSGGC
National Training Programme Director Medical Microbiology
Dept of Microbiology
Queen Elizabeth University Hospital
Glasgow
[redacted]

From: Bustillo, Sandra
To: Best, Jonathan
Subject: Fwd: filters in theatres
Date: 21 June 2019 14:56:03

Sent from my iPhone

Begin forwarded message:

From: "Joannidis, Pamela" [redacted]
Date: 21 June 2019 at 14:30:53 BST
To: "Bustillo, Sandra" [redacted]
Subject: FW: filters in theatres

FYI

From: Dodd, Susie
Sent: 21 June 2019 14:14
To: Joannidis, Pamela [redacted]
Subject: FW: filters in theatres
Importance: High

FYI

Susie Dodd
Lead Infection Prevention and Control Nurse
Royal Hopsital for Children
[redacted]

From: INKSTER, Teresa [redacted]
Sent: 21 June 2019 08:41
To: Brindley, Nicola
Cc: Dodd, Susie; Redfern, Jamie; Whiteside, Jeanette
Subject: [ExternaltoGGC]filters in theatres
Importance: High

Dear Nicola

I would be greatful if you could forward the email below to your surgical and anaesthetic colleagues.

We have requested filters to be put on outlets in theatres. We have had an unusual cutaneous infection in an immunosuppressed child secondary to an atypical mycobacteria called Mycobacterium chelonae. On testing the water in the ward the patient was in we have found this organism in the unfiltered

water. The child has also been elsewhere in the hospital , including theatres.

We have been closely monitoring water in theatres and the water quality is good with no requirement for filters , but we don't routinely test for mycobacteria. We now plan to do so and pending results, which take 6 weeks, we have agreed to put filters on as a precautionary measure. We will reassess the need for filters after the results .

There are no additional control measures required in theatre at this time.

Kind regards

Teresa

Dr Teresa Inkster
Lead Infection Control Doctor NHSGGC
National Training Programme Director Medical Microbiology
Dept of Microbiology
Queen Elizabeth University Hospital
Glasgow
[redacted]

From: Bustillo, Sandra
Sent: 25 June 2019 19:07
To: Dell, Mark
Subject: Fwd: IMT GNB & Mycobacteria chelonae

You heard from Teresa?

Sandra

Sent from my iPhone

Begin forwarded message:

From: "Devine, Sandra" [redacted]
Date: 25 June 2019 at 19:06:28 BST
To: "Bustillo, Sandra" [redacted]
Subject: Re: IMT GNB & Mycobacteria chelonae

She did respond to me re the update I sent about half an hour ago?

Sent from my BlackBerry 10 smartphone on the EE network.

From: Bustillo, Sandra
Sent: Tuesday, 25 June 2019 18:51
To: Devine, Sandra
Subject: Re: IMT GNB & Mycobacteria chelonae

Thanks Sandra. Nothing back from Teresa yet.

Sandra

Sent from my iPhone

On 25 Jun 2019, at 18:32, Devine, Sandra [redacted] wrote:

A43941023

Sent this today – may be of some use.
Sandra

Sandra Devine
Acting Infection Control Manager
NHS Greater Glasgow & Clyde
[redacted]

From: Devine, Sandra
Sent: 25 June 2019 18:32
To: Armstrong, Jennifer [redacted] Mcguire, Margaret [redacted] Deighan, Chris [redacted] Steele, Tom [redacted] Hill, Kevin [redacted]; Davidson, Scott [redacted]
Cc: 'INKSTER, Teresa (NHS GREATER GLASGOW & CLYDE)' [redacted] Dodd, Susie [redacted]; Joannidis, Pamela [redacted]; Rodgers, Jennifer [redacted] Best, Jonathan [redacted]; Kennedy, Iain [redacted]
Subject: IMT GNB & Mycobacteria chelonae

Hi
Summary of today's IMT.

Gram negative blood cultures ward 6a

- Six possibly seven cases since 8 April. Four are healthcare associated, two are considered hospital acquired, although one of these is thought to be due to gut translocation. [redacted]. The seventh case is still being investigated.
- All patients are reported as giving no cause for concern today due to the infection.
- Of the 6 cases there are three different GNB and so far three samples have been sent for typing and all are unique strains.
- Water samples within acceptable levels for GNB post and pre filter.

Mycobacteria chelonae

- Two cases in 13 months but this is considered to be an unusual infection incident. Local epidemiology – four adult cases in 10 years, no paediatric cases until current two.
- Outlets in ward 6a and theatres positive (6a it was pre filter samples). Samples taken in response to increase in GNB but were subsequently tested for M. chelonae.
- HPS to find out if any other board are reporting either water samples or cases of M. chelonae.

Actions

GNB Specifically

- HPS asked for information regarding sampling in other boards and if they have a view on the epidemiology. It is possible that this could be our normal background levels.

M. chelonae

- Filters put on outlets in clinical areas that patients from haematology/oncology may attend.
- Lines for families being prepared
- Draft holding press statement being prepared
- Clinical team or W & C SMT will speak to the families of both cases tomorrow.
- Increase in the amount of chlorine in the system and consider shock dosing of system.
- Samples sent to St Andrews for typing.

Both

- SICPs audits will be done in some theatre areas and the ward.
- Samples sent to St Andrews for typing.
- Sample water from chilled beams.
- Check PPE are not located near sinks or outlets.
- Air sampling will be undertaken in ward 6a and theatres.
- AHG to be used in addition to normal HH.

HIIAT Assessed as AMBER

Severity of Illness – Minor
Impact on Services – Minor
Risk of transmission – Moderate
Public Anxiety – Moderate.

Next meeting W/B 1 July.

ICM agreed to contact HPS/HFS re sharing information with Lothian.

Kind regards
Sandra

A43941023

Sandra Devine
Acting Infection Control Manager
NHS Greater Glasgow & Clyde
[redacted]

A43941023

From: Bustillo, Sandra
Sent: 26 June 2019 11:00
To: Devine, Sandra
Subject: RE: IMT GNB & Mycobacteria chelonae

You may have seen that Teresa came back to approve the statement. Waiting to hear how meeting with families went although there was a pre-meeting with Alan Mathers, Jamie Redfern, Brenda and Teresa and Mark sent Jamie approved statement ti see if that could form the basis of the briefing with staff.

Sandra

Sandra Bustillo |Interim Director of Communications |NHS Greater Glasgow and Clyde
JB Russell House |Gartnavel Royal Hospital |1055 Great Western Road, G12 OXH
[redacted] web: www.nhsggc.org.uk

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From: Devine, Sandra
Sent: 26 June 2019 09:16
To: Bustillo, Sandra [redacted]
Subject: RE: IMT GNB & Mycobacteria chelonae

Anything if not I will chase and see what the story is.
Sandra
I did try and call twice last night

Sandra Devine
Acting Infection Control Manager
NHS Greater Glasgow & Clyde
[redacted]

From: Bustillo, Sandra
Sent: 25 June 2019 19:41
To: Devine, Sandra [redacted]
Subject: Fwd: IMT GNB & Mycobacteria chelonae

Sent from my iPhone

Begin forwarded message:

From: "Dell, Mark" [redacted]

A43941023

Date: 25 June 2019 at 19:37:09 BST
To: "Bustillo, Sandra" [redacted]
Subject: Re: IMT GNB & Mycobacteria chelonae

Only one not heard from.

Tom and Chris fine with lines. I'll send you over Kevin's comments.

Sent from my iPhone

On 25 Jun 2019, at 19:07, Bustillo, Sandra [redacted] wrote:

> You heard from Teresa?
>
> Sandra
>
> Sent from my iPhone
>
> Begin forwarded message:
>
> **From:** "Devine, Sandra" [redacted]
> **Date:** 25 June 2019 at 19:06:28 BST
> **To:** "Bustillo, Sandra" [redacted]
> **Subject: Re: IMT GNB & Mycobacteria chelonae**
>
> She did respond to me re the update I sent about half an hour ago?
>
> Sent from my BlackBerry 10 smartphone on the EE network.
>
> **From:** Bustillo, Sandra
> **Sent:** Tuesday, 25 June 2019 18:51
> **To:** Devine, Sandra
> **Subject:** Re: IMT GNB & Mycobacteria chelonae
>
> Thanks Sandra. Nothing back from Teresa yet.
>
> Sandra
>
> Sent from my iPhone
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> On 25 Jun 2019, at 18:32, Devine, Sandra [redacted] wrote:
>
> > Sent this today – may be of some use.
> > Sandra
> >
> > Sandra Devine
> > Acting Infection Control Manager
> > NHS Greater Glasgow & Clyde
> > [redacted]

[redacted]

From: Devine, Sandra
Sent: 25 June 2019 18:32
To: Armstrong, Jennifer [redacted]; Mcguire, Margaret [redacted]; Deighan, Chris [redacted] Steele, Tom [redacted]; Hill, Kevin [redacted] Davidson, Scott [redacted]
Cc: 'INKSTER, Teresa (NHS GREATER GLASGOW & CLYDE)' [redacted]; Dodd, Susie [redacted]; Joannidis, Pamela [redacted]; Rodgers, Jennifer [redacted]; Best, Jonathan [redacted]; Kennedy, Iain [redacted]
Subject: IMT GNB & Mycobacteria chelonae

Hi
Summary of today's IMT.

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- HPS asked for information regarding sampling in other boards and

if they have a view on the epidemiology. It is possible that this could be our normal background levels.

M. chelonae

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- AHG to be used in addition to normal HH.

HIIAT Assessed as AMBER

Severity of Illness – Minor
Impact on Services – Minor
Risk of transmission – Moderate
Public Anxiety – Moderate.

Next meeting W/B 1 July.

ICM agreed to contact HPS/HFS re sharing information with Lothian.

Kind regards
Sandra

Sandra Devine
Acting Infection Control Manager
NHS Greater Glasgow & Clyde
[redacted]

From: Bustillo, Sandra
To: Steele, Tom
Cc: Best, Jonathan; Hill, Kevin; Deighan, Chris; Mathers, Alan
Subject: Re: URGENT : Ward 6A parent communication
Date: 26 June 2019 19:03:05

This point was made in our holding statement which was approved by Teresa and Sandra so it should be included.

Sandra

Sent from my iPhone

On 26 Jun 2019, at 18:53, Steele, Tom [redacted] wrote:

> We need to emphasise that the unfiltered water is safe for the other patients, staff and visitors of the hospitals? I did specifically ask this at the IMT yesterday and the ICD response was, yes.
>
> Tom Steele | Director of Estates and Facilities
> | NHS Greater Glasgow and Clyde | JB Russell House | Gartnavel Royal Hospital | 1055 Great Western Road | Glasgow | G12 0XH
> [redacted]
>
> **From:** Best, Jonathan
> **Sent:** 26 June 2019 18:17
> **To:** Hill, Kevin [redacted]; Bustillo, Sandra [redacted]; Steele, Tom [redacted]; Deighan, Chris [redacted]; Mathers, Alan [redacted]
> **Subject:** Re: URGENT : Ward 6A parent communication
>
> Kevin,
> Looks fine.
> Jonathan
>
> Sent from my BlackBerry 10 smartphone on the EE network.
>
> **From:** Hill, Kevin
> **Sent:** Wednesday, June 26, 2019 6:14 PM
> **To:** Best, Jonathan; Bustillo, Sandra; Steele, Tom; Deighan, Chris; Mathers, Alan
> **Subject:** URGENT : Ward 6A parent communication
>
> Jonathan,
> I would appreciate your approval to the revised lines below being shared with parents and staff on ward 6A to ensure appropriate communication commences tonight.
> Happy to discuss.
> Kind regards
>
> **From:** Redfern, Jamie

Sent: 26 June 2019 18:02
To: Hill, Kevin
Cc: Dell, Mark
Subject: RE: parent lines

Note our revised draft

Feedback from clinical team is parent has been on Facebook and been very critical of the hospital and how safe it is. I have not seen what was said as it is a closed book. I would imagine there is high risk still that the parent is going to go to the press. I was also informed that the parent immediately following the meeting with Prof Gibson and Teresa spoke on the telephone to [redacted]. So we need to urgently deal with this family noting my email earlier today.

I will not offer the attached lines until you / JB are happy. Mark is the on-call comms person

---

From: INKSTER, Teresa (NHS GREATER GLASGOW & CLYDE)
[redacted]
Sent: 26 June 2019 17:50
To: Redfern, Jamie; Gibson, Brenda
Subject: [ExternaltoGGC]parent lines
Importance: High

Comments?
Brenda - Jamie will come to the ward once we have agreed content

A 6A patient has recently been diagnosed with a rare bacteria called Mycobacterium Chelonae. We are currently investigating this case and one other case of the same bacteria from last year .

This bacteria is found in the environment particulary in soil and water and there are multiple different strains.

We have tested the water in the hospital and found evidence of the bacteria in **unfiltered** water. We have yet to determine whether the strain in patients and the water are the same . Investigations are ongoing.

The water in 6A which is **all filtered** is safe and children can continue to shower and wash.

Dr Teresa Inkster
Lead Infection Control Doctor NHSGGC
National Training Programme Director Medical Microbiology
Dept of Microbiology
Queen Elizabeth University Hospital
Glasgow
[redacted]

From: Bustillo, Sandra
Sent: 09 August 2019 10:44
To: Rodgers, Jennifer
Subject: [redacted]
Attachments: Information Brief for families ward 6A August 2019 080819version2.docx

Here it is again. I've shared it with Jennifer, Scott et al as they were not copied in to the email last night. I am happy with the letter but I'll give colleague till lunchtine for comments on this and the statement and then we can action in the early afternoon.

Have you agreed how you are going to inform parents of outpatients/day cases?

Sandra

_____

Sandra Bustillo |Interim Director of Communications |NHS Greater Glasgow and Clyde
JB Russell House |Gartnavel Royal Hospital |1055 Great Western Road, G12 OXH
[redacted] web: www.nhsggc.org.uk

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From: Rodgers, Jennifer
Sent: 09 August 2019 11:34
To: Bustillo, Sandra [redacted]
Subject: RE: [redacted]

Hi Sandra,

Would be helpful to see the updated version of the draft we sent last night for parents so I can compare at the same time if possible.

Also would be good to get the comms to families approved this morning so we can go to the ward and discuss with them all at lunch time. We got a lot of criticism about the late Friday update last week.

Thanks so much

Jen

Thanks

Sandra

Greater Glasgow and Clyde NHS Board

JB Russell House
Gartnavel Royal Hospital
1055 Great Western Road
GLASGOW
G12 0XH

[redacted]
www.nhsggc.org.uk

Consultants in Paediatric Haematology/Oncology
Dr E Chalmers, Dr S Chaudhury,
Dr AM Ewins, Prof B Gibson, Dr C Halsey,
Dr N Heaney, Dr Murphy, Dr McIntosh,
Dr Pinto, Dr M Ronghe, Dr J Sastry

Haematology Oncology Secretary
[redacted]

Date: 4th September 2019
Our Ref: JG/LLPAE

Enquiries to: Jane Grant
[redacted]

Dear Colleagues

Thank you for your letter of 30th August 2019 outlining your concerns in relation to the issues that have affected your unit over the last period. We absolutely appreciate that this has been a challenging time for all concerned and would like to thank you for your constructive approach during this time. We are fully committed to working with you to ensure a successful outcome.

We are aware that Jonathan Best, Chief Operating Officer and Dr Scott Davidson, Deputy Medical Director, met with you on Monday 2nd September 2019 and have let us know that you had a useful discussion covering the range of issues outlined in your letter. Efforts are underway to source an appropriate colleague to provide the external advice agreed at the IMT and suggested within your letter and we will provide an update on that issue as soon as possible.

In the meantime, we will make arrangements through Kevin Hill, Director Women and Children to meet with you in the near future to discuss the issues highlighted in your letter.

Yours sincerely

[redacted]

Jane Grant
Chief Executive
NHS Greater Glasgow and Clyde

[redacted]

Dr Jennifer Armstrong
Medical Director
NHS Greater Glasgow and Clyde

Cc: Kevin Hill, Director Women and Children

REVIEW OF RECOMMENDATIONS AND ACTIONS ARISING FROM THE REPORTS ON WATER SYSTEMS AT QEUH AND RHC – RISK ASSESSMENT DATED SEPTEMBER 2017

DELIVERY STATUS

Using the descriptors below describe your overall assessment of the current delivery status for each recommendation? Where available please provide and embed supporting evidence.

DESCRIPTORS

Fully Implemented (F)	➢ Policy in place ➢ Health Board taking action ➢ Being monitored/evidenced
Mostly Implemented (M)	➢ Policy in place ➢ Health Board taking action ➢ Not yet fully evidenced ➢ Close but not 'perfect fit' ➢ More can be done
Partially Implemented (P)	➢ Policy/discussions started ➢ Different ways of doing things/testing ➢ More can be done ➢ No evidence yet
Not Started (NS)	➢ Yet to begin

	RECOMMENDATION	CURRENT POSITION INCLUDING SUPPORTING EVIDENCE	WHAT MORE NEEDS TO BE DONE	TIMESCALE FOR COMPLETION	DELIVERY STATUS (F, M, P, NS)
1	Legionella Management - Significant gaps were identified in the Legionella Management on site. Please refer to the Gap Analysis for further information	 Adobe Acrobat Document		21.12.18	F
2	Other Risk Systems - Please refer to section 8 for recommendations on other risk systems identified on site. This assessment provides a brief description of each system and an initial assessment however we would advise specialists in each field are consulted to confirm this initial assessment is reflective of the function of the system and would present these findings as draft only until this is confirmed."	The only specialist system we have on this site is a hydropool and there are specific RAs (dated Feb 18) in place to support these.  Adobe Acrobat Document			F
3	Water Source Basement Main Tank plantroomHardgate Road (Small) - As this mains lines is likely to have a low turnover of water DMA would recommend the NHS confirms that this main is separated from domestic water mains by a double check valve or similar (possibly external to building) to prevent potentially stagnant water from contaminating the domestic mains."	A flushing regime has been implemented. Refer to evidence in 2015RA.			F
4	Water Source Basement Main Tank plantroom Govan Road - RHS Trades Water Tank inlet valved off creating a deadleg. This should be incorporated into the weekly flushing regime until such times as CWST issue corrected. Please refer to CWST section for further recommendations.	The RHS trade tank has been removed..			F
5	Water Source Basement Main Tank plantroom Hardgate Road (Large)- Deadlegs (drain points/injection points) should be removed or incorporated into low use outlets flushing regime (for recs on isolated mains into T1A please see CWST recommendations).	Now incorporated into flushing regime. Reference 2015RA.			F
6	Water Source Basement MTHW/Chilled plantroom Govan Road - Deadlegs (drain points/injection points) should be removed or incorporated into low use outlets	Room naming data from DMA is incorrect and should refer to the main manifold room. There are drain/injection points on the MTHW system			F

	flushing regime.	but these would not require flushing. The only drain/injection points on the cold water supply is on the 6in main with a 22mm pipe with a valve and cap. This is now added to the flushing regime.  \\sgd-fs-vs\ S-Estates$\Water Qu			
7	Water Source Basement Main Tank plantroom Hardgate Road (Large) -There are return lines/vents from the check valve on the mains returning into the CWSTs. The operation of these should be confirmed and checks made to ensure they are not creating deadlegs/trapping stagnant water – incorporate into site flushing regime if lines not being flushed through at least twice weekly."	This is not a deadleg. This is a pressurisation line to close the Keraflow automatic float valve.			F
8	Water Source Basement Main Tank plantroom Govan Road - There are return lines/vents from the check valve on the mains returning into the CWSTs. The operation of these should be confirmed and checks made to ensure they are not creating deadlegs/trapping stagnant water – incorporate into site flushing regime if lines not being flushed through at least twice weekly."	This is not a deadleg. This is a pressurisation line to close the Keraflow automatic float valve			F
9	All plant items - All plant items, pipework and valves should be labelled for identification purposes.	Duplicate from 2015. Completed as part of 2015RA.			F
10	All CWSTs though particularly Bulk Water Tank 2B - Storage temperate in 2B combined with heavier water mark may indicate this CWST is not turning over as well as the others. This should be monitored and CWSTs balanced.	Tanks have been cleaned. Water tank cleaning reports are stored on the SGH shared drive in Water Tanks>C&D Reports July 2018"			F
11	Filter System - Ensure filter system is maintained in accordance with manufactures instructions	Service contract and reports in place. Filter cleaning reports are stored on the SGH shared drive in Water Quality>Filtration Reports. PO Attached.			F

		 \\sgd-fs-vs\ S-Estates$\Water Qu			
12	Bulk Water Tank 2B - The heavy water mark noted in 2B is unexpected following a 0.2micron filter though may have been introduced in initial occupation phase. We would advise this is investigated and it confirmed the filter system is operating"	Filter system is operational and tanks have been cleaned. See evidence at points 10 & 11 above.			F
13	CWST Basement Tank Plantroom Bulk Water - DMA noted small debris including washers in Bulk Water Tank 2B and would advise that this tank is cleaned to remove debris and then disinfected."	Tanks have been cleaned. Water tank cleaning reports are stored on the SGH shared drive in Water Tanks>C&D Reports July 2018"			F
14	CWST Basement Tank Plantroom Trades Water Water - RHS side of the Trades tank has been isolated on inlet for approx. 3 years. (though tank full of water with signs of stagnation). DMA would advise the tank is cleaned and disinfected prior to the tank being reinstated.	Both tanks cleaned. RHS drained and isolated. Report attached.  \\sgd-fs-vs\ S-Estates$\Water Qu			F
15	CWST Basement Tank Plantroom Bulk Water - CWSTs require to be cleaned and disinfected.	Duplicate of point 13 above - Water tank cleaning reports are stored on the SGH shared drive in Water Tanks>C&D Reports July 2018"			F
16	All expansion vessels - Wherever possible/practical expansion vessels should be 'flow through' vessels and suitably insulated. Where this is not possible a expansion vessel should be included in site flushing regime (to correct procedure). Estates advised during the Gap Analysis that no expansion vessel flushing is being carried out and we would advise this is started immediately in addition to any servicing of the vessel which may also have been missed previously.	There is a monthly flushing regime for the expansion vessels and calorifiers. See evidence in clause 26 below. Expansion vessels have now been replaced.			F
17	Raw Water CWSTs- Some evidence of biofilm forming on baffles at mains inlets, possibly due to splashing etc. Baffles should be inspected periodically (e.g. monthly) and cleaned as and when required.	Raw water tanks have been cleaned and disinfected - completed on 22.06.18.			F

		 \\sgd-fs-vs\ S-Estates$\Water Qu			
18	All Raw & Bulk CWSTs - A suitable screened screen should be fitted to the warning pipe and it should be confirmed that the overflow is suitably screened.	This screen is internal to tank and not visible.			F
19	CWST Basement Tank Plantroom Bulk Water - Ensure short connection between booster sets is thoroughly flushed before use should it ever be required.	Confirmed with AP Water (Mel MacMillan) that this spool piece between the booster sets contains a drain point allowing all water to be drained once operation to switch between booster sets has been carried out. Confirmed to be empty of water upon investigation.			F
20	CWST Basement Tank plantroom Bulk Water - Ideally drain points should be fitted to pump manifolds to allow end of lines to be flushed.	Currently there are blanks on the ends of these lines without drain points. This is an OEM off-the-shelf product which has no drain point included. After further investigation there is no room to install a drain point. Not practical. A Risk Assessment has been put in place to support this. Item 189 of 2015RA.			F
21	CWST Basement Tank Plantroom Bulk Water - There are various drain points and bypass valves fitted to the pipework in the plantroom. These should be included in site flushing regime"	Flushing regime in place. Refer to evidence in Item 6 above.			F
22	All Raw & Bulk CWSTs - Additional access hatches on tanks for cleaning/inspection purposes should be considered.	This was considered and discussed with DMA and given design of tanks, the risk to integrity of the tanks was considered to outweigh the benefits of having hatches. This is addressed as part of the RAMS.			F
23	CWST Basement Tank Plantroom Raw Water - There are drain down points on pipework. These should be included in site flushing regime.	Flushing regime in place. Refer to evidence in Item 6 above.			F
24	CWST Basement Tank plantroom Trades Water - A suitable screened vent should be fitted to the overflow.	This has been completed by DMA. This is an internal screen not visible externally.			F
25	CWST Basement Tank plantroom Trades Water - Ideally a	This is an OEM system and it is not practical to			F

	drain should be fitted to pump manifold to allow end of lines to be flushed (if practicable)"	do this.			
25.5	All CWSTs - All plant items, pipework and valves should be labelled for identification purposes.	Duplicate from 2015 RA. Dwgs updated and tags fitted.			F
26	All Calorifiers - DMA noted very dirty water was purged from a number of calorifier drains which may indicate the flushing regime should be increased (Estates advised during the Gap Analysis that base flushing is being carried out though were unable to provide supporting evidence), or that the methodology for flushing should be reviewed to ensure the calorifier base is being purged and not just the supply pipework. Additionally, Estates were unable to advise on the completion of annual calorifier inspections, clean/descale and disinfections. We would therefore advise all calorifiers are inspected, cleaned/descaled and disinfected.	The blowdown of all calorifiers and expansion vessels is carried out on a monthly basis at present.. See attached.  All Evidence.zip			F
27	All expansion vessels - Wherever possible/practical expansion vessels should be 'flow through' vessels and suitably insulated. Where this is not possible a expansion vessel should be included in site flushing regime (to correct procedure). Estates advised during the Gap Analysis that no expansion vessel flushing is being carried out and we would advise this is started immediately in addition to any servicing of the vessel which may also have been missed previously"	Expansion vessel flushing/blowdown is done and recorded at the same time as the calorifier blowdown. See example record sheets submitted under Item 26.			F
28	Calorifier Plantroom P22 -01/02/03 - Calorifier P22 01 temperature very slightly lower than the other calorifiers. Ensure linked calorifiers are balanced to provide equal throughput of water through each calorifier and calorifier brought up to full temperature."	This is factually incorrect. The pipework has been installed as designed by the contractor to ensure correct operation of the system.  \\sgd-fs-vs\ S-Estates$\Water Qu			F
29	Calorifier Plantroom P22 -01/02/03 - Deadleg pipework in this area should be removed (see also outlet recommendations regarding drain points/flushing points etc. in plantrooms)	No deadleg found.			F

30	Calorifier Plantroom 33-01/02/03 - There is a deadleg on the cold feed at these calorifiers – this should be removed or included in site flushing regime"	No deadleg found			F
31	Calorifier Plantroom 41 01/02/03 - P41 Calorifiers 01, 02 & 03 temperatures all low. Ensure calorifiers set to store and deliver water at a minimum of 60°C at all times.	Calorifier set point was adjusted to 65 degC in 2015. The image submitted below shows a screenshot of the current setpoint and flow/return temperatures."  Item 31 - Calorifiers screenshot.PNG			F
32	All calorifiers - The return temperatures recorded at the calorifiers were consistently below 55°C (P31 04/05/06 being the exception) which DMA were advised was the control set point for these, though all calorifier returns were reaching 50°C. It may be prudent to increase calorifier set points to ensure calorifier returns remain above 55°C as this is the control set point. This may also help maintain a 60°C minimum flow temperature when demand is placed on the calorifiers at peak periods. Increasing the calorifier temperatures may also have the beneficial effect of increasing the cold water usage as more cold water will be required at TMVs to blend water to TMV set point and so may assist in reducing any high cold water temperatures being recorded within the system."	Action was taken to address this back in 2015.			F
33	All calorifiers - Ensure linked calorifiers are balanced to provide equal throughput of water through each calorifier."	See evidence submitted at clause 31.			F
34	All Calorifiers (Circulation Pumps) - Fit caps to ends of spare circulation pump.	Complete.			F
35	Calorifier Plantroom 22 01/02/03 - Water flushed from drains on Calorifiers P22 01 & 02 ran very dirty for approx. 20 seconds before beginning to clear up. This should be investigated to determine cause – increased flushing frequency may be necessary if no cause and/or corrective action determined."	Flushing regime implemented. See evidence submitted at clause 26.			F

36	Calorifier Plantroom 31-01/02/03 - Calorifier P31 03 temperature very slightly lower than the other calorifiers. Ensure linked calorifiers are balanced to provide equal throughput of water through each calorifier and calorifier brought up to full temperature."	See evidence submitted at clause 31.			F
37	Calorifier Plantroom 31-07/08/09 - Water flushed from drains on Calorifiers P31 - 07, 08 & 09 ran very dirty for approx. 20 seconds before beginning to clear up. This should be investigated to determine cause – increased flushing frequency may be necessary if no cause and/or corrective action determined if no cause and/or corrective action determined"	Expansion vessel flushing/blowdown is done and recorded at the same time as the calorifier blowdown. See example record sheets submitted under Item 26.			F
38	Calorifier Plantroom 32 01/02/03 - Water flushed from drains on Calorifiers P32 - 01, 02 & 03 ran very dirty for approx. 15 seconds before beginning to clear up. This should be investigated to determine cause – increased flushing frequency may be necessary if no cause and/or corrective action determined."	Expansion vessel flushing/blowdown is done and recorded at the same time as the calorifier blowdown. See example record sheets submitted under Item 26.			F
39	Calorifier Plantroom 33-01/02/03 - Calorifier pump insulation stripped off due to previous leak – confirm fitting is stainless steel and not mild steel (Unable to confirm at time of survey). Replace if not stainless steel."	This is stainless steel.			F
40	Calorifiers Plantroom P41 - 01/02/03 - Water flushed from drains on Calorifiers P41 - 01, 02 & 03 ran very dirty for approx. 15 seconds before beginning to clear up. This should be investigated to determine cause – increased flushing frequency may be necessary if no cause and/or corrective action determined."	Expansion vessel flushing/blowdown is done and recorded at the same time as the calorifier blowdown. See example record sheets submitted under Item 26.			F
41	All Calorifiers -All plant items, pipework and valves should be labelled for identification purposes. The calorifiers do not have labels on them, instead being labelled at present by a marker pen, with a separate small identification plate on the side of each calorifier. The labelling does not match up in every instance between the hand written and id plate. It is advised that calorifiers have formal identification label attached to each one."	Drawings updated and tags fitted.			F
42	Calorifier Plantroom 33-01/02/03 - P33 Calorifier 01 gauge at base appears to be reading incorrectly – This should be replaced."	Replaced April 18.			F

43	QEUH (Adults) and Royal Hospital for Children - As the building users include persons with acute underlying medical conditions which increases susceptibly to contracting legionellosis then the requirements for L8, HSG 274 and HTM/SHTM 04-01 compliance is of paramount importance.	This is a note, not a non-compliance.			F
44	Connections to non domestic outlets - There are connection points onto other “non-domestic” outlets such as renal dialysis (both plant and individual ‘emergency’ points), endoscopy wash, pressurisation units, steam humidifier units and MRI chiller cooling which are connected to the Bulk Water system. DMA were advised by Mercury Engineering in 2015 that connections to ‘other risk systems’ had double check valves fitted during installation, though these are covered by insulation and DMA were unable to verify how close to the tee-off points these are. This should be checked and if necessary double check valves repositioned/fitted as necessary. It is also advised that fast fill connections are disconnected when not in use due to the different water categories between the wholesome domestic water and the chemically treated closed systems."	Duplicate from 2015 RA. Action complete.			F
45	Emergency Dialysis Points - NHS Estates have fitted ‘Emergency Dialysis’ points on cold water system since the initial installation. NHS should confirm location of all Emergency Dialysis Points and ensure System Drawings and Asset Lists (not produced as part of this assessment) are updated to reflect this."	This has been identified as a service requirement and drawings have been updated to reflect this."  Item 45 - Renal emergency water poi			F
46	Drain Points/Connection - There are also numerous connection points and drain points on the domestic water system within plantrooms and risers (which DMA have assumed were installed for flushing purposes and bypasses) which are creating deadlegs on the system. It is advised that these be removed wherever practicable or a register of the locations created and points incorporated into the site flushing regime (no evidence this	Duplicate of various 2015 RA points and actioned under that RA.			F

	is being completed at present)."				
47	Renal Plant and Disinfections"It should be noted that there is no separate dedicated supply to the Renal Plant (or other medical) systems, with all being fed from the Bulk Water system. This means that system disinfections will require to be very carefully scheduled or carried out locally as the disinfection procedure/chemical may interfere with the renal/medical systems and impact on patient welfare. Emergency procedures should be formulated to allow for system disinfection"	Duplicate of various 2015 RA points and actioned under that RA.			F
48	Cold Water Temperatures - Cold water temperatures recorded by DMA vary with some indicating heat gain on the cold water system. Investigations should be carried out as to the reasons for this with appropriate remedial actions taken e.g. additional insulation, installation of flushing valves, manual flushing of outlets, servicing of TMVS to reduce likelihood of back flow of hot into cold (or opposite). Sampling, disinfections and background dosing should be considered as part of the escalation process should issues persist.	This is a note - not a non-compliance.	.		F
	Increasing the calorifier temperatures may also have the beneficial effect of improving the cold water temperature profile as more cold water will be required at TMVs to blend water to TMV set point.	Set point increase on calorifiers was done in 2015.			F
	DMA were advised flushing valves are installed at a number of points on the domestic cold water system in the lower floors of the Adult and Childrens hospitals however Estates were unable to confirm the location of all valves.	Location of flushing valves are on the BMS and on drawings.			F
	The operating conditions for the valves (e.g. temperature controlled/timed) should be confirmed and included with the written scheme.	Written scheme has been updated with this information.			F
	It may be prudent to consider additional dump valves at the end of main or subordinate pipe work runs to improve cold water flow throughout site. Venturi loop systems may also be installed as part of such as system."	No new dump valves considered to be required by AP Water.			F
49	Access for Monitoring - Domestic water pipework runs	Duplicate from 2015 RA and will be actioned on			F

	above ceilings throughout the building. Access for ongoing monitoring will be problematic as ceiling tiles cannot be easily removed within the hospital environment and alternative methods of monitoring should be considered should current BEMS monitoring points not be sufficient for the hot flow and return system (e.g. additional BEMS monitoring points installed).	that RA.			
50	Thermostatic Mixing Valves/Taps/Showers - TMV servicing in high risk areas (advised to DMA by Estates) including flushing of hot and cold supplies to tap via flushing adapters has recently been carried out by DMA as we were advised the Estates regime may have lapsed. Servicing of some outlets (e.g. Armitage Contour Taps) is restricted as DMA have been advised we are unable to remove IPS panels. This gives further cause for concern as Estates were unable to confirm if the strainers on the supplies have ever been removed for cleaning/disinfection or taps fully serviced. The vast majority of TMVs installed are TMV taps, (Horne Optitherm in clinical areas and Armitage Shanks in nonclinical areas) with the only exceptions noted being infrared outlets in non-patient area toilets with infrared taps which have a TMV mounted approximately 0.5m from the outlet. Thermostatic mixing valves (TMVs) should be regularly serviced as per the manufacturers instructions and in accordance with the Written Scheme for site which should include input from the relevant NHS departments (e.g. Estates, Clinical, Infection Control, Authorising Engineer, Compliance Team, Health & Safety, Water Safety Group etc. – please note DMA's attendance at Water Safety Group meetings has not been requested) for local infection control guidance for bacterial control taking into account the location, design, operation, servicing and requirements of infection control. Horne Optitherm TMV taps are designed to be demounted for maintenance and servicing elsewhere but the facilities for this are yet to be completed and commissioned. Specific service method statements and maintenance	All High Risk areas have had TMT servicing and maintenance carried out until most recently when Point of Use (PoU) filters were installed. The only area where routine maintenance is not being carried out is on taps and showers across the QEUH/RHC. This will begin once the full water system chlorinisation project at the QEUH has been completed. High Risk Areas are currently protected by PALL filters installed at each outlet. All reactive maintenance is being auctioned through FMFirst (CaFM System). All 'little used outlets' are being flushed as per identified in 2017 RA (hyperlink above). Other major water assets (water tanks; calorifiers, dump valves etc) are being fully maintained.	It was agreed at the Board Water Technical Group (WTG) that any outstanding maintenance tasks will be carried out once the full water system chlorinisation project at the QEUH has been completed. .		F

	requirements for these items in these areas should form part of the written scheme."				
51	Thermostatic Mixing Valves/Taps/Showers - In addition, the strainers located on the supplies to the TMV taps in “Non-Clinical” areas (e.g. patient, visitor and staff toilets) are located behind panels and therefore infection control procedures are required (Scribe) in order to remove panels for service. We understand no servicing of any of these valves and the associated strainers in non-high risk areas has been carried out since the hospital opened and there has been a very limited program of servicing in ‘high risk’ areas. We are unaware of any servicing works being carried out and had access to servicing records on TMV taps in other areas of the hospital at the time of assessment. The recent (prior to assessment delivery) issue with regards to Cupriavidus bacteria being detected in the system water has highlighted that the servicing requirements of the TMV taps should be reviewed to ensure that in addition to manufacturers service instructions being carried out the servicing of TMV taps includes any additional control measures as deemed necessary by infection control e.g. full thermal bypass/disinfection of the taps where practicable and safe (this would require to be carried out remotely from patient areas) and flow regulator, O rings and other components cleaning, disinfection and/or replacement. There are no records that manufacturers recommendations have been implemented to date regarding commissioning and component changes. Estates advised there is currently no mechanism in place for ‘no access’ reports to be reactioned to ensure all valves are completed in the necessary time frame."	See Item 50 **This is to be removed from this RA as it was not identified at the time of the RA (ie September 2017.**			P
52	Shower heads and hoses - Showers appear to be a standard design throughout the hospital with no adjustable heads noted during the survey. However, as NHS Estates are unable to confirm the service history of the units and cleaning and disinfection of shower heads we would advise	Shower heads and hoses are now replaced quarterly (disposable).			F

	consideration is given to changing all heads and hoses with new WRAS approved heads and hoses."	 Item 52 - Example Shower Clean Record			
53	Flexible Hoses - DMA were advised by Mercury Engineering and Estates in 2015 that all materials fitted during the construction are WRAS approved and therefore do not support bacterial growth. In addition, EPDM flexible hoses have been installed in a small number of non-clinical areas with the only patient areas DMA have noted as having flexible hoses being the connection to Arjo baths (both connections to the hot/cold system and internally within the actual bath). Wherever possible DMA would recommend all flexi hoses are removed and connections hard piped. Where flexible hoses cannot be removed then replacing with alternative WRAS approved hoses with linings other than EPDM should be considered. In healthcare premises additional guidance on the replacement and use of flexible hoses is provided in the "safety action notice SAN(SC)09/03". Flexible hoses have also been noted on the boosted bulk water system on pressure reducing valves. If possible, these should be hard piped (stainless steel) or WRAS approved hoses with linings other than EPDM should be considered. Should these not be available for these types of units/connections then a regular inspection and replacement schedule should be implemented for these."	Arjo bath flexible hoses were changed out for WRAS hoses and are replaced on a rolling 2 year program. Regarding flexible hoses on the boosted bulk water system, it was confirmed by AP Water (Jim Guthrie) that the whole valve as an assembly with the hoses is WRAS approved.  Item 53 - Flexi Hose 2 Yearly Replacement			F
54	Trades Water System The bib taps, irrigation points (which DMA have been informed are no longer connected to the water system) and 12th floor heli-pad fire suppression system are fed from the Trades system with very long pipework runs through the building and plantrooms to the outlets. DMA would advise all points on the trades system should be included in the site flushing regime. Please also refer to section 8 for information on other risk systems. No outlets on the Trades system have been designated as "sentinel outlets". Due to the type of system and the	This included in the flushing regime. Duplicate of 2015RA.			F

	extended pipe runs to the outlets it may be prudent to designate all outlets from this system as sentinel and include in monthly monitoring and site flushing regime."				
55	Outlet 00 OPD/Concourse OPD0-073 (Shower) - Shower not working creating deadlegs. Outlet should be repaired and lines thoroughly flushed.	Complete.  Temperature Checks.pdf			F
56	Outlet 00C Decontamination DCU-003 (Wet Room) - Cold water temperature too high. Investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
57	Outlet 00C Radiology RCG-068 (Baby sleep) - Cold water temperature too high. Investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
58	Outlet 01 Radiology RAF-005 (Reception) - Ensure unused connection point included in flushing regime until put into use	Complete. For evidence see files attached to No.55			F
59	Outlet 01 Stroke STW-082 (Bath) - Out of order outlets (bath) in room creating deadlegs - these should be repaired and lines thoroughly flushed.	Complete. For evidence see files attached to No.55			F
60	Outlet 01C Critical Care CCW-021 (Bathroom) - Hot temperature slow to rise. It should be confirmed that hot outlet(s) are on a long leg and not that the flow and return has failed locally in this area	Confirmed that this is a long leg. For evidence see files attached to No.55			F
61	Outlet 01C Critical Care CCW-021 (Bathroom) - Hot water temperature too low. Investigate and correct.	Confirmed that what was measured was from a mixed outlet and mixed temperature is acceptable. For evidence see files attached to No.55			F
62	Outlet 01C Theatre 001-011 - Cold water temperature too high. Investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
63	Outlet 01C Theatre THE-009 (Toilet) - High cold temperature. Investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F

64	Outlet 01C Theatre THE-078 (Prep room) - High cold temperature. Investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
65	Outlet 01C Theatre THE-102 (Facilities) - Evidence of heat gain in cold water - investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
66	Outlet 01C Theatre THE-106 (Anesthetic room) - Cold water temperature too high. Investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
67	Outlet 01C Theatre THE-157 (Recovery room) - Cold water temperature too high. Investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
68	Outlet 04A - RENW-028 - Cold water temperature too high. Investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
69	Outlet 04A HOW-024 (Bathroom) - Cold water temperature too high. Investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
70	Outlet 04A HOW-027 (Bathroom) - Cold water temperature too high. Investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
71	Outlet 04B HOW-030 (Bathroom) - Cold water temperature too high. Investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
72	Outlet 04B HOW-065 - Cold water temperature too high. Investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
73	Outlet 04C RENW-153 (Bathroom) - Cold water temperature too high. Investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
74	Outlet 04D RENW-094 (Bathroom) - Cold water temperature too high. Investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
75	Outlet 05A GENWA-029 (Bathroom) - Cold water temperature too high. Investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F

76	Outlet 06A GENW1-029 (Bathroom) - Cold water temperature too high. Investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
77	Outlet 06D GENW2-034 (Bathroom) - Cold water temperature too high. Investigate and correct. Cold water temperature too high. Investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
78	Outlet 06D GENW2-065 (Bedroom) - Cold water temperature too high. Investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
79	Outlet 08D GENW10-057 (Bedroom) - Cold water temperature too high. Investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
80	Outlet 09A GENW13-029 (Bathroom) - Cold water temperature too high. Investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
81	Outlet 09B GENW16-036 (Bathroom) - Cold water temperature too high. Investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
82	Outlet 09D GENW14-028 (Bedroom) - Cold water temperature too high. Investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
83	Outlet 09D GENW14-065 (Bedroom) - Cold water temperature too high. Investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
84	Outlet 10A GENW17-029 (Bathroom) - Cold water temperature too high. Investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
85	Outlet 4B HOW-039 CDC - Cold water temperature too high. Investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
86	Outlet Basement KIT-031 - Unused vend connection should be removed or included in flushing regime	Vending connections all in use.			F
87	Outlet Hydrotherapy Plantroom A-1FMB-030 - Include bib tap & Emergency Shower in flushing regime	Confirmed to be working and these are on a flushing regime. For evidence see files attached to No.55			F

88	Outlet Hydrotherapy Plantroom A-1FMB-030 - Remove all deadleg pipework in this area.	Confirmed that deadleg pipework described could not be located. For evidence see files attached to No.55			F
89	General System - Pipework runs above ceilings in throughout every floor of the building. Access to these for ongoing monitoring will be problematic as ceiling tiles cannot be easily removed within the hospital environment and alternative methods of monitoring should be considered should current BEMS monitoring points not be sufficient for the hot flow and return system. additional BEMS monitoring points installed). DMA identified a very small number of localities where the hot water system did not appear to be functioning correctly and these should be investigated with corrective actions taken."	This is a note, not a non-compliance.			F
90	Oultet 06A GENW1-034 (Bathroom) Evidence of heat gain in cold water - investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
91	Outlet 00 A&E EMC-100 (Service) Evidence of heat gain on cold - investigate and correct	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
92	Outlet 00 A&E EMC-100 (Service) Include Unused outlets into site flushing regime	Confirmed that these are not unused and temperature is below 20degC. For evidence see files attached to No.55			F
93	Outlet 00 Acute Assess AAW-173 (Clinical Support) Include Unused outlets into site flushing regime.	Confirmed that these are not unused and temperature is below 20degC. For evidence see files attached to No.55			F
94	Outlet 00 Concourse ENT-038 (Baby Change) Include Unused outlets into site flushing regime.	Confirmed that these are not unused and temperature is below 20degC. For evidence see files attached to No.55			F
95	Outlet 00 Discharge DLO-008 (Consulting Room) Low mixed water temperature - Investigate and correct (TMV may require servicing)	Confirmed that this is a little used outlet and flushing is responsibility of Domestic / Clinical Users. For evidence see files attached to No.55			F

96	Outlet 00 Medical Illustration MIL-010 (Studio) Evidence of heat gain in cold water - investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
97	Outlet 00 OPD OPD0-003 (Male Change) Include Unused outlets into site flushing regime.	Confirmed that these are not unused and temperature is below 20degC. For evidence see files attached to No.55			F
98	Outlet 00 OPD OPD0-049 (Treatment Room) Evidence of heat gain in cold water - investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
99	Outlet 00 Orthotics ORT-017 (Disabled) Include Unused outlets into site flushing regime.	Confirmed that these are not unused and temperature is below 20degC. For evidence see files attached to No.55			F
100	Outlet 00 Pharmacy PHA-002 (Facilities) Low mixed water temperature - Investigate and crrect (TMV may require servicing)	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
101	Outlet 00 Radiology RAG-108 (Anaesthetic) Evidence of heat gain in cold water - investigate and correct.	Confirmed that this is a little used outlet and flushing is responsibility of Domestic / Clinical Users. For evidence see files attached to No.55			F
102	Outlet 00 Rehab REH-013 (OT Room) Evidence of heat gain in cold water - investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
103	Outlet 00 Rehab REH-013 (OT Room) Include Unused outlets into site flushing regime.	Confirmed that these are not unused and temperature is below 20degC. For evidence see files attached to No.55			F
104	Outlet 00C A&E EMC-059 (Bed Bay 6) Evidence of heat gain in cold water - investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
105	Outlet 00C A&E EMC-060 (Bed Bay 5) Evidence of heat gain in cold water - investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
106	Outlet 00C Consultancy CPS-003 (Consulting Room) Evidence of heat gain in cold water - investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F

107	Outlet 00C Consultancy CPS-003 (Consulting Room) Include Unused outlets into site flushing regime.	Confirmed that these are not unused and temperature is below 20degC. For evidence see files attached to No.55			F
108	Outlet 00C Consultancy CPS-006 (Toilet) Include Unused outlets into site flushing regime.	Confirmed that these are not unused and temperature is below 20degC. For evidence see files attached to No.55			F
109	Outlet 00C Decontamination DCU-003 (Wet Room)Include Unused outlets into site flushing regime.	Confirmed that these are not unused and temperature is below 20degC. For evidence see files attached to No.55			F
110	Outlet 00C Observation OBW-061 (Bedroom) Evidence of heat gain in cold water - investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
111	Outlet 00C Observation OBW-061 (Bedroom) Include Unused outlets into site flushing regime.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
112	Outlet 00C OPD OPD-125 (Changing) Include Unused outlets into site flushing regime.	Confirmed that these are not unused and temperature is below 20degC. For evidence see files attached to No.55			F
113	Oultet 01 Radiology RCF-001 (Facilities) Ensure any outlets which have been removed have not left deadlegs behind panels.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
114	Outlet 00C Radiology RCG-068 (Baby sleep) Include Unused outlets into site flushing regime.	Confirmed that this is a little used outlet and flushing is responsibility of Domestic / Clinical Users. For evidence see files attached to No.55			F
115	Outlet 00C Radiology RCG-087 (Dirty Utility) Evidence of heat gain in cold water - investigate and correct.	Confirmed that this is a little used outlet and flushing is responsibility of Domestic / Clinical Users. For evidence see files attached to No.55			F
116	Outlet 00C Radiology RCG-087 (Dirty Utility) Include Unused outlets into site flushing regime.	Confirmed that these are not unused and temperature is below 20degC. For evidence see files attached to No.55			F

117	Outlet 01 Critical Care CCU-036 (Bedroom) Evidence of heat gain in cold water - investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
118	Outlet 01 Critical Care CCW-029 (Toilet) Include Unused outlets into site flushing regime.	Confirmed that these are not unused and temperature is below 20degC. For evidence see files attached to No.55			F
119	Outlet 01 Critical Care CCW-087 (Bed Bay 37) Evidence of heat gain in cold water - investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
120	Outlet 01 Critical Care CCW-089 (Bed Bay 38) Evidence of heat gain in cold water - investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
121	Outlet 01 Critical Care CCW-092 (Gowning Room) Evidence of heat gain in cold water - investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
122	Outlet 01 Critical Care CCW-126 (Dirty Utility) Include Unused outlets into site flushing regime.	Confirmed that these are not unused and temperature is below 20degC. For evidence see files attached to No.55			F
123	Outlet 01 Critical Care CCW-131 (Pharmacy Support) Evidence of heat gain in cold water - investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
124	Outlet 01 Medical Day Unit MDU-012 (Treatment Room) Low mixed water temperature - Investigate and correct	Confirmed that cold supply temperature is below 20degC. For evidence see files attached to No.55			F
125	Low mixed water temperature - Investigate and correct Low mixed water temperature - Investigate and correct (TMV may require servicing)	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
126	Outlet 01 Medical Day Unit MDU-046 (Facilities) Evidence of heat gain in cold water - investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
127	Outlet 01 OPD POA-015 (Consulting Room) Evidence of heat gain in cold water - investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F

128	Outlet 01 OPD OPD1-063 (Dirty Utility) Evidence of heat gain in cold water - investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
129	Outlet 01 Stroke STW-047 (Bathroom) Evidence of heat gain in cold water - investigate and correct.	Confirmed that these are not unused and temperature is below 20degC. For evidence see files attached to No.55			F
130	Outlet 01 Stroke STW-079 (Arjo Bathroom) Include Unused outlets into site flushing regime.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
131	Outlet 01C Critical Care CCW-014 (Clinical) Evidence of heat gain in cold water - investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
132	Outlet 01C Critical Care CCW-098 (Critical Care Bed) Evidence of heat gain in cold water - investigate and correct.	Confirmed that these are not unused and temperature is below 20degC. For evidence see files attached to No.55			F
133	Outlet 01C Theatre 001-011 Include Unused outlets into site flushing regime.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
134	Outlet 01C Theatre 23HU-008 (Toilet) Evidence of heat gain in cold water - investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
135	Outlet 01C Theatre 23HU-051 (Toilet) Evidence of heat gain in cold water - investigate and correct.	Confirmed that these are not unused and temperature is below 20degC. For evidence see files attached to No.55			F
136	Outlet 01C Theatre THE-009 (Toilet) Include Unused outlets into site flushing regime.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
137	Outlet 01C Theatre THE-069 (Lab) Evidence of heat gain in cold water - investigate and correct.	Confirmed that these are not unused and temperature is below 20degC. For evidence see files attached to No.55			F
138	Outlet 01C Theatre THE-069 (Lab) Include Unused outlets into site flushing regime.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F

139	Outlet 01C Theatre THE-117 (Theatre Scrub) Evidence of heat gain in cold water - investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
140	Outlet 02 Dermatology DMW-025 (Bathroom) Evidence of heat gain in cold water - investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
141	Outlet 02 Dermatology DMW-031 (Bathroom) Evidence of heat gain in cold water - investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
142	Outlet 02 Dermatology DOPD-025 (Technician) Evidence of heat gain in cold water - investigate and correct.	Confirmed that these are not unused and temperature is below 20degC. For evidence see files attached to No.55			F
143	Outlet 02 FMA2-014 (Changing) Include Unused outlets into site flushing regime.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
144	Outlet 02 Renal RENO-016 (Room 3) Evidence of heat gain in cold water - investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
145	Outlet 02 Renal RENO-033 (Clean Utility) Evidence of heat gain in cold water - investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
146	Outlet 02 Renal RENO-064 (Equipment Servicing) Evidence of heat gain in cold water - investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
147	Outlet 02 Theatres THE-033 (Female Changing) Evidence of heat gain in cold water - investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
148	Outlet 02 Theatres THE-091 (Dirty Utility) Evidence of heat gain in cold water - investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
149	Outlet 02 Theatres THE-105 (Dirty Utility) Evidence of heat gain in cold water - investigate and	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
150	Outlet 02 Theatres THE-287 (Bed Bay A9) Evidence of heat gain in cold water - investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F

151	Outlet 02 Theatres THE-289 (Bed Bay A1) Evidence of heat gain in cold water - investigate and correct.	Confirmed that these are not unused and temperature is below 20degC. For evidence see files attached to No.55			F
152	Outlet 02 Theatres THE-289 (Bed Bay A1) Include Unused outlets into site flushing regime.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
153	Outlet 02 Theatres THE-302 (Bed Bay A7) Evidence of heat gain in cold water - investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
154	Outlet 02 Theatres THE-319 (Dirty Utility) Evidence of heat gain in cold water - investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
155	Outlet 02 Theatres THE-327 (Recovery) Evidence of heat gain in cold water - investigate and correct.	Confirmed that these are not unused and temperature is below 20degC. For evidence see files attached to No.55			F
156	Outlet 02 Theatres THE-327 (Recovery) Include Unused outlets into site flushing regime.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
157	Outlet 02 Transport Base TPB-001 (Clinical Workroom) Evidence of heat gain in cold water - investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
158	Outlet 02C Aseptic Unit ASU-039 (Changing Room) Ensure no deadlegs remain after outlets removed	Confirmed that these are not unused and temperature is below 20degC. For evidence see files attached to No.55			F
159	Outlet 02C Ward SCH-063 (Treatment Room) Include Unused outlets into site flushing regime.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
160	Outlet 02C Ward SCH-092 (Hospital Night Team) Evidence of heat gain in cold water - investigate and correct.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
161	Outlet 03C Ward GW2-035 (Bedroom) Evidence of heat gain in cold water - investigate and correct.	Confirmed that these are not unused and temperature is below 20degC. For evidence see files attached to No.55			F

162	Outlet 03C Ward GW3-068 (Lab) Include Unused outlets into site flushing regime.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F
163	Outlet 04 WS4-017 (Male Change) Evidence of heat gain in cold water - investigate and correct.	Confirmed that these are not unused and temperature is below 20degC. For evidence see files attached to No.55			F
164	Outlet 04B HOW-064 (Bedroom) Include Unused outlets into site flushing regime.	Confirmed that these are not unused and temperature is below 20degC. For evidence see files attached to No.55			F
165	Outlet 04B HOW-193 (Bedroom) Include Unused outlets into site flushing regime.	Confirmed that these are not unused and temperature is below 20degC. For evidence see files attached to No.55			F
166	Outlet 04C RENW-127 (Consulting Room) Include Unused outlets into site flushing regime.	Confirmed that these are not unused and temperature is below 20degC. For evidence see files attached to No.55			F
167	Outlet 04C RENW-156 (Bathroom) Include Unused outlets into site flushing regime.	Confirmed that these are not unused and temperature is below 20degC. For evidence see files attached to No.55			F
168	Outlet 04D RENW-060 (Bedroom) Include Unused outlets into site flushing regime.	Confirmed that these are not unused and temperature is below 20degC. For evidence see files attached to No.55			F
169	Outlet 10D GENW18-001 (Bedroom) Include Unused outlets into site flushing regime.	Confirmed that temperature is below 20degC. For evidence see files attached to No.55			F

NHS Greater Glasgow & Clyde

Meeting to discuss Prophylaxis
For Paediatric Haem-Onc patients

Tuesday 24th September 2019
9:30am-11:30am
Level 0 – OPD 016

Attendees: **Dr Dermot Murphy, Dr Christine Peters, Dr Teresa Inkster, Dr Shahzya Chaudhury**

Apologies: **No apologies noted**

Chair: **Dr Conor Doherty**

Minutes: **Ashley Millar**

Introduction

CD introduced the group and specified that the aim of the meeting was to review current prophylaxis strategies against gram negative bacteraemias and fungal infections among paediatric haem-onc patients.

Assessment of current risk: data sources detailing Gram-ve and environmental Gram –ve bacteramias

In order to assess current risk CD presented the 13/09/19 SBAR from the IMT detailing Gram –ve and environmental SPC charts and the view of the IMT regarding current risk.

Discussion centred on differing perceptions of current risk and different methodologies employed to assess. CP and TI discussed the SPC format and ECOSS data sources as well as local microbiological data which are collected longitudinally on individual patients. CP and TI shared data at the meeting and it is their conclusion that significant concerns remain. They would welcome examination and peer review of their data and concerns

Action: CP and TI to share locally held data with the group

DM informed the group that the haem-onc clinicians would welcome clarity on the differing assessment of risk. After a meeting last night in relation to re-opening Ward 6A the haem-onc clinicians felt that they needed more information before agreeing to do this and that an external review process had been agreed.

Assessment of current risk: potential ward sources of environmental Gram –ve's

CD relayed the current view of the IMT regarding environmental G-ve risk. In order to assess risk and need for prophylaxis CP and TI asked for current assessments of specific potential sources and current environmental sampling data.....

(Teresa – could you specify what we need to view and I'll complete action below)

Action:

Current use of ciprofloxacin prophylaxis

Current usage of ciprofloxacin prophylaxis started in June 19 to mitigate the risk of environmental Gram-ve infections on ward 6A. The rationale for this intervention was discussed. Adult BMT

practice on some units was discussed of using ciprofloxacin for a limited period to reduce risk of non environmental Gram –ve infections. Currently this practice is employed in select paed patients going through BMT similarly. However ciprofloxacin usage currently is more widespread amongst paed haem-onc patients and designed to mitigate environmental risk.

Other interventions had previously been examined in the prevention of CVL infection in this patient group including the use of taurolidine line locks for a short period. The potential for ciprofloxacin side-effects and the generation of further resistance was discussed and it was agreed these side-effects need to be balanced against efficacy.

A step down approach to the usage of ciprofloxacin prophylaxis in select patients (e.g. peri-transplant) and usage of taurolidine line locks was discussed and TI requested review of current environmental Gram –ve sampling data in order to better assess options

(Teresa – again could you specify what we need to view and I'll complete action below)

Action:

Antifungal prophylaxis

EORTC and current GGC guidance has specified which haem-onc patients should be considered for anti-fungal prophylaxis and this is particularly targetted to chronic neutropenia. In late December 2018 after the recognition of [redacted] cases of cryptococcal infection ([redacted]) a policy of more widespread usage of anti-fungal prophylaxis was enacted with either ambisome, pozaonazole, or caspofungin and fluconazole employed. There had also been pre-exisiting concerns re environmental molds on 6A.

Criteria specified included (please check this Teresa and could Shazya/Dermot confirm how the current anti-fungal prophylaxis is being employed)
- recent history of neutropenia (<0.5) for > 10 days
- allogeneic stem cell transplant
- prolonged use of steroids i.e. > 3 weeks
- treatment with other recognised T cell immunosuppressants during the past 90 days

Concerns were discussed over the potential for anti-fungal prophylaxis to interact with and/or potentiate side-effects associated with chemotherapy.

It was agreed that there was potential to more clearly specify which patients require antifungal prophylaxis. The rationale for Cryptococcus specific prophylaxis wanes as time passes from the [redacted] cases however current strategies are also driven by concerns over environmental mold infections. CD did not have any access to current environmental sampling data and this was requested by the group to rationalise prophylaxis strategies. CP discussed recent Irish guidance on better targeting of antifungal prophylaxis in environments of higher risk of mold infections

(Teresa – again could you specify what we need to view and I'll complete actions below)

Action 1) request for environmental mold sampling data – request to IMT
2) CP to share recent Irish guidance
3) Antifungal prophylaxis targeting strategies (Dermot & Shazyza – any mileage is consulting other large paed haem-onc units for their current guidance on how they interpret EORTC re what constitutes high risk?)

It was agreed that initial progress with the actions above will determine next meeting of the group.

From: Gibson, Brenda
To: Mathers, Alan; Mathers, Alan (NHSmail)
Cc: INKSTER, Teresa (NHS GREATER GLASGOW & CLYDE); Inkster, Teresa; Redfern, Jamie
Date: 27 July 2019 13:33:19
Attachments: Water organisms 2017.xlsx

Dear Alan and Teresa,

We meet a number of months ago to discuss the positive blood cultures in the Unit in 2017. I attach the file with the outcome for these patients. This was done by Shahzya Chaudhury who wasn't a consultant at that time and therefore it is truly independent . I am sorry for the delay but there has been a lot going on.

You will see that there are 3 deaths.

[redacted]

[redacted]

[redacted]

I wonder if [redacted] should be independently reviewed .I will leave this decision with you . I don't think that the others need to be . I don't know who is best to do this review, but presumably it should be independent . I am confident that once the organism was isolated that everything that could be done was done.

B.W.
Brenda

Royal Hospital for Children

1345 Govan Road

Govan

GLASGOW
G51 4TF
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www.show.scot.nhs.uk/yorkhill

Haematology/Oncology Department - Schiehallion Ward and Day Care Unit

Haematology Nurse Specialist: [redacted] Haemophilia Nurse: [redacted]

Ward 2A (Schiehallion): [redacted] Ward 2B (Schiehallion D/C): [redacted]

Prof Gibson, & Dr McIntosh's, Dr Downie & Dr Murphy's Secretary: [redacted]
Dr Chalmers, Dr Heaney & Dr Halsey Secretary: [redacted]
Dr Sastry, Dr Ronghe & Dr Chaudhury's Secretary: [redacted]

Ref: Haem Onc Consultants/AH

Date dictated: 5/12/19
Date typed: 5/12/19

Dear Jane,

We refer to your communication with parents following Mr Sarwar's press release. Paragraph 3 states

"I would once again encourage any parent who remains concerned about the quality of care their child has received to contact me directly to arrange a meeting" .

We would ask you as a matter of urgency to clarify the meaning of this sentence. It is our understanding that it is the quality of the environment which is of concern and not the quality of care. It is also our understanding that this communication has gone out to 400 parents and therefore very important that you clarify what you mean by "quality of care" and do so by return.

Yours sincerely

Prof Brenda Gibson
Dr Elizabeth Chalmers
Dr Fernando Pinto
Dr Nicholas Heaney

Dr Christina Halsey
Dr Shahzya Chaudhury
Dr Dermot Murphy
Dr Jairam Sastry
Dr Milind Ronghe
Dr Jonathan Downie
Dr Diana McIntosh

Greater Glasgow and Clyde NHS Board

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[redacted]
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Private and Confidential
Haemato Oncologist Consultants
Royal Hospital for Children
1345 Govan Road
Glasgow
G51 4TF

Date: 5th December 2019
Our Ref: JG/LLPAE

Enquiries to: Jane Grant
[redacted]

Dear Colleagues

Thank you for your letter dated 5th December 2019 regarding a statement made recently which has been shared with families, which included the line:

"I would once again encourage any parent who remains concerned about the quality of care their child has received to contact me directly to arrange a meeting".

You have asked me to clarify the meaning of this sentence, which I very much welcome the opportunity to do.

I would like to be extremely clear that this statement in no way reflects that there is any belief whatsoever that the clinical care and treatment of children is in any way the issue at hand. On the contrary, I am fully aware that the quality of the care you offer to patients and their families is exemplary. I therefore want to express my heartfelt thanks and gratitude to you for your hard work and dedication, particularly at the moment, when things have been so difficult. The excellent care that both the medical and nursing teams deliver to this group of patients has been commented on by many parents who have been in contact with me, which further supports this view.

With the benefit of hindsight, I understand why the sentence referenced above has caused concern, and for that I am truly sorry. The message I was trying to convey is that if any parent has concerns about what the recently reported issues mean in relation to their individual child, then I would encourage them to get in contact with us, and, as described above, I certainly did not mean to imply that there was an issue with clinical care.

I once again offer you my most sincere apologies. In order to address this, a further communication will go out to all parents, to clarify exactly what was meant by my statement. I hope this action will go some way to show my support of you all.

Yours sincerely

[redacted]

Jane Grant
Chief Executive
NHS Greater Glasgow and Clyde

NHS GGC

Acute Services

Women and Children's Directorate / Hospital Paediatrics and Neonatology

Appraisal of Options for Interim Inpatient and Day Care Arrangements while Ward 2A/2B RHC remains unavailable until March 2020

Option Ref	Option Description	Access to PIC/ Theatres/ Radiology	Adequate Inpatient Bed Capacity	Keeping All Paediatric Haematology Oncology Service Elements Combined	Effective Links to Paediatric HaN	Impact on Adult Services	Impact on Paediatric BMT Service	Impact on Day Care	Impact on Staff	Risk patients directed to English provider
1	Status Quo Ward 6A / Ward 4B (4 beds) – new patient admission restrictions still in place to Ward 6A	Yes	Yes – and Ward 6A available to March 2020	New patients being directed to RHSC Edinburgh. Short term chemotherapy inpatients being directed to RHSC Edinburgh and Aberdeen	Yes	General Adult Service relocated to Gartnavel. Pressure on Adult Stem Cell Capacity	Potential Impact. If beds to be used flexibly to avoid patient travel to Edinburgh / Aberdeen	No impact. More flexible working space with less inpatients in Ward 6A	Nursing / medical staff may need to be directed to Edinburgh / Aberdeen to support patients	Yes
2	Status Quo Ward 6A / Ward 4B (4	Yes	Yes – and Ward 6A	Yes – across different	Yes	General Adult Service	No impact	Limited capacity but service	No impact	No impact

	beds) – new patient admission restrictions lifted		available to March 2020	floors of Adult Hospital		relocated to Gartnavel. Pressure on Adult Stem Cell Capacity		capable of working within allocated floor plan		
3	Status Quo Ward 6A / Ward 4B (4 beds + additional beds – new patient admission restrictions still in place to Ward 6a	Yes	Yes – and Ward 6A available to March 2020	Avoid transfer of patients to Edinburgh and Aberdeen with extended use of Ward 4B	Yes	General Adult Service relocated to Gartnavel. Extended pressure on Adult Stem Cell Capacity	No impact	No impact. More flexible working space with less inpatients in Ward 6A	No impact	No impact
4	Paediatric Haematology Oncology	Yes	N/A	Yes (all staff in a single floor)	Yes	Adult Stem Cell Transplan	Likely impact – service may	Likely Impact – Limited	No impact	Adult Stem cell transplant

	Service transferred to Ward 4B			Not achievable see Impact on Day Care		t service would need to be relocated	need to be suspended due to lack of beds	room for daycare in 4B, so would need housed in separate location / remain 6A		patients may need to be transferred to English unit
5	Relocation of Paediatric Haematology Oncology service to another Hospital in NHS GGC e.g. B eatson	No	TBC	TBC	No	TBC	Service suspended	TBC	Change of Base hospital and local clinical supervision arrangements	Stem cell transplant patients would need to be transferred to English unit

6	Relocation of Paediatric Haematology Oncology service to another paediatric Hospital out with NHS GGC	Yes (if NHS Lothian but note reduced PIC / Theatre and Radiology capacity they will have)	Unlikely existing RHSC Edinburgh service current footprint could sustain the full transfer of RHC workload without extra space being prioritised	Unlikely. Transfer of proportion of workload required to be split between Edinburgh and Aberdeen. Outpatient services to be retained in RHC. Yes/No General day care services be retained in RHC? Yes/No	Yes (but different hospital provider)	No impact	Service suspended	TBC Query should general day care services be retained in RHC? If yes where?	Yes. Nursing and medical staff would need to follow patients	Stem cell transplant patients would need to be transferred to English unit

7	Use of a Modular Build	Yes – external pathway would need to be considered	Yes – if flexibility to build to specification. And a preferred location on campus could be identified	Yes – if flexibility to build to specification	Yes – but impact would depend on location of modular build	No impact	Impact dependent upon specification of modular build. Risk service suspended	Impact dependent upon specification of modular build	No impact	Dependent upon stem cell transplant impact and specification of the modular build

Footnotes

1) There are potential options within options 1 – 7 (especially around the provision of day care and Stem Cell transplant)
2) The infection control impact is embedded in the options – future drafts may need to be more explicit on this particular risk

Kevin Hill
Director
Draft version 1 - 13/09/19

09/11/2015

Dear Dr Stewart

Further to the outcome of your investigation on 30/10/15 into concerns we raised regarding patient safety we feel it necessary to write to you to reiterate these concerns. Whilst we acknowledge there are issues within the infection control team with respect to functioning , governance, behaviour and cultures the focus of our concerns was and remains patient safety. It is unclear to us how the OD event later this month will adequately address these concerns. A brief summary of ongoing issues and patient safety concerns are detailed below.

QEUH new build

There was minimal involvement from the Infection Control Team (ICT) with regards to the new build design. SHFN 30 clearly delineates the roles and responsibilities of the ICT at each stage from planning to handover and ongoing monitoring. In summary plans for ventilation specifications were not signed off, validation reports were unchecked and monitoring prior to and after patients moving in was not undertaken. As a result essential components were missing from the design putting patients at risk. We have no had assurances that these deficiencies have been addressed in the following areas;

A) **Adult BMT** - ward 4B QEUH was moved back to the Gartnavel site in July 2015 .The BMT rooms in 4B were not fit for purpose. During our involvement with the process of moving the unit back specification plans and validation reports were not made available to us. No environmental monitoring took place prior to patients moving in . Air monitoring subsequent to patients moving in revealed high levels of fungus in the environment . Please note that on two occasions reference to CDC guidance on specification was forwarded to the design and infection control teams by Dr Inkster at least a year prior to the move. Ward 4B has now been handed back to the users. The last involvement either of us had was the meeting on Friday July 10th when the decision was made to move the patients back to the Beatson. We were not invited to the follow up meeting on the Monday and have had no correspondence regarding the process of remedial work until Dr Inkster was informed on Monday 2nd November that the building was being handed back and she was now Leading for infection control regarding the move back from the Beatson. Our concerns have yet to be adequately addressed.

B) Children's BMT –In contrast air monitoring was performed in the children's BMT prior to patients entering the unit. Despite fungus being found on air sampling and holes present in the ceiling where light fittings were missing, patients were moved in and transplants allowed to proceed. Whilst remediation works are taking place transplants continue to take place and air sampling results have continued to be positive. Highly pathogenic fungi were frown in the environment eg Mucor and Aspergillus.

C) **Isolation rooms in critical care** – On several occasions we have been informed by senior management that these rooms are safe. In July BICC were assured that these rooms met the national specs, however in June Dr Peters had pointed out to IC management that this was not the case as permeability testing was not carried out and she had concerns around the design and commissioning process. Furthermore on inspection pressures have been wrong (-30 Pa instead of +10Pa), baffles were jammed shut, and rooms are not sealed. There are no alarms in place which is a specific stipulation in the SHBN-04 for consideration of these rooms to be fit for purpose. We continue to experience calls regarding safe placement of patients with infectious conditions with no assurances that these rooms meet the required specification. There continues to be confusion regarding which rooms have been "fixed" and we are not in receipt of any documentation that gives us assurance that this is the case.. In addition to patient safety issues there are issues with staff safety should these rooms not be functioning.

D) **Other clinical areas**
– there had been shortcomings in design and commissioning with regard to the decontamination room in A+E which was identified as the place to admit ?VHF patients
- Respiratory clinics did not have adequate decontamination facilities with buckets of water being used as decontamination sinks were not provided in the design.
- We have heard rumours regarding other defects in ventilation and design, but have no access to the information or the discussion surrounding the design and commissioning of these units eg dental facilities, audiology units etc..

Old Build

A)**Neurosurgical theatres**– there have historically been recurrent sewage leaks in these theatres. During investigation of a recent leak fungus was

identified on air sampling and wet mouldy materials removed from ceilings above theatres. Major issues were noted with theatre layout and practice and these have been escalated but not actioned. Of particular note is that sterile stores for instruments do not meet recommended standards with respect to ventilation . One such store has missing ceiling tiles with evidence of water damage but is still in use. A recent review of spinal surgery rates indicate that NHS GGC rates are up to six times higher than the literature on the subject quotes.

Outbreaks/Incidents

A) **NICU** – [redacted].
We are aware from attendance at team meetings that Serratia has been present in the unit since July. Despite asking we were given minimal information as we do not have ICD responsibility for this area . Screening for a source was suggested by us in August however we were told that this was not felt necessary until further cases emerged. Other environmental organisms such as Acinetobacter , Pseudomonas and Burkholderia have also been identified. . [redacted]. This would suggest major failings with the environment . Furthermore there have also been a number of SABs, and genotyping of isolates has been suggested, but not carried out to date which would clarify whether these are the same strain or not. Whilst this is not our area of responsibility, we do cover the unit out of hours and have concerns that IC issues have not been resolved.

B) **EBOLA**

IC planning for the care and isolation of ?VHF cases has lacked clarity. The decon room in A+E was identified as an appropriate place to care for high risk patient, however the room was not functional, with doors not shutting , temperature control being inadequate and the floor difficult to decontaminate due to rough surface, among other issues. That room was designed for radiological and chemical incidents, with completely different requirements from infectious agents. There is confusion around which level of the IPCT is responsible for the full planning of such incidents and decisions are made without being communicated to local teams which had a direct adverse consequence in the recent Ebola case as well as with ?MERS cases admitted recently.

In conclusion we do not have reassurance that these situations are being adequately addressed/ resolved . We are concerned that local colleagues with expertise have also raised concerns regarding these issues. We suggest that it may be beneficial to have an external expert opinion with regard to these situations in order to give the organisation comfort that patients are not being put at risk.

Dr Teresa Inkster MBChB, BSc (Hons), FRCP, DTMH, MPH, FRCPath
Consultant Microbiologist and Infection Control Doctor
Training Programme Director, Medical Microbiology.
Dept of Microbiology
Queen Elizabeth Hospital
Glasgow

Dr Christine Peters MBChB, BSc (Hons), DTMH, FRCPath
Consultant Microbiologist and Infection Control Doctor
Dept of Microbiology
Queen Elizabeth Hospital
Glasgow

From: Robertson, Lynne
To: Redfern, Jamie
Subject: FW: BMTU RHSC
Date: 05 June 2015 10:27:29

Regards Lynne

Lynne Robertson | Clinical Services Manager| NHS Greater Glasgow and Clyde
(Yorkhill Hospital) | RHSC Glasgow | Dalnair Street | Glasgow G3 8SJ
[redacted]

From: Gibson, Brenda
Sent: 05 June 2015 09:12
To: Robertson, Lynne
Subject: Re: BMTU RHSC

We have planned a transplant who will need hepafiltration around 20th June. If we can't guarantee this then we need to refer to Newcastle. That will cost £250,000. It is inconceivable that a transplant unit was built without hepafiltration. Truly shows the priorities all show and no substance.
Sent from my BlackBerry 10 smartphone on the EE network.

From: Robertson, Lynne
Sent: Wednesday, 3 June 2015 22:25
To: McNamee, Sandra; Powrie, Ian
Cc: Walsh, Tom; Joannidis, Pamela; Gibson, Brenda; Williams, Craig; Redfern, Jamie; Hill, Kevin
Subject: RE: BMTU RHSC

Ian,
At our management meeting today Kevin Hill asked me to ensure that we got a costing for the hepafilters and an approximate date of delivery for the order and to communicated these details to him prior to ordering the filters. Are you able to email this to me please

Sandra,
The situation you describe below I will need to ask Brenda to confirm at what stage of treatment that positive pressure and hepafiltration is required and are any of the current patients requiring this level of isolation. I am led to believe that this is not the case so this would not effect the current client group's transfer as positive pressure would be adequate and therefore not impact on migration dates

Brenda can you please confirm

Regards
Lynne

Lynne Robertson

CSM
Women and Children's Directorate
[redacted]
P.A. Cathy Crookes
[redacted]

From: McNamee, Sandra
Sent: 03 June 2015 17:01
To: Powrie, Ian; Robertson, Lynne; Williams, Craig
Cc: Walsh, Tom; Joannidis, Pamela
Subject: BMTU RHSC

Hi
Craig is not back until Friday but I think we need to sort out a meeting that day about the ventilation in the BMTU in the children's hospital. I understand the filters will take 10 days to order and that the clinical team has delayed the first transplant but I think Craig will need to say what would be needed in order for the other children to be safely looked after in this area. I'm not an expert but I have spoken to two other ICD/microbiologists today and they think that there is a requirement for the filters to be in place before any children are transferred over but Craig may have a different opinion. this has the potential to delay the transfer of services beyond the migration date.
regards

Sandra McNamee
Associate Nurse Director
Infection Prevention & Control
[redacted]
[redacted]

From: Redfern, Jamie
To: Gibson, Brenda
Subject: Re: Hepa filtration
Date: 05 June 2015 12:34:56

Yes no problem
No decision would be taken without your okay and input

Sent from my Samsung device

-------- Original message --------
From: "Gibson, Brenda" [redacted]
Date: 05/06/2015 12:28 PM (GMT+00:00)
To: "Redfern, Jamie" [redacted]
Subject: RE: Hepa filtration

TOO BUSY TO REPLY PROPERLY. DO NOT CHANGE MIGRATION PLAN UNTIL WE ALL TALK.

Brenda

From: Redfern, Jamie
Sent: 05 June 2015 12:26
To: Gibson, Brenda
Cc: Williams, Craig; Robertson, Lynne; Beattie, Jim; Dawes, Heather; Powrie, Ian
Subject: Hepa filtration

Hi Brenda
I just spoke to CW and he has noted
1. Hepafiltration should be functional by early next week in nch
2. As a result of works to do pt 1 and associated testing we will prob need to alter migration plan to later in the week.
As a result of this there should be no risk to the transplant case scheduled later in month.
I've ccd CW into email and he can confirm if accurate.
We can shortly agree how we take forward pt2 and what this means for us and any other clinical services.
Jamie

Sent from my Samsung device

From: Gibson, Brenda
To: Redfern, Jamie
Subject: Re: Transplants 2a
Date: 06 August 2015 20:17:04

We think the we are okay but can't find anyone who can confirm. We have been trying to establish which rooms are suitable but everyone seems to be on holiday. We have time to sort tomorrow.

Sent from my BlackBerry 10 smartphone on the EE network.

From: Redfern, Jamie
Sent: Thursday, 6 August 2015 22:39
To: Gibson, Brenda
Cc: Robertson, Lynne; Mathers, Alan
Subject: Transplants 2a

Hi Brenda
I'm picking up some email traffic that suggests we have an issue with suitability to transplant in w2a.
Can you confirm? If helpful happy to talk to you on mobile tonight or tomorrow first thing?
Cheers

Sent from my Samsung device

From: Gibson, Brenda
To: Williams, Craig; Redfern, Jamie; MacKinnon, Yvonne
Cc: McNamee, Sandra; Walsh, Tom; Powrie, Ian
Subject: RE: BMT unit
Date: 19 August 2015 08:27:55

We really do need a decision today about whether or not we resume transplant. [redacted] I can't do an afternoon meeting , only late morning.

Brenda

Prof Brenda Gibson
Consultant Haematologist
Schiehallion Ward (Ward 2A)
Royal Hospital for Sick Children
1345 Govan Road
GLASGOW G51 4TF

[redacted]

From: Williams, Craig
Sent: 18 August 2015 15:17
To: Redfern, Jamie
Cc: McNamee, Sandra; Walsh, Tom; Gibson, Brenda; Powrie, Ian
Subject: BMT unit

Dear Jamie

I've done a quick phone around of Microbiology Consultants taken from the list of Paediatric transplant centres listed on the BSBMT registry. Our build is in line with all of the other paediatric centres that I have been able to contact so far. There is a lot of variability in how the ongoing testing of the rooms is done which will be useful to discuss further. I will try and get hold of more centres prior to the meeting. Not sure if this tallies with Prof Gibsons findings

Best wishes

Craig

Prof Craig Williams
Consultant Microbiologist Royal Hospital for Children Glasgow
Professor of HAI UWS

From: Redfern, Jamie
To: Gibson, Brenda
Subject: FW: Urgent - BMT
Date: 24 August 2015 15:20:00

Hi Brenda

Obv we are hoping for good news and agreement we can start transplanting new patients again fairly soon

If we receive less positive news on the case which is clinically urgent over next couple of weeks which alternative unit should we be considering referral to?
Not at this stage going to do anything but would be useful to know what your thoughts on this would be.
Do we have a preferred transplant start date for this child?

Jamie

From: Loudon, David
Sent: 24 August 2015 14:15
To: Calderwood, Joanne
Cc: Armstrong, Jennifer; Stewart, David; Williams, Craig; Redfern, Jamie; Mathers, Alan; Walsh, Tom; Powrie, Ian; Cannon, Paul; Archibald, Grant
Subject: Re: Urgent - BMT

Grant

I am I'm meetings all day and have asked Peter Moir to attend any meetings.

Therefore, can Craig, Peter and Ian Powrie meet this afternoon to address the questions you have raised.

Regards

David

David W Loudon MCIOB CBIFM MBA
Director of Facilities and Capital Planning
NSH Greater Glasgow & Clyde

On 24 Aug 2015, at 13:48, Calderwood, Joanne [redacted] wrote:

> Dear All
>
> As you know I was keen to meet with you today to progress the RHSC BMT Ward. It has not been possible to arrange for the necessary relevant parties to be available at the same time. On that basis, I recommend that there is an exchange of commentary between David Loudon and Craig Williams which identifies the folloiwng:
>
> 1. An opinion regarding the suitabiliity of the facilities in their current configuration

2. An Infection Control opinion identifying if the rooms can now be used.

3. Identification of what others actions ICT/Estates require to be conducted to make the rooms operational.

4. The timescales for effecting item 3 if it applies.

As you know, we have patients awaiting care and therefore it is an absolute priority we have a clear opinion on this matter as soon as practicable, preferably by close of play today. I would thank you for your assistance.

Kind Regards

Grant Archibald

From: Gibson, Brenda
To: Williams, Craig; Redfern, Jamie
Date: 02 September 2015 12:07:36

Hi,

We now need a definite decision re SCT transplant and rooms. I understood that if we couldn't go ahead two weeks after the last meeting , that we would send the children elsewhere. Two weeks have elapsed , so you either reassure the SCT team that these rooms are fit for purpose now or we make arrangements for these children to be treated elsewhere. We should not have moved until it was known that the environment was safe.

B.W.Brenda

Prof Brenda Gibson
Consultant Haematologist
Schiehallion Ward (Ward 2A)
Royal Hospital for Sick Children
1345 Govan Road
GLASGOW G51 4TF

[redacted]

From: Gibson, Brenda
To: Armstrong, Jennifer
Cc: Williams, Craig; Redfern, Jamie
Date: 04 September 2015 17:30:36

Dear Jennifer,

I have just meet with Craig Williams and I understand that the problem with the isolation rooms on ward 2A has not been resolved. This has now gone of for two months and every deadline has been
breached. As a clinical team we have lost faith and find it difficult to repeatedly be unable to give the families any firm timelines. [redacted] Suggesting referral to another centre is not the solution it may appear , because all centres have a waiting list and will not be in a position to accommodate a transplant in the timeframe needed.

We feel that we are due an explanation as to how this problem arose. If this were a commercial enterprise - a drug company- who required a clean facility , only a company with a sound track record in this area would have been engaged. Did this happen here? Any problem would have been promptly resolved because of the financial penalty. We have no feeling that the appropriate sense of urgency is in place. Is NSD , the funders of the transplant programme , aware that the transplant programme has been severely compromised?

B.W.

Brenda

Prof Brenda Gibson
Consultant Haematologist
Schiehallion Ward (Ward 2A)
Royal Hospital for Sick Children
1345 Govan Road
GLASGOW G51 4TF

[redacted]

Draft meeting report

25/4/2018

NHS Greater Glasgow & Clyde

FAO Dr Teresa Inkster

Dr Susanne Lee BSc.(Hons) PhD., FRSPH., CBiol., FRSB., FIHEEM., FWMSoc., MRCSHC
Director / Owner: Leegionella Ltd,
Email :- [redacted]
[redacted]
Providing Independent Public Health Microbiology Services to the Public and Private sector

1 Limitations

This report an overview of the meetings which took place on the 25/4/18; in the morning with Dr Inkster, Annette Rankin - Nurse Consultant , Health Protection Scotland, .Prof Brenda Gibson - Cons haematologist, Royal Hospital for Children and Susie Dodd - Lead IPCN , RHC and in the afternoon with Dr Teresa Inkster , Annette Rankin, Maryanne Kane - Interim Director of facilities, Ian Powrie - Estates manager, Ian Storrar - Health facilities Scotland and Colin Purdon – estates.
Because of the limited time the discussions focused on the children's hospital only and included a visit to ward 2A.

2 Summary

The visit was at the request of Dr Teresa Inkster lead Infection prevention and Control Doctor based at the Queen Elizabeth Hospital in Glasgow following the identification of hospital acquired *Cupriavidus pauculus* and also *Stenotrophomonas* spp. associated with the water system. Both of these are clinically significant
The meeting began with an overview of the situation to date and a description of the water supply, storage and distribution to the wards.
The hospital is supplied from 2 separate points off the main (for resilience) into two storage tanks; these tanks are alternated on an 11 hour cycle. For the children's hospital the water is pumped at 5 bar to a roof top plant room and the via gravity feed to the outlets.
The children's hospital is a national centre for paediatric haematology oncology including bone marrow transplantation. About 95% of the patients fall into the category of very high risk of infection. As an interim measure point of use filters have been fitted throughout the hospital whilst longer term remedial measures are sought.

3 Discussion points included:

3.1 Reason for the growth of *C. pauculus* and other waterborne opportunistic pathogens

The isolates are naturally occurring waterborne microorganisms and therefore may have been present in the supply water in low numbers but were able to colonise and grow within the water systems (both hot and cold). Their presence in the hot water suggests that temperature control has not always been achieved.

In new buildings in particular the highest risk time for contamination is during the build and installation and commisioning; if adequate precautions are not taken to ensure that pipework; components etc. are not protected from contamination before installation e.g by the manufacturer capping the ends of pipes; not pressure testing with water etc. the system can be contaminated before it is even filled.

A common major failing is that water systems are filled with water for pressure testing and then not adequately managed (they should then be managed as if the building was fully operational). There was at least a 12 month lag between filling the systems and occupation , this allows biofilms to develop and establish .

Because biofilms can penetrate all nooks; crevices and all the surfaces within components etc. it is not possible to eliminate them successfully from a system . biofilms are inherebtly more resitant to biocides than their free living counterparts.

Recommendation 1. **Water systems should be pressure tested with gas whenever possible and the systems filled with water as late in the build as possible. Once filled they should be disinfected and flushed to remove nutrients such as cutting fluids etc. and the kept flowing and disinfected as if the building was in full operational use. Records should be kept of when the system is filled; commissioned; handed over; and occupied together with all disinfection monitoring and flushing and any remedial works that need to be carried out.**

3.2 Fungal contamination including by *Aspergillus*

During demolition work it is accepted that hazards such as *Aspergillus* spp. and other environmental fungi may be released into the air. Damping down to reduce risk is an important control measure. However, it has been noted that cleaners have reported higher than expected dust on surfaces within the hospital buildings as a result of this demolition work. *Aspergillus spp.* have been cultured from numerous hospital sources including unfiltered air, ventilation systems, contaminated dust dislodged during hospital renovation and construction, horizontal surfaces, and food as well as water supplies [1]

There is strong association of construction and renovation with *Aspergillus* outbreaks . Weber et al 2009 [1]:review guidelines for reduction of risks. It is likely that the fungal contamination is a consequence of the ongoing demolition work.

3.3 Training

It is important that installers are aware of aseptic technique and the need to keep separate tools for working on clean and dirty systems or being trainined in disinfection techniques and an understanding of why water hygiene can make the difference between life and death for vulnerable patients. SERC Northern Ireland runs a course specifically for healthcare plumbers and I have forwarded the contact there to Dr Inkster.

Staff training should be reviewed for all staff. It is important that training is updated in light of the changes to the HSE guidance and HTM series, HTM 04-01. Advises that updated water

[1] David J. Weber, Amanda Peppercorn, Melissa B. Miller, Emily Sickbert-Benett, William A. Rutala; Preventing healthcare-associated Aspergillus infections: review of recent CDC/HICPAC recommendations, Medical Mycology, Volume 47, Issue Supplement_1, 1 January 2009, Pages S199–S209, https://doi.org/10.1080/13693780802709073

hygiene awareness should be given to all relevant members of staff including the CEO and board, those working on water systems, including plumbers (including those working for outside contractors), plumbers working on water systems in healthcare should attend or have attended a "Watersafe" or equivalent course.

Recommendation 2. **It is important that all internal maintenance staff; estates officers and contractors undergo training not just in *Legionella* awareness but also other potential waterborne pathogens of interest, the site policies; procedures; patient confidentiality; documentation requirements; requirements for bringing equipment safely on site; relevant legislation and guidelines etc.**

Recommendation 3. **To ensure that plumbers / contractors use separate or disinfected tools for working on clean systems and these are kept apart from those used on the waste water systems. Only contractors who have successfully completed an approved training programme should be allowed to work on the healthcare water systems. HTM 04-01 recommends a "Watersafe" or equivalent qualification for plumbers working within healthcare. SERC in NI runs an accredited course for healthcare plumbers.**

3.4 Water safety group

The WSG as described within the scheme of control does not comply with the latest best practice guidance (WHO; HSG 274 and HTM 04-01) and is still very much geared to *Legionella* . Whilst *Legionella* remains a high threat to patients from contaminated water there is increased awareness of the potential for water to cause other waterborne hospital acquired infections from a range of opportunistic pathogens of bacterial; fungal; viral and protozoan origin.

Recommendation 4. **I recommend that the composition of this group is reviewed so that it has a more holistic multidisciplinary approach to water safety management.**

Recommendation 5. **The WSP should also include water used in diagnosis and treatment. This needs to be reflected in a greater input from Infection Prevention and Control who should lead the oversight of all uses of water for all types of user within the hospital including representation from special user groups. such as renal dialysis; hydrotherapy; augmented care; obstetrics, pharmacy etc.**

3.5 Water safety plan

The WSG should adopt the water safety plan approach for all uses of water on site, this involves the development of an asset register, which identifies the significant components; as well as equipment and any associated ancillary systems (e.g. pool waters ;).

Recommendation 6. **To delop an asset register as described above, This asset register should then inform the group of the needs for risk assessment, management and maintenance regimes and surveillance and monitoring requirements.**

The WSG should determine the quality of water required for the safety of each user group; for example for respiratory nebulizers; bathing neonates etc. only sterile water should be used. The WHO water safety in buildings includes a list of recommendations from the French Guidelines for hospital water quality which may prove an aide[2]. WHO[34]:- states *" renal dialysis requires large volumes of water that is of higher quality than drinking-water. Water used for dialysis requires special processing to minimize the presence of microorganisms, endotoxins, toxins and chemical contaminants. There are special requirements regarding aluminium, which, in the past, has caused dialysis dementia,* ***and dialysis patients are also sensitive to chloramines****, which needs to be considered when chloramination is used to disinfect drinking-water supplies, particularly in areas where there are home dialysis patients and states that "****All health-care facilities should have specific WSPs as part of their infection control programme. These plans should address issues such as water quality and treatment requirements, cleaning of specialized equipment and control of microbial growth in*** **water systems and ancillary equipment.**[5]

3.6 Design issues

3.6.1 Single barrier approach

It is a concern that a hospital intended for high risk patients was not designed with a multiple barrier water safety plan approach and relies solely on temperature as a control measure. It is predictable highly that in large complex systems that water temperatures are unlikely to meet the control temperature target at every outlet 100 % of the time (55 °C within one minute at hot outlets and < 20 °C within 2 minutes). In addition in the very high risk areas it would have been prudent to have anticipated the need for point of use filters to protect the highest risk patients. Outlets which are demountable for disinfection (washer disinfector) or sterilisation (autoclaving) are available and some with screw fittings to accommodate a good POU filter connection. Whilst these would not be necessary throughout the hospital it would be prudent to have this type of outlet in augmented care areas. Overprovision of outlets

It was felt that there was overprovision of outlets which contributes to low flow in parts of the system; particularly patient ensuite bathrooms. There are several reasons why designers overprovide on the number of washhand basins:-Sadly the formula for working out the number of outlets has not

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2 http://apps.who.int/iris/bitstream/handle/10665/76145/9789241548106_eng.pdf;jsessionid=CC651523E1A09DBD1A0F496029390FAE?sequence=1

3 http://apps.who.int/iris/bitstream/handle/10665/254637/9789241549950-eng.pdf?sequence=1

5

changed for decades and does not take into account the reduced need for WHBs in modern healthcare because:

- **less handwashing is carried out as a result of the increased use of alcohol gels.**
- **patient stays are much shorter and when in hospital; patients are generally much sicker so they do not use outlets as frequently as previously (if at all) .**
- **The move to single en suite facilities with showers compounds the problem; consideration should be given to providing en suites with a toilet and wash hand basin but communal showers to reduce the risk of stagnation and both capital and on-going operational and maintenance costs .**

Recommendation 7. **To review the numbers and placement of washhand basins and remove those deemed unnecessary. The installation of flow sensors may indicate where there is a lack of use and the potential for stagnation. The WSG in consultation with the users should agree where washhand basins should be retained and if a flushing regime needs to be implemented. Self-flushing outlets installation, based on local risk assessment, may reduce the risk of the human factor especially where there are access problems such as in isolation rooms etc. however there must be accompanying information so patients are not unduly alarmed at outlets turning themselves on. The timing of the flushing should also be considerate of patients sleep patterns etc.**

3.6.2 Sluice rooms

A further consideration during the design process hould be the position of sluice rooms to reduce the distance for nursing, ancillary staff and patients relatives to have to carry basins for water used for patient hygiene. In ward "a for example these are placed at each end of the ward. More central based utility rooms would reduce the distance and the likelihood of clinical sinks being misused .

Recommendation 8. **The Trust to develop / review their design guide in collaboration with Infection Prevention and control specialists to ensure infection risk reduction is inherent in any future design. This includes the separation of hot and cold services to reduce the risk of heat gain / loss in the water systems.**

3.7 Flow straighteners / aerators

Inserts at the outlet are not recommended in healthcare and have been linked to *Pseudomonas aeruginosa* infections in patients including the deaths of 3 neonates in Belfast. Work carried out by public health England isolated 2.2 x 10^7 cfu/ *Pseudomonas aeruginosa* from the inserts fro the NICU at BHSCT. As long ago as 1966 plastic inserts were identified as being a cause of waterborne HAIs. This is because they increase significantly the surface area so providing a large surface for biofilm formation , the small meshes collect dirt and debris providing further surface area for colonisation. This is exacerbated when the outlet is placed over the drain as splashback form the drain may include not only *Pseudomonas aeruginosa* but also strains carrying antibiotic resistance genes.

Recommendation 9. **The Trust design guide should exclude the use of outlets with inserts and opt for more hygienic single bore outlets which are demountable for disinfection. In high risk areas consideration should be given to removing these high risk outlets and replacing with those which can be easily maintained.**

Recommendation 10. **For such outlets in lower risk areas (the WSG to determine which areas are designated as high / augmented care areas) to develop a procedure developed for removing and disposing of the inserts art regular intervals. The timescale to be determined by the amount of debris / film build up. Quarterly would be a good starting point with a review after 12 months.**

3.8 Point of use filters

Demountable outlets with and without POU filters give an extra barrier for the most vulnerable of patients. For those very high risk areas, where water quality needs to be above and beyond the quality required for non-high risk patients; point of use filters may be required throughout these patients stays. The filters should ideally be fitted directly to an outlet which is demountable and has a screw fitting (see above). It was noted that the filters are currently being changed more frequently than is necessary (manufacturers' recommendations). This is not ideal as the more frequently they are removed the higher the risk of external contamination and splashing with contaminated water.as well as additional cost.

I understand the concern re: possible contamination of a filter, however if proven this is an extremely rare event and is more likely to have been as a result of inadequate fitting; removal or external contamination during fitting.

Recommendation 11. **To ensure the filters are fitted correctly to the outlet ; change only as recommended by the manufacturer or when the water pressure drops (e.g as a result of particulate build up) . it may be worth ensuring those fitting the filters are fully trained in both fitting and aseptic technique. Filters should never be refitted.**

Recommendation 12. **Parents should be advised to fill baby baths through the shower filters to reduce the risk of filter removal and refitting**

3.8.1 Cleaning

There was some discussion about the cleaning of the POU filter housing;

Recommendation 13. **The information supplied by PALL with the filters includes a list of compatible chemicals; the most straight forward method is to use single use alcohol wipes. Ensuring that the outlet itself is not contaminated. A video link to a cleaning protocol produced by Dr Elaine Cloutman Smith from GOSG in collaboration with the RSPH has been forwarded to Dr Inkster.**

3.8.2 Backflow prevention

When POU filters are installed on wash hand basins they must still comply with the Water Regulations on backflow prevention and have sufficient space above the high water level in the basin to create an effective air gap. In addition there should be sufficient activity space so that hands can be washed without contaminating the filter housing and especially the point at which water exits from the POU filter .

This is not the case where POU filters were fitted in the patients bathrooms , there is neither a suitable air gap (and therefore not compliant with the water fittings regulations) or activity space.

Recommendation 14. **Where POU filters are deemed to be necessary on a WHB where there is an insufficient airgap, ideally the outlet should be replaced to one which allows sufficient height to retain both a sufficient airgap and activity space. Where this is not possible or as an interim measure, the plug can be removed so that the basin cannot be filled and the airgap is therefore protected. Users should be advised why the plug has been removed and on how to avoid contaminating the external surfaces of the filter.**

3.9 Patient and environmental isolates

there was some discussion relating to the finding that the environmental strains did not match the patient isolates and whether water could then be ruled out as the potential source. It is likely that water was the source and cannot be ruled out because the isoaltes do not match. To date three different strains of C. pauculus have been identified. However to be sure that there is no patient strain in the system, multiple isolates from several samples from around the site where the patients may have been would have to be picked and identified. Statistically you would need to identify at least 30 different isolated from each culture plate to be sure a particular strain was not missed.

•

3.10 Water temperatures

Currently there is no information available on water temperatures as there has been a problem with the BMS system and data loss as a consequence. This means the Trust is not able to show due diligence and I am therefore unable to comment on the temperature control regime. .

3.11 Appendix 1 Dr Susanne Lee Abbreviated CV

Dr Susanne Barbara Lee (formerly Surman- Lee) BSc, PhD, FRSB, CBiol, FRSPH, FWMSoc, FIHEEM, MRCSHC. Is a State Registered Consultant Clinical Scientist with the Health Professions Council Reg. No. CS2982 and Director and Owner Leegionella Ltd., an independent public health consultancy specialising in the detection of waterborne pathogens and the prevention of waterborne disease.

Email : [redacted]

[redacted]

3.11.1 Relevant Experience

Dr Susanne Lee is a Public Health Microbiologist with over 35 years' experience in clinical and public health microbiology working with government funded public health bodies and now working as an independent public health advisor and consultant. Between 1994 and 2010, working for the Public Health Laboratory Service which was integrated within the Health Protection Agency, latterly as Director of the London Food Water & Environmental Microbiology Laboratory . In that role Dr Lee worked closely and trained environmental and port health authorities and also health protection teams supporting both food and waterborne incident and outbreak investigations and was a member of the national Legionnaires ' disease investigation team. Dr Lee has worked with over 50 hospitals advising on the control of water systems and the investigation of cases; outbreaks and gross contamination.

Dr Susanne Lee is currently a Consultant and Advisor on water microbiological issues particularly on:

- **The management and control of water systems; working with and supporting several NHS and independent hospitals nationally and internationally, on environment matters relating to infectious hazards from environmental sources in the hospital environment and auditing actions including following patient fatal incidents and outbreaks.**
- **Working with trusts to develop water safety plans and bespoke audit tools for monitoring water safety within the healthcare**
- **Water quality in hydrotherapy pools , leading the re drafting of the PWTAG Hydrotherapy pool guidelines**
- **Training on water safety; including one to one sessions with CEOs, updates for Board and Senior staff; Engineers and Infection Control; support services: housekeeping; sampling; Sterile services; Medical Physics etc.**

Relevant Current offices/ activities

- **Member of the working group which revised HTM 04-01, HSE ACoP L8 and Guidance HSG 274**
- **Member of the joint HSE / PHE working group which revised the Spa pool guidelines HSG 282**
- **Working Group Lead; revision of the Pool Water Treatment Groups Hydrotherapy Pool Guidelines**
- **Chair of the European Society of Clinical Microbiology and Infectious Diseases (ESCMID) European Study Group on *Legionella* Infections (ESGLI) subgroup**

responsible for updating the European Technical Guidelines for the investigation and control of travel related Legionnaires' disease

- **Programme Director: Royal Society for Public Health (RSPH) water safety webinar series**
- **Chair of the RSPH Water Special Interest Group;**
- **Chair of the International Forum for Water Hygiene in Buildings**
- **Member of the ESMID Food- and Water-borne Infections Study Group – EFWISG**
- **Member of the Technical Committee of the Water Management Society**
- **RSPH representative on the Pool Water Treatment Advisory Group (PWTAG)**
- **RSPH representative on various British Standards Institution working groups for preparation of standards relating to water quality and microbiology including the update of BS 8580 Code of practice for *Legionella* Risk Assessments and BS 8680 code of Practice for Water Safety Plans**
- **RSPH representative of the healthcare infection Society's water guidelines working group**
- **Independent water safety specialist consultant (Authorising Engineer (water) (HTM 04-01) and auditor to several NHS Foundation Trusts and independent healthcare providers**
- **Member of the Wesley Hospital Queensland Expert Advisory Panel**

Dr Lee has vast experience of developing and presenting training at both national and international level and was involved in the development and teaching of many courses, Master Classes and seminars on food and waterborne infections and developing water safety plans and has been invited to speak and provide training around the world including:-

- **Training for ELDSNET members of the new European guidelines and risk assessment at ECDC Stockholm October 2017**
- **Invited keynote speaker to the Institute Of Plumbing Inspectors Brisbane (water safety plans; *Pseudomonas aeruginosa* ; risk assessment)**
- **Invited speaker art Masterclasses for hospital staff in Melbourne; Sydney; Adelaide and Brisbane 2017**
- **Invited keynote speaker ; Legionella Control Everybody's Business; Brisbane 2016**
- **Bespoke training for various Trusts including to Estates; infection control, housekeeping staff; and Contractors 2017**
- **Bespoke training for Aquatic therapists; assistants and Estates pool operational staff (2015-17)**
- **ESCMID funded European Study Group postgraduate course coordinator and tutor: April 2014**
- **Development and presentation of a City and Guilds accredited course on the roles of the responsible person for in house staff, local authority, housing association; healthcare and private clients on behalf of water treatment company**

- **The EU funded European Working Group for *Legionella* Infections (EWGLI) annual training course 1999-2011)**
- **A EWGLI course for hoteliers in Bulgaria on travel associated prevention of Legionnaires disease ;**
- **Training courses on investigating and control of outbreaks of legionnaires' disease in as part of the Irish cross Border Initiative, (Ireland and Northern Ireland).**
- **Invited speaker : Ministry of Health funded training course on Legionnaires' disease in Czech Republic,**
- **Seminars / Master classes on the detection and control of *Legionella* in Poland and Denmark, Germany, South Africa, Sweden, Bulgaria, Germany,**
- **Training course on investigating and controlling legionnaires" disease in Dubrovnik, Croatia, and for the Swedish Association for Infection Control, Södertälje, Sweden**
- **Development and delivery of Water Safety Conferences for the Royal Society of Public Health on *Legionella* , Keeping Travellers Healthy, Water Safety Plans in Healthcare, Pool Water Safety, and *Pseudomonas aeruginosa* infections in augmented care and updates on the new HSG Guidance HSG 274.**

Other Relevant activities include:

- **Lead Editor / Author European Technical Guidelines for the Control and Prevention of Travel Associated Legionnaires Disease published on the ECDC website 2017**
- **Author and editor of the World Health Organizations' Water Safety in Buildings published in 2011**
- **Author and editor of the World Health Organizations' *Legionella* and the prevention of legionellosis –published 2007**
- **Chair of the Organising Committee for the ESCMID Study Group of *Legionella* Infections 2015 international conference.**
- **Working with government (the Health and Safety Executive, the Department of Health and Public Health England) and non-government (the Water Management Society) organizations to update the UK, Health and Safety Executive's Approved Code of Practice Legionnaires' disease The control of legionella bacteria in water systems (L8) and associated guidance (HSG274) and Spa Pools**
- **Invited speaker and session chair 8th and 9th International Conferences on *Legionella* , Melbourne Australia 2012 and Rome 2017 , Co-chair and co-organizer and speaker RSPH conferences on Water Hygiene in Healthcare, the implications of the *Pseudomonas aeruginosa* addendum to HTM 04-01 keeping traveller healthy and jointly with the HSE the implications of the new guidance HSG274**
- **Appointed temporary advisor to the World Health Organisation (WHO) workshop in Jordan on water safety plans and water hygiene in healthcare premises;**

- **Programme developer and Trainer; ECDC funded course on the investigation of travel associated Legionnaires' disease**
- **Contributor, WHO Guidelines for drinking water quality 4th Edition**
- **Author and editor of the Health Protection Agency and Health and Safety Executives Management of Spa Pools**
- **Membership of the HPA working group which produced guidelines for sampling in hospitals and hospital water standards, and water quality on board ships**

Glasgow

NHS GGC

Acute Services, Women and Children's Directorate (W&CD), Hospital Paediatrics and Neonatology (HPN)

Minutes of the Clinical Review Group held 17th February 2020 at 4:30pm in RHC Level 3 Seminar Room

In Attendance

Jamie Redfern (JR), Pamela Joannidis (PJ), Jen Rodgers (JRo), Kerr Clarkson (KC), Kirsten Meikle (KM), Dermot Murphy (DM), Angela Howat (AH), David MacDonald (DMaC) and Gael Rolls (GR)

Apologies

Alan Mathers (AMM), Sharon Johnstone (SJ), Brenda Gibson (BG)

Estates

No significant estates issues in Ward 6a reported

KC noted the change to toilet system would be in place middle of March 20 and completed for Ward 6a next round of the Chill Beam cleaning.

All standard SOPs for tap flushing in place and implemented in the week.

No outstanding issues from previous week's Enhanced Inspection

Room sign off sheet following completed works now in place.

Domestics

No issues for domestics reported in week.

There was general discussion on the cleaning of floors and SOP in use. DMac would prepare a discussion paper for next meeting.

The Deli Cart was in the process of being purchased for Ward 6a. Meeting to agree what would be provided from it had been cancelled and was in process of being rearranged.

Infection Control

PJ confirmed there had been No new gram negative cases reported in week. No RCAs have been required.

PJ confirmed there had been no new cases of concern for review / discussion.

Enhanced report discussed by all with no significant issues / concerns. Hand hygiene for Wards 6a / 4b reported 100% use and 100% technique.

PJ noted ventilation Room SoP now in place and working well.

Run charts discussed and up to date; PJ to prepare in March for end of February.

Group informed there were no concerns raised by Microbiology to CRG covering water, air or environment sampling.

Clinical Service

DM/ KM/ AH/ GR confirmed T-Lock SoP finalised and would be implemented week beginning 24/7; training of wider teams out with Haem Onc being completed. DM agreed to write up QI documentation supporting this change including how service will measure improvement.

JR agreed to set up a shot life working group with DM and others to monitor progress on WOS shared care across haematology oncology.

AH / KM noted ward had been very busy both inpatient and day care. Plans for the one stop recruitment plan to fill vacancies would be completed soon. Both confirmed the housekeeper post had been appointed to. CRG members noted current challenges with sickness absence across nursing teams for both wards; some further thought to be given to how this might be managed.

GR noted meetings with Diana McIntosh and Pamela McGoldrick to be arranged and for the Interactive Patient group to be progressed.

JR / JRo thanked staff for routinely reporting the PMO form daily including weekends to high quality.

Noted the Closed Facebook Group was being actively promoted within the Ward. JR / JRo continued to view this as an important engagement tool with staff and patients / families.

Corporate

JR / JRo noted there were still a number of parents who were being responded to following the Chairman& Chief Executive Officer's letter & meetings inviting discussion.

JRo updated on the work of the Communication sub group of the Oversight Board. She confirmed that a series of letters would be issued to parents within the next week or so relating to clinical review of

cases. Final drafts being finalised. Update on the public enquiry was expected soon and on receipt parents would be contacted.

DM agreed to produce a response to JRo on the Bereavement service provided by the team in comparison to what was offered in selected US sites. This response would be circulated to the Communication sub group.

JRo noted Terms of reference for aforementioned Clinical Review and Public Enquiry were in the process of being finalised.

JR confirmed there had been further discussion between PF and NHS GGC on MM case.

[redacted]

Any other Business / Date of Next Meeting

There was no other business reported.

Date of next meeting was 24/2/20 on third floor seminar room RHC.

NHS GG&C – QEUH/RHC

Review of Issues Relating to Hospital Water Systems' Risk Assessment

1.0 Introduction

The Queen Elizabeth University Hospital, (QEUH) and the Royal Hospital for Children, (RHC) were handed over to the GGC Health Board on 26th January 2015. Patient care started at the hospital in April 2015 and both hospitals were fully occupied by mid-June 2015.

Ward 2A has two sections: 'Schiehallion', the Paediatric Bone Marrow Transplant Unit and the 'Teenage Cancer Trust', (Oncology). Patient groups, cared for in Ward 2A can be immunocompromised, which makes them more susceptible to infection.

1.1 Background

There have been 17 cases of patient infection in Ward 2A between 2016 and 31 May 2018. The infections complicated the patients' conditions and treatment. There were no related cases on Ward 2A between May and September 2018 but a further 6 patients contracted infections in later in September. No mortality has been associated with any of the infections. The nature of the microorganisms make it very difficult to categorically determine the exact source of the infections. Microorganisms that might be harmful to people, particularly those that are immunocompromised, are common in the general environment. It is possible that at least some of the infections resulted from exposure to microorganisms outside of the Hospital. However, NHS GGC Infection Control professionals believe it is also possible, that some infections are associated with microorganisms from the hospital's water and/or drainage systems.

1.2 L8 Risk Assessment

In April 2015 a Risk Assessment, (RA), (based on, 'L8, Legionnaires' Disease. The Control of Legionella bacteria in water systems, the Approved Code of Practice'), was provided to the Board by DMA, a company of independent, qualified water consultants. The RA report gave a list of recommended actions. DMA provided a further RA in October 2017 and this inferred little progress against the original list of recommendations at the time of their survey.

1.3 Terms of Reference

In August 2018, the Board CEO asked Mr Jim Leiper, Project Manager, to review the context and circumstances relating to the Board's response to the DMA Risk Assessments' findings.

1.4 Methodology

The intention to undertake the review was communicated to Trades Union Representatives and to the members of staff to be interviewed. Mr Leiper, supported by Ms Gillian Gall, Senior HR Advisor, conducted prearranged interviews with Staff members who could be accompanied if they wished. Responses to a set of pre formed and supplemented questions by Mr Leiper, were recorded by Ms Gall and Ms Allyson Hirst, PA to the Director of Property, Procurement & Facilities, onto a template previously utilised by the Board.

A draft of the completed notes on individual responses was provided to each interviewee to comment on factual accuracy and to provide any necessary clarifications. These notes, together with any copies of associated documentation provided by the interviewees and author's notes of discussion/argument and more detailed conclusions arising from the interviews, are retained to inform any further, subsequent and more detailed investigation if this is considered appropriate.

The findings of this review are provided in light of factual occurrences and drawn from information received (and where possible, corroborated), during this 'brief' review. There has been strenuous effort during the review, to try to put the findings 'in context' and to understand how circumstances that persisted at the time, on the balance of probabilities, might have contributed to outcomes.

The contributors to the review gave a strong impression of openness in their accounts to the best of their recollection. The brevity of the review slightly curtailed the ability to interview everyone that may have had some contribution and a significant number of people that might have been able to give good testimony are now retired or no longer employed by the Board. It is considered however, that the level of detail gained from this review is sufficient to allow a reasonable understanding of salient events and it is thought that a good level of confidence can be assumed in the accuracy of the high level findings. The level of detail and corroboration of findings might be supplemented by a more forensic review if that is felt appropriate and achievable.

The author's high level findings and conclusions are presented below for consideration of the CEO.

2.0 High Level Findings

It is considered that the following issues have contributed to the level of response to the DMA L8 Risk Assessment recommendations.

2.1 Changing the Procurement Model
The change from a PPP to a Treasury funded procurement model had implication to the post contract arrangements for Hard FM service provision.

2.2 Contribution by the Board's Estates Professionals
Earlier inclusion may have encouraged a more meaningful and valuable contribution.

2.3 Design Issues
Aspects of the design of the water systems and some of the components installed may have contributed to the proliferation of microbiological contamination of systems.

2.4 Resource Estimation Methodology
The process that established the original estimates of the Board's operational resource requirements, may have been more accurately defined if there had been the opportunity for a further, refined iteration.

2.5 Contractor's Actions
Some project outcomes and adversarial responses by the Contractor to some requests by the Board might have been improved if the Board's Requirements had been more explicit and prescriptive.

2.6 Definition of Roles & Responsibilities
The early formal appointment of a recommended management structure for specific technical systems would possibly have allowed a smoother transition between the contractor and the Board's team taking over responsibility for the systems.

2.7 Operational Preparedness and Readiness at Handover
The Board's Estates team was relatively small and inexperienced. Despite their huge effort, it is clear they were overwhelmed by the wave of demand. They worked extremely long hours over a protracted period of time and their overall contribution to sustaining the functionality of the hospital should not be underestimated or overlooked.

2.8 Fluidity of Staff and Impacts on Response to the L8 Risk Assessment
The Board has experienced a high level of movement within the Technical and Project teams. An Action Plan was in place which was informed by the L8 Risk Assessment. An overlap in its progress with the 207 Risk Assessment perhaps partly explains an apparent lack of progress on the recommendations and a formal management structure would have driven a more intensive, defined level of review and monitoring.
The delayed level of response seems to have been obscured by the large volume and intensity of other priority demands.

2.9 Source of Contamination
Routine monitoring results from before handover up until the subsequent investigation by the Board following higher than expected levels of patient infections had largely shown good results, with occasional variations for acceptable standards being effectively managed.
Only subsequent investigation by the Board identified microorganisms not normally screened for under the national standard monitoring regime common across the NHS in Scotland.
The installation of point of use filters effectively mitigated the risk from the water system.
The latest number of patient infections in Ward 2a are thought to have emanated from the drainage system, which may have been contaminated from microorganisms from people's hands, but the source of the contamination has not yet been categorically established. Work is progressing now to control the risks identified.

3.0 Concluding Remarks

It is apparent that actions on the recommendations in the L8 risk assessment could have been better and that a more robust response may have reduced the risk levels. It is possible that the source of some of the problems being experienced was potentially routed in activities during the design, construction and commissioning of the hospital.

The chain of events, reflected above, together, all created the circumstances where the probability of some omission was arguably predictable. To allocate responsibility for confusion and oversight to an individual would ignore systemic causation and the arising significant mitigation. Disciplinary action would, in the opinion of the writer, be unsafe, unfair and quite inappropriate.

The significant additional pressure and apprehension staff have experienced since this review was announced could be lifted by signalling the matter has been concluded, if the findings of this review are accepted.

Future endeavours would benefit from the application of strategic learning arising from the experience.

It is noted, at the time of writing that:

- The training of all appropriate staff on water systems has been completed.
- All necessary formal appointments have been made
- There is a robust management structure in place for the management of the hospital's water systems
- The latest report from the independent Authorising Engineer records significant improvement in the Board's approach
- The recommended actions from the L8 Risk Assessment have been successfully managed
- The Board is currently considering how it might improve the governance oversight of its Support Services.

The author would wish to thank NHS GGC Staff for their cooperation and contribution to the review.

NHS GG&C – QEUH/RHC
Review of Issues Relating to Hospital Water Systems' Risk Assessment

Findings

Impact of the Change in Procurement Model

The procurement for the QEUH & RCH project was originally proposed as a Public, Private Partnership, (PPP).
The Board prudently augmented the deployed Project Team with in house professionals. Some were seconded to the Project Team to afford a degree of familiarisation with the new facilities and to seek their valuable input as the designs were being devised. In house Technical Advisors, Ian Powrie and Brian Gillespie provide initial brief comment on Electrical and Mechanical elements. This was the case until Brian left NHS GG&C in November 2010. Ian continued occasional input to the project after that time in addition to his day to day duties at the GRI. Ian was eventually seconded to the project team in 2013.
In the post-contract arrangements, in a PPP procurement, the post-handover Hard FM services are normally performed by an external, third-party FM Provider. The external FM Provider is frequently associated with the Main Contractor and the necessary collaboration on the design between the parties is readily achieved.
It is less expensive and disruptive to the project to make alterations to the designs as they are being worked up by the contractor as they will all be covered in the eventually established final cost of the project and be factored through to the monthly revenue costs payable by the Board. The payment by the Board includes elements for the Hard FM services being provided, repayment of the capital for the project, originally raised by the Contractor from investors, Banks, etc., together with elements for Contractor and funder's profit.
It is much more expensive and disruptive to the project programme, to make alterations to the designs once they have been completed, the procurement for materials and components are underway and worse still, if construction has commenced. Any changes at this point are correctly discouraged and any significant variation would only happen if it was considered that the outcome of the installation would be unsafe or grossly untenable.
The depth of involvement of the **in house** Technical Advisors was fairly shallow, possibly because the in house team were not originally expected to be responsible for the post-handover Hard FM Services and the Board would have had an expectation that it's appointed external technical advisors would have offered sufficient technical representation on its behalf.
When the Board received the instruction from the Scottish Government in 2007, to change the model of procurement to one that would be Treasury Funded from the Public Purse, the post contract arrangements also effectively changed and the post-handover Hard FM Services would then become the responsibility of the Board's in house Estates team. Without further investigation and information from people that have now left the Board, it is not possible to determine why the input of the in house technical team was so light and why it took 6 years to second an in house technical representative to the Project Team. There could be a reasonable explanation for this, but it is obvious that the opportunity for any positive, effective input from the in house technical professionals was missed, or at least inhibited.

Contribution by the Board's Estates Professionals

The reason for the delay in seconding the Board's Estates professionals to the project team until 2013 is not known. An earlier meaningful input to the design could have averted some of the issues now being experienced. Despite the deliberate secondment of Ian Powrie to the Project Team in 2013, the opportunity for meaningful input to the designs, particularly any input that would suggest changing the designs that were now under construction, was very remote.
There is corroborated evidence that Ian Powrie was 'isolated' within the Project Team after his secondment. His contribution, based on opinions given during the investigation, was sometimes actively discouraged by the Project Director, possibly due to the stage the contract was at and the potential increase the contract costs and likely disruption to the project's programme that could have been caused by changes at this stage of the contract. There is evidence however, that his contribution did lead to at least one significant design change in ventilation systems to avoid plant automatically shutting down at temperatures below -6^{o}C. This was observed as a problem in the Laboratory building, (completed in advance of the hospital), and changes apparently made in the Hospital ventilation system controls to avoid the same issue.
So, the timing of the change in procurement model and the delay to a meaningful input of the Board's Estates professionals, indirectly, potentially affected the Board's ability to correct any identified weaknesses in the designs which might have been learned by the in house professionals over the years of maintaining the operation of various

healthcare properties. It is possible therefore, that weaknesses in the Hard FM infrastructure, which have caused severe operational difficulties for the Board since handover and occupation, could perhaps have been avoided had there been an earlier opportunity for useful and more comprehensive involvement.

Contribution by the Board's External Technical Advisors

One might reasonably expect that the Board's appointed technical advisors would have detailed oversight of designs for the new hospital and be advising the Project Director on any risks to the Board arising from the design proposals being made by the Contractor. The level of scrutiny of the Technical Advisors would be proportional to the terms of their appointments determining the level of resources they would provide and the levels of expertise and experience of the Advisors. The relative merits and performance of the Board's advisors are not within the scope of this review, but the significance of the post-handover challenges now facing the Board might suggest an opportunity to improve future contractual engagements with technical advisors through the experience gained on this project. There appears to be little, well-defined accountability apportioned to the technical advisors through the NEC3 contract engagements. Any recourse to the Board for a considered deficiency in performance would give the Board difficulty in establishing evidence if the detail of accountability is not prescriptive enough in the conditions of contract.

Design Issues

Aspects of the design of the water systems and some of the components installed have the potential to contribute to proliferation of microbiological contamination.

Resource Estimation

A significant source of weakness in the project's post-handover, technical outcomes could be directly related to resources.

It seems that, initially, following the change in procurement model, the Hard FM costs were estimated through a finance-driven, estimating process, probably/possibly originally intended for use within the Public Sector Comparator.

Contractor's Actions

The absence of prescriptive national guidance, (which is written with the intention that it is interpreted by the 'Caring Professional') and the NEC3 contractual process, (which has been developed to encourage a partnership ethos and encourage 'Private Sector innovation'), allows the main contractor and designer a degree of latitude in interpretation and application. The motivation to ensure this 'freedom to act' is applied appropriately and in the best interest of the Client, is assisted by robust, accurately recorded specifications in the Board's (Employer's) Requirements. Some project outcomes, which should perhaps been a matter of concern to the Board's Project Team and have been highlighted by its external Technical Advisors, and adversarial responses by the Contractor to some requests by the Board might have been improved by a higher definition of some of the Board's Requirements. A more prescriptive specification is not normally encouraged this has a tendency to inhibit the expected Private Sector innovation. So, it is a real skill to strike the necessary balance between rigidity to nail down issues of essential importance to the Board, without becoming technically 'responsible' for the design and at the same time leave scope for the Contractor's flexibility and innovation. Satisfactory equilibrium is a very difficult ambition to satisfy and it is arguably, frequently under-achieved.

Definition of Roles & Responsibilities

Throughout the project, there seems to have been a lack of formality, particularly in the definition of support roles and responsibilities. There is no evidence observed of any formal stipulation of responsibility or accountability provided to those seconded to the project team.

There is also, a recognised management structure, normally deployed for the functional management of a hospital's technical systems. The roles and responsibilities of the trained, formally appointed individuals are defined and agreed. This structure, recommended by the technical guidance, is a fundamental component of the safe management of a range of technical systems, which allows the Board an acceptable level of assurance that these complex systems are being managed appropriately.

Circumstances appear to have conspired against the formation of these recommended structures that would have ideally been functional prior to the handover of the hospital.

The contractual process does not formally prescribe the timing or nature of management structure to enable the transfer of tenure between the contractor and the Client, so it is up to the Board to recognise that this might be a good idea and to organise it accordingly.

The secondment of one technical manager and the latter appointment of a relatively inexperienced technical team just prior to handover, would possibly not constitute a robust formal structure. If there had been, this would have possibly allowed a smoother transition between the contractor and the Board's team taking over responsibility for the systems and allowed the raising of concerns about system's functionality at an early stage, e.g. prior to handover. It might also have minimised any confusion of responsibility and accountability.

Operational Preparedness & Readiness at Handover

The Board's Estates team was relatively small and inexperienced. Despite their huge effort, it is clear they were overwhelmed by the wave of demand as the hospital opened and began to be occupied. Managing the ongoing intensive contractor activity, significant emerging operational difficulties with several essential, technically complex systems, the transfer of clinical functions and the demands of staff beginning to occupy the hospital, all without efficiently functional Building Management and Facilities Management Systems whilst trying to improve on their basic familiarisation of the hospital and its systems, afforded little time to effectively plan activity. They worked extremely long hours over a protracted period of time, often at personal cost, and their overall contribution to sustaining the functionality of the hospital should not be underestimated or overlooked.

Fluidity of Staff and Impacts on Response to the L8 Risk Assessment

The Board has experienced a high level of movement within the Technical and Project teams. People retired and others changed jobs within and out with the Service. The dilution of corporate memory and the effect on activity and approach is unavoidably damaged when people leave their positions. There is a diminished ability to ensure consistency when a string of changes occurs over a relatively short period of time to one specific role.

These circumstances appear to have applied to the role that might have carried responsibility for implementing actions in response to the L8 Risk Assessment recommendations. The in house post holders had not been fully trained, to a formal standard, (in relation to the technical guidance), for all aspects of all systems that they were responsible for maintaining.

There is evidence that actions on water systems were being implemented, some of which were apparently informed by the findings recorded in the L8 Risk Assessment. It appears that the timing of these actions may have overlapped the survey to inform the 2017 DMA gap analysis and this perhaps explains why there appeared to be little progress. The transition between incumbents changing roles was fairly informal and of short duration and probably contributed to delaying the progress on actions. The consistency of approach appears to have been further compounded by the absence of the formal recommended management structure, which would have driven a more intensive, defined level of review and monitoring.

Response to the DMA Risk Assessment Recommendations

The accounts provided in the review interviews, vary in detail on the events surrounding the Board's management of the 2015 L8 Risk Assessment carried out by DMA, (the external, independent, 'water qualified' Surveyors). There is enough information however, to achieve a reasonable explanation about the cause, presented now for consideration.

Ian Powrie initiated the pre-occupation survey assessment by DMA. Assessment information was given to Ian by DMA at a meeting (not recorded by a minute), also attended by 2 representatives from DMA, David Bratty, Jim Guthrie and Melville McMillan. The accounts of the detail of matters discussed, the timing of and attendance at this meeting are confused. This variation may have been, in part, the result of misunderstanding due to an expectation that the report was of a routine nature because it was carried out on systems that had been monitored with no concerning issues being evident. Despite the apparent confusion, it appears that recommendations contained in the Assessment Report, eventually informed part of an Action Plan for the water systems covering the new building and also the properties in the 'retained' estate. The time taken to construct the Action Plan, seek and be awarded funding and in addition to the fluidity of the staff involved, could all have had a bearing on the rate of response on the Assessment recommendations. There is evidence that certain financial allocations were actually used to progress actions on the Plan, with little used outlets and other components being improved in the 'retained' estate. Also, the level of appreciation of the urgency required on recommendations could have been variable due to a lack of training of the individuals concerned and a lack of detailed scrutiny of the report. The risks were recorded in a manner that should have perhaps been plain and obvious that there should be some urgency attached to them if they had been properly scrutinised.

The level of scrutiny and the response on the recommendations was almost certainly, significantly affected by the scale and quantum of the demands which had overwhelmed the small technical team. In addition the managerial oversight and monitoring of progress on the recommendations, that would almost certainly have recognised the

need for greater urgency, was more focussed on other significant technical challenges and the opportunity seems to have been lost. The technical team was under-resourced and largely inexperienced and lacked formal training. The focus of their capacity seems to have been to 'keep the hospital running' and this was achieved by the whole team working long hours, in excess of that permitted by statutory instruments, for an extended period of time. There is little doubt that these circumstances could have obscured their ability to respond more effectively to the outstanding Assessment Recommendations, or indeed that their commendable actions helped to sustain an environment capable of providing healthcare services.

Source of Contamination

Routine monitoring results from before handover up until the subsequent investigation by the Board following higher than expected levels of patient infections had largely shown 'good' results, with occasional variations for acceptable standards being effectively managed.

The subsequent investigation by the Board then apparently identified microorganisms not normally investigated for under the national standard monitoring regime common across the NHS in Scotland and although these could not categorically identified as the source of the infection, were theoretically thought possible to be a potential source.

There is evidence that, pipework was contaminated during construction. Also, prior to commissioning (and perhaps subsequently), the water system was filled with water that bypassed the installed filtration system. This may have been carried out due to the failure of the filtration system, (which appears to have been an early issue being experienced), or, with the best of intention, for practical and/or financial reasons. This may however, have been the original source of the contamination of the water system and its proliferation could have been encouraged by 'dead legs' in the system, temperatures out with acceptable limits, the lack of turnover of water in the system that would have been fairly inevitable between hand over and full occupation of the hospital, despite arrangements being put in place to have the systems flushed, between handover and occupation.

The installation of point of use filters as a precaution, (once concerns were raised about the potential for wider contamination in the system than in a few localised instances), effectively mitigated the risk from the water system in the (higher risk) locations they were installed in. The potential risk from the water system still remains where there are no PoU filters installed.

It is anticipated, that the imminent installation of a new chemical dosing system will help to eventually establish a safer, cleaner water system in the hospital.

The latest number of patient infections in Ward 2a are thought possibly to have emanated from the drainage system, which could have been contaminated by microorganisms from people's hands or other uses of the sinks in addition to any possible water source, but the actual source of the contamination has not yet been categorically established. Work is progressing now to control the risks being identified.

Annex 1

Discussion / Argument

Discussion

Contributory factors

Based on a brief initial investigation, there appears to have been a chain of events, all of which may have contributed to the microbiological contamination of the hospitals water system.

Pre Contract Stage

Procurement Model

Early in the procurement process, c2007, a political decision changed the model of procurement from a Public Private Partnership, (PPP), the capital for which is sourced from the private sector, to a process of 'Competitive Dialogue' to be Treasury Funded by the Scottish Government.

Implications for Post-Handover Arrangements

With this procurement decision being taken, the handover of the Estates Management responsibility for the maintenance of the buildings and the engineering systems at the conclusion of the contract changed from it being the responsibility of a third party FM Provider to the in house NHS Estates and Facilities, (NHS E&F), teams. It should be recognised that, as the project progressed past the preferred bidder stage and 'clarifications' on the Employers Requirements, (basically, the Board's specification), for the project were achieved, the ability to alter elements of the design without costing money and or causing difficulty, is greatly diminished. It is clear that the change in the model of procurement had this detrimental impact on this project in respect to the how the post contract arrangements transpired.

Resource Estimation

It appears there was little comprehension that the cost of running older, less mechanised hospitals would be a fraction of the cost of running an intensively equipped, highly serviced, modern healthcare facility. Establishing a Hard FM cost base in the manner that was apparently applied, using the existing cost base of the demitting hospitals as a starting point, would inevitably lead to an undervalued estimate of the resources required for the new hospital. Views have been expressed that the budget levels of the old hospitals were also insufficient in any case. The use of these budgets as an estimation of resource requirements for the new hospital would have been questionable, particularly if the budgets considered were the final year budgets for the demitting hospitals.

If 'logic' is then applied to reduce the original estimated budget to reflect an 'expectancy of efficiencies that would be gained through modernisation' which would normally be a reasonable assumption, the cost base under-estimate is decreased further and it therefore becomes more grossly undervalued. It is an important ambition to tightly control any volatility in costs established in a project's business case, but this inevitably results in a rigidity that severely inhibits the prospect of any elemental increases.

The strategic financial estimates produced in March 2015 by Ian Powrie, (copy provided), built up in a detailed elemental basis for actual, existing cost comparators predicted the resources required, at three to four times the amounts already captured in the business case. The impact of this report appears to have been lessened by the suspicion of senior Board executives that it might have been 'over-egged' and 'seeking a gold standard'. Credibility appears to have been further compromised by the inability to give convincing explanation to questions on some financial elements of the proposed budget that appeared unexplainably high. Recent investigation has apparently shown that there was a simple arithmetic error in the report that explained the over-estimate.

Whilst the substantial difference between the amount provided and that originally estimated for Hard FM services may have been suspicious, it appears that there was an acceptance that the original estimates were too low. This is evidenced by the significant early increase in estimated revenue budget for Hard FM services that presumably came from financial 'balancing' within the overall revenue package for the project. There appears to have been a general acceptance that the funding level, eventually arrived at was, 'all that is available'. It is unlikely therefore, that the Hard FM budget was accurately established and it is questionable if the existing resources are sufficient for the purpose intended. If these conclusions are considered reasonable, the Board may lack confidence that all of its statutory responsibilities for the effective maintenance of all of its equipment,

buildings and installed systems are being adequately discharged. Strategic risks associated with these circumstances, in terms of Board governance, are directly related to patient safety and a review to investigate and correct any divergence will reduce the possibility of action by the enforcing authorities, which might have corporate and / or personal consequences.

Contribution of and Collaboration with, the 'In House' Team

The early inclusion of, and intense consultation with the NHS E&F team would have been of particular importance. It appears the Board recognised the value of this essential contribution. A number of key members of the in-house team were transferred into the Project Team where the Project Director would have become their line manager. The purpose of this was to advise the Project Director and the Project Team in their areas of expertise to positively influence the eventual systems and facilities that would be built.

There was a real desire by the team to deliver a fantastic, modern 21st century facility.

Initially, due to the expectation that the procurement model was to be 'a PPP' with the responsibility for 'Hard FM (Estates)' maintenance being carried out by a third party, the level of consultation with the in-house Estates Professionals was very much less than that taking place with the other professions. The necessary collaboration with the in-house Estates Team changed when the procurement model was changed.

Ian Powrie and Brian Gillespie from the in house Estates Team assumed 'liaison responsibilities' for providing advice on electrical and mechanical systems, respectively in 2010, when they were both employed at GRI and IRH respectively. When Brian Gillespie left the Board in March 2010, Ian Powrie remained as the Board's sole in-house technical contributor to the Project on Hard FM issues, but neither Brian nor Ian gave any significant input to the design of the water system at this time. These were the only 'technical contributions' from the in house team until Ian Powrie was seconded to the Project Team in 2013. This meant that Hard FM was a late participant in the collaboration process and construction had already started on the hospital, making any significant changes to the designs problematic and potentially expensive.

The vehicle to capture staff contributions was at numerous project committees in addition to scrutiny and comment on technicalities of the design proposals by some individuals. The attention to, and inclusion of, the provided technical contributions were rarely fed back to the contributors and it was not clear to them what, if any advice, was actually adopted.

Common Reasons for Relationship Tensions

Generally, in-house NHS Estates & Facilities, (E&F), Teams and the NHS Project teams are uneasy bedfellows and collaborations can often be problematic. This is normally due to the tension created by the ambition to deliver the project within a very tight financial envelope and the consequent constraints this applies to achieve the best value, but also the safest designs and to attain installed systems that can be readily managed and maintained throughout the life of the hospital. The bridging of the quality/cost-gap between these two positions is rarely spanned to any one person's complete satisfaction and there is always a need for compromise. It is the level of the compromise necessary to bridge the gap that can have severe life-cycle implications for the facility.

Pre Handover Stage

Impact of New Laboratory Building

The new Laboratory building was also built by Brookfield; commissioned and hand over in April 2012.

At this time, the hospital was beginning to be constructed.

The lack of established and tested electronic maintenance systems for the Laboratory Buildings, that one might have expected to be provided as an operational, functioning system at the handover, meant that a 'paper driven' system had to be established by Ian Powrie in order to attempt to maintain safe systems at a level that would not invalidate warranties on plant and equipment etc. To do this 'single handed', is a very difficult task and to also take responsibility for the supervision and workload of the Fitter and Electrician seconded to him only stretched him further.

Weaknesses he observed in the design and operation of the functioning Laboratory Buildings were highlighted, but it appears that this did little to avert similar design solutions that were now being adopted in the construction of the new hospital.

Meaningful Collaboration

Ian Powrie was transferred 'to the Project' in 2013. The purpose of his secondment to the Project Team was well intended; to give the benefit of his wide professional experience to the Project Team in the anticipation of better outcomes and to get things ready for the handover of the hospital. The inclusion was however, probably too late in the process to alter established designs.

The reason for the late secondment of Ian Powrie can only be speculated upon but his earlier input could have helped avert some of the difficulties experienced by the Board since handover. It should have been known, when the procurement model changed that the handover arrangements of the Hard FM function would have been to the in-house team and it would have been sensible to intensively involve them at an early a stage as possible. Whether the input was not recognised as being important, or if it would have caused a weakness in cover at the hospitals functioning at that time, or if it was thought that the support of the external technical advisors was sufficient, or some other reason, can only be speculated upon, but there is little doubt that a five year delay in involvement led to a much reduced ability to effect anything of significance in the design of the hospital.

Ian Powrie didn't receive any clear terms of reference for the duties expected of him and there is corroborated evidence that he was 'isolated' within the Project Team and that his professional contribution was inhibited and at times, apparently, directly discouraged by the Project Director(s). This was possibly/probably due to the potential cost implications to the Project at that stage of any significant alterations. He concentrated on working up a detailed Strategic Case for Hard FM Services.

Source of contamination

GGC's Infection Control Doctor, Dr Teresa Inkster's initial interpretation of investigation results concluded:

"There are several hypothesis for these findings;

1) Low level contamination of the incoming water supply - unlikely given we have a 0.2micron filter
2) Contamination at the time of construction/installation e.g. pipework
3) Back seeding from contaminated outlets because the outlets themselves were contaminated at installation
4) Back seeding from contaminated outlets from organisms found in patients via hands of healthcare workers or patients themselves

Given the range of bacteria and fungi found 2 and/or 3 seem most likely"

It is possible however, that the original microbiological seeding of the hospital's water system happened when the system was filled with unfiltered water due to the level of breakdown experienced with the filtration unit. There was also some evidence that the materials handling and hence cleanliness of the interior of water pipes was not entirely efficient during the construction phase of the hospital, which may also have introduced some contamination into the systems.

The proliferation of this initial contamination may have been compounded by aspects of the system's design and installation and the efficacy of the interim management of the water system prior to handover. The reason for filling the system without the filter media in place could have happened because the filtration system had broken down, which apparently had been a common issue at that time. It could have been that the filter media would have introduced an unacceptable time delay to pass the volume of water required through a very fine filter, which would also have had a significant cost penalty due to a high incidence in filter replacement at a time of intense use. It was perhaps considered that a post fill disinfection and flushing would have dealt with any seeded contamination, but that would only be as effective as the methodology applied. Subsequent analysis, carried out in line with the nationally recommended protocols of monitoring samples gave a good level of confidence that the system was 'clean'. The confidence was apparently misplaced as it appears that other pathogenic strains of microorganisms were present that were not normally screened for under the existing national protocols, which will probably need to be augmented in the learning coming from the circumstances experienced in NHS GGC.

System Design & Installation

Components of the Water System

During the construction phase of the hospital, early in 2014 research findings[1] were published, following infant mortalities in a Northern Ireland hospital which determined, that harmful bacteria, (Pseudomonas), was

predominantly found in biofilms in particular components of water taps which had been the possible source of the infections observed. There were concerns about similar components being installed in the QEUH. Due to the significant expense of changing the components that had already been installed in the hospital's system and the lack of intelligence about an appropriate, available, safe alternative, the decision was taken to retain these components which had already been installed and to mitigate the associated risk with operational procedures. One might conclude that this decision had been taken correctly and with the best of intention in the circumstances, but, in retrospect, it is possible that these components may also have contributed to proliferation of the contamination in the water system.
The installed water system pipework configuration had some dead-legs and the available record drawings were not comprehensive and there appears to have been some disagreement between some 'as fitted' drawings and the system that had been installed. It is surprising that these circumstances have been experienced and, if substantiated, it does not reflect well on the installer's proficiency or expertise.

Interim Management of the Water Systems

Water Turnover & Flushing
There appears to have been a low turnover of water in the Hot & Cold Water Systems prior to handover of the hospital. The system temperature breached the lower cold water temperature threshold and occasionally also breached the lower threshold of the hot water temperature. Despite the attention given to flushing of the water systems, in the absence of normal 'user demand' in the unoccupied hospital, this was probably inadequate to obviate the heat gain into the cold water system from its surroundings and to replicate what would be a reasonable turnover of the systems that would be experienced in an occupied facility.

Cleaning of Water Tanks
The water tanks were cleaned several times before handover. In one sense, this shows attention was being given to the levels of contamination in the tanks. In another sense, there is a suspicion that this indicates higher than normal levels of contamination in the tanks that necessitated that frequency of cleaning.

Filtration System Failures
The main filtration system appears to have had fairly frequent failures which led to the tanks being replenished, bypassing the filters, so there was certainly on-going potential for the seeding and contamination of the water system.

Water Sampling – Monitoring of Water Conditions
The measurement of 'Total Viable Count', (TVC), in water samples can give an indication of the conditions of the water system and the potential for microbiological contamination of the system.
The examination of the samples for TVC was terminated at some point after the national guidance was changed and the monitoring of TVC's was no longer recommended. The identification of the potential risks arising in the system, which might have been highlighted by monitoring TVC's may therefore have been missed if this monitoring was not undertaken.
Samples are also routinely tested for the actual presence of specific harmful microorganisms, e.g. Legionella and Pseudomonas.
The test results of water samples taken from the system, (based on the standard basic tests for Legionella, Pseudomonas, TVC), seem to have been largely within acceptable limits, with only a small fraction of issues identified which were apparently treated appropriately by local precautions being implemented, e.g. flushing, local disinfection, retesting etc, all as per that recommended in the guidance. This is a normal and routine function of the management of water systems in most, if not all, healthcare establishments.
It was apparently only after other infections had become evident and investigated further, that some infections were identified as resulting from microorganisms that were not routinely screened for, as part of the normally recommended monitoring of water samples.
These microorganisms are now screened for, as part of the NHS GG&C routine monitoring protocol.
It is anticipated that these findings will inform changes in national monitoring procedures recommended to the whole of the NHS that may now be thought necessary and prudent in the light of the experience in NHS GGC.

Operational Preparedness

Financial Resources

Part of the estimation process for the new hospital's revenue costs was informed by the revenue cost of the four older hospitals that were being replace by the new hospital. There is no information available at this point in time that could show that the existing maintenance budgets for these hospitals actually reflected a sufficient resource level to provide a safe, comprehensive maintenance regime. It is common, when it is known that hospitals are to close down, that the level of maintenance attention is curtailed to give only essential maintenance cover. As the time nears the anticipated hospital closure date, budgets are normally an increasing source of CRES, with budget being released to leave a level that would reflect a prudent, bare-minimum to cover only essential items. So, on the balance of probabilities, the budget levels at the older hospitals might have been increasingly undervalued. Testimony from some of the people interviewed suggests that the budget levels on the demitting hospitals were also insufficient. Depending on when the consideration of these budgets took place, when informing the new hospital resource level, the accuracy of the sums involved would probably diminish as time went on.

The older hospitals that were being decommissioned were not intensively serviced with mechanical systems. They were old buildings and the maintenance intensity would reflect the age of the plant and systems. Older systems, intuitively, require more attention and hence relatively more resources to keep them functional. So, if the new hospital's systems could be considered 'like for like' for the systems in the old hospitals, one would intuitively expect a reasonable financial return on the resources required to maintain new, modern systems. The new hospital however, is an enormous facility and the buildings are 'sealed' (no opening windows etc), which means that the environment needs to be formed by mechanical systems. The provision of mechanical ventilation, cooling and heating of the new building would therefore be significantly greater than that of a similar floor area of Victorian Hospitals, for example. The revenue implications for levels of energy and maintenance contracts to maintain the new hospital would be proportionately higher.

The revenue budget process used by NHS GGC to estimate the required human and financial resources for the future operation of the hospital, according to opinion in testimony, was undertaken quickly and it failed to recognise attributes, explained above, of the new hospital that would imply significantly more revenue consequences. Estimates appear to have been based on the budgets of the demitting hospitals to establish the budget for the new hospital and a further deduction applied to reflect a saving due to the modernisation of systems. This would probably have grossly under estimated the required budget. The estimates that fed the Business Case (Public Sector Comparator?) appear to have been very much lower than the lifecycle costs which were established to have allowed a private sector FM Provider to safely maintain the facilities, which reflects the logical outcome explained above.

Staff Resources

The numbers of Estates Officers deployed initially at the handover of the hospital was low and a significant proportion of the Team, newly transferred to the hospital, were inexperienced and had to be mentored and trained 'on the job' to try to quickly improve their levels of expertise. This mentoring of the Estates Team added a further dimension of responsibility to the more experienced Officers.

It is possible that the levels of experience of the majority of the Estates Management team and the day to day focus of the team on emerging technical difficulties and user demands prevented a satisfactory prioritisation of urgencies.

The issues of 'under-staffing' appears to have been exacerbated by the unusually high staff movement due to retiral or staff moving between posts. The impact on corporate memory and consistency of approach is inevitably damaged due to this high incidence of staff movement. It appears too, that the handover between staff demitting and taking up positions was less formal than would have been helpful. The impact would probably have been that delay would have been introduced to programmes of work and changing levels of responsibility within the various posts might have added confusion to who was doing what.

When the more senior managers had their focus on various significant technical challenges on multiple systems, it is plausible that their level of monitoring of work programmes would suffer and the absence of formal structures with clearly defined responsibilities would also quite possibly have contributed to the unintentional oversight in relation to the L8 Risk Assessment.

Members of the Project Team apparently altered their roles and responsibilities at some time in 2014. Some were stood down and others assumed roles to assist the commissioning of the hospital. These changes appear to have happened without giving any announcement or information to the wider staff group that was generally closer to the Project Team. It is not possible to communicate every action that takes place within the Project Team, but it is important that a certain audience has a clarity of roles and responsibilities of the people they are dealing with. This episode seems to reflect an impression that there was a general informality of role definition might have had a detrimental effect in how communication took place and the levels of knowledge and understanding of other key stakeholders.

Computerised Systems

It would have been a reasonable expectation to have had a fully functional, tried and tested Computer Assisted Facilities Management, (CAFM), System. There was apparently, a contractual obligation on the contractor to provide a CAFM system and an expectation therefore, that a suitable system would be supplied after appropriate consultation with Estates staff. There were investigations by the in house team to determine which CAFM system would be the most suitable to allow an ease of data transfer from the old system being used in the retained estate. It is not known for certain, but it is speculated that the Contractor, frustrated by the indecision of the Board, eventually 'announced' that they would be providing ZUTEC. ZUTEC was incompatible with existing systems and not one commonly used in the NHS in Scotland. The ZUTEC system provided was more of a data base system with very laborious functionality if intended to be used as a CAFM system. In addition, the contractor was supposed to number the assets in the hospital and they only made an attempt at this after receiving additional payment. If the Board's Requirements were clearer and more specific, there would not have been the need for additional payments and the apparent lack of detail allowed the Contractor to seek additional payment and also fail to deliver a technically effective, comprehensive CAFM system. The Estates team has taken more than two years to correct the Contractor's attempt at the CAFM provision and to establish something which is functional for a portion of the installed systems. They have re-numbered and identified tens of thousands of assets and built up planned maintenance protocols for each of the assets reflecting good industry and engineering standards and manufacturers' maintenance recommendations. This replaced a number of strange inspection regimes at impractical frequencies constructed by the Contractor and handed over to the Estates Team. This material was less than useless and meant that anything of value and usefulness of all the data in the system would have been difficult, if not impossible to use and interrogate effectively. Arguably, it would have probably been easier to have dismissed the Contractor and carried out the installation of a CAFM system in house, but this may not have been financially possible. If the system had been constructed and installed in house, it would have saved the work of having to correct the Contractor's failures. Essentially, a CAFM system should be properly constituted, tested end to end and be fully functional at handover. Without an effective CAFM system in place it would almost be impossible for the Board to be provided with the assurance that all of its statutory responsibilities are being adequately discharged. This particular issue raises concerns about the Contractors other contracts within the NHS in Scotland, if they believe what they did in Glasgow to be anything like acceptable.

Familiarisation by the Contractor

The training provided by the contractor to the in house staff was considered by the in house team to be quite ineffective and to give nothing more than an initial appreciation of some of the systems. In fairness, it is difficult to impart any significant depth of expertise and experience in initial familiarisation.

The real familiarisation will go on for many months and the in house team would take a considerable amount of time to become proficient in wayfinding and to get to know the installed systems. Ironically, the level of issues the in house team had to deal with initially, particularly in the first year of occupation, would have had a positive effect to their 'on the job' learning. The paucity of familiarisation would have been a further disadvantage to the in house team that was struggling with the weight of demand upon them.

'Soft Start' Arrangements

There is some ambiguity about the 'contacted' period of time that the Contractor's representatives would be available to give post-contract support to the Board. Further investigation would be required to establish if there was any contractual definition of the scope of the support arrangements or if any post-contract responsibility or accountability could be attributable to the Contractor. The 'soft start' arrangements, intended to provide the support of the project contractors to the in house team during the initial period after handover of

the project were view by the in house staff as being largely ineffective because the contractor's workforce had largely vacated the site and those remaining continually argued that many of the issues were not their responsibility. There was a range of opinion among those interviewed about the length of time of this facilitation arrangement was in place for. In addition, the ability to report issues to the Contractor was inhibited due to the overly bureaucratic reporting protocol introduced for the purpose. The effectiveness of the process may therefore have been further damaged as the in house staff were reluctant report issues and to spend productive time getting tied up in arguments over which party was responsible, with a diminishing chance of getting a positive outcome and solution to their problems.
Improved clarification and definition of roles and accountabilities and a contractual stipulation about the period of time the defined level of support would be in place for would probably improve any future 'soft start' arrangements. Arguably, had there been a determined, efficient pre-handover preparation to establish a proficient, experienced technical team with good levels of knowledge of the installed systems, there would be less of a necessity to have any soft start support from the contractor.

2015 L8 Risk Assessment

The first RA by DMA was started prior to the handover of the hospital in January 2015. The detail surrounding the information gathered through the review's interview process was fairly confused. The reasons for this might be due to the passage of time and the filter of personal memory, either actual or selective, and the levels of understanding and expertise held by individuals at the time the report was given by DMA.
The RA was apparently handed over to Ian Powrie at a meeting in January 2015. The meeting is thought to have been attended by David Bratty, Jim Guthrie and Melville MacMillan, two representatives from DAM and Ian Powrie. There was no minute taken at the meeting.
Melville MacMillan categorically denies being in attendance at the meeting, but memory of his attendance at 'a meeting', at least similar to the one being spoken about has been corroborated by at least two people. Surprisingly, it appears that the report was not scrutinised in any detail at the meeting. There was perhaps an expectation of there being little of any consequence in a brand-new hospital, where the basic, standard monitoring results of the water in the systems had consistently shown reasonably good, satisfactory results and there had been little evidence of contamination issues. It has been stated that the DMA representatives did not highlight any areas of concern or draw anyone's attention to the large number of 'red' risks they had identified. If this happened as described, there is cause for concern, as one would have expected some kind of alert to be given and some level of scrutiny of the report's content at the meeting.
It is asserted by Ian Powrie that he gave the RA over to David Bratty, who in turn handed this off to Jim Guthrie and/or Melville MacMillan to deal with any issues arising. David Bratty is now retired and was not interviewed and there is no testimony from him which might give further clarification. Both Melville and Jim have said that their memory is that the report had not been given to them and they had not been asked to follow up on any actions.
It has been corroborated by several contributors that Jim Guthrie had responsibility for the hospital's water systems and it would be conceivable and a reasonable expectation that actions on the water system would be his responsibility. Jim does not recall reading the contents of the 2015 RA, but has advised that actions recommended in the RA actually informed the Action Plan that emerged for the new QEUH campus.
Melville MacMillan was responsible for systems other than the water system, so it is unlikely that he would have had much to do with the actions arising from the RA, hence his focus may not have been primarily trained on this RA.
Whatever the situation was, it seems that a confused understanding of roles and responsibilities contributed to the oversight that led to a delay in the response to the recommendations in the report. There was perhaps a lack of experience of some individuals that prevented a detailed scrutiny of the RA report. Had there been a structure of trained and formally appointed team in place for the management of the water system that is recommended in the guidance, as the hospital opened, there would have been a deliberate regime of oversight and monitoring of this RA that appears to have been absent in this instance.
It is easy, in hindsight to look at the weaknesses in the circumstances surrounding this report, but without a formal, defined management structure, there is the chance that confusion of who is doing what, becomes an issue.
It could be argued that either David Bratty or Ian Powrie should have maintained an oversight of the RA, but the extreme demand on their time appears to have been a salient issue that prohibited them doing what now seems so apparent.

It would have been people more senior to Ian and David that probably should have had a formal management structure in place, but the level of training and understanding of this requirement at a senior level appears not to have been clear, or at best, otherwise focussed. It appears, from Ian's perspective that he understood he had handed the report to others for action. The fact that this lacks corroboration, perhaps reflects a process weakened by informality. A formal structure would have had the process more closely managed.
Jim Guthrie denies receiving the RA but also gives testimony that the findings of the report are at least reflected in the Action Plan for the wider campus. So, it appears that someone did have a look at the RA and perhaps used intelligence of this report to inform the Action Plan.
The extreme level of demand being experienced by individuals certainly affected the ability of individuals to act in a more focussed way in respect to the actions required in the RA.
It is apparent that the Board's handling of the RA could have been much better, but the systemic issues appear to have conspired to create circumstances where this kind of omission would have been fairly predictable and this set the stage for the later gap analysis to expose the weaknesses at the opening of the hospital.
It is a concern, (which is perhaps reflected right across the NHS in Scotland), why professionally qualified, NHS-experienced engineers, that understand and routinely apply technical guidance as 'caring professionals', are not routinely required at a senior level in each organisation. This would be an important mitigation against the potential oversights and deficiencies caused by the lack of expertise in the application of technical guidance that seem to emerge with concerning regularity, particularly in large NHS capital projects.

Action Plan

Some evidence emerged during the review which suggested that recommendations from the L8 Risk Assessment had actually been included in an action plan being led by Jim Guthrie. Further investigation is required to clarify how this action plan was initiated, but there is evidence that the Board was engaged in risk reduction in connection with water systems. Capital allocation was apparently provided for this purpose but its prioritisation appears to have been directed at little used outlets and other weaknesses largely within the retained estate. The timing of this might have overlapped the subsequent DMA gap analysis and not been recognised given the prioritisation had been largely in the retained estate, but it is clear that there was action happening, but not in a timescale or in a comprehensive risk based prioritisation that would have been helpful. It needs to be recognised however, that this would have been restricted by the level of finance available, the time constraints on individuals and the lack of efficient, functional computerised systems.
It should be noted that a visible improvement of formality in the action and oversight happened when the Compliance Team were established and worked on water system actions with the in house team. Since that time there is copious records of actions that have taken place. Further improvement has been experienced recently when formal training and appointments have been made to a management structure for the management of the Board's water system.

2017 L8 Risk Assessment

The second RA by DMA was started mid-2016, was not concluded until late-2017 due to access difficulties in the hospital which was now operational. It is clear from comparison of both RA Reports that there was an apparently minimal response by the Board to the 2015 recommendations. It does not recognise that the prioritisation of the available funding that presumably happened and which directed resources to other high risks in the retained estate's water systems.

Current conditions

It is noted, at the time of writing that:

- The training of all appropriate staff on water systems has been completed.
- All necessary formal appointments have been made
- There is a robust management structure in place for the management of the hospital's water systems
- The latest report from the independent Authorising Engineer records significant improvement in the Board's approach
- The recommended actions from the L8 Risk Assessment have been successfully managed
- The Board is currently considering how it might improve the governance oversight of its Support Services.

Future endeavours would benefit from the application of strategic learning arising from the experience.

References

1 Walker, J.T., Jhutty, A., Parks, S., Willis, C., Copley, V., Turton, J.F., Hoffman, P.N. and Bennett, A.M. (2014) Investigation of healthcare-acquired infections associated with Pseudomonas aeruginosa biofilms in taps in neonatal units in Northern Ireland. *Journal of Hospital Infection*, 86 (1), 16-23. (doi:10.1016/j.jhin.2013.10.003). (PMID:24284020)

Conclusions

General Conclusions

- Key stakeholders changed during the life of the project affecting continuity due to the loss of corporate memory.
- Aspects of the project prior to handover, contributed significantly to the source of the original contamination and its subsequent proliferation.
- The consultation with the NHS Estates professionals could have been of more benefit to the project outcomes had it been earlier in the process and more comprehensive and inclusive.
- There is evidence that important sources of technical expertise were, on occasion, deliberately isolated possibly due to the potential cost of the inclusion of their observations at a particular stage of the project.
- There is no information yet evident which would confirm any significant contribution to the design of the water system by any of the in house technical professionals.
- The roles and responsibilities of some individuals in supporting roles to the Project, appear to have lacked formality, clarity and been ill-defined.
- The roles and accountabilities of the Board's appointed external Technical Advisors could be better defined to be more exacting.
- The recording of the Employer's Requirements could profit from higher detail and more robust, succinct definitions.
- The change of procurement process for the project led to a late consideration of the Board about HARD FM services and this prohibited any meaningful contribution by the Board's Technical advisors, which may have averted operational deficiencies in systems that are now evident.
- The process employed by NHS GG&C of arriving at the level of Hard FM resource, (included in the Business Case), that would be required to safely operate the hospital after handover and comply with its statutory obligations, was weak and inaccurate.
- The numbers of technical staff deployed by NHS GG&C to take responsibility for the maintenance of the new hospital was insufficient and, at that time, largely inexperienced.
- Technical staff numbers were also depleted due the delay in their intended deployment to the new hospital because they had responsibilities for decommissioning the old hospitals that were closing.
- Computer Assisted Maintenance Systems that are necessary to allow the building to be safely maintained were not in place at handover and took significant effort to eventually get functionally acceptable.
- The Building Management System had had been set up in a way that presented operational difficulties in responding to the number of 'emergency' alarms programmed on the system.
- The low level of operational preparedness was a significant hindrance to the ability of the NHS Estates Team to effectively run a safe maintenance regime at handover and beyond.
- The intention of the 'Soft Start' initiative, (the post-handover assistance to the Board by the Contractor) was innovative but the reporting process was bureaucratic, burdensome and often contentious.
- The actual contribution provided by the contractor through the 'Soft Start' process was variable in quality and usefulness; its benefit was grossly disproportionate to the effort required to achieve it.
- The 'Soft Start' arrangements and protocols would be better if defined with clarity within the Contract conditions.
- The magnitude of technical support required over the period of the transfer of staff and patients into the new hospital and the initial period of occupation, overwhelmed the available NHS E&F resources.

- After handover, Estates managers worked excessively long hours for a protracted period of time, at significant personal risk to their mental health, compensating for the low resource levels.
- The Boards compliance with the European Working Time Directive may not have been comprehensive.
- The associated pressures on individuals were enormous, but despite this, there is little doubt that their dedication, commitment, tenacity and selfless actions allowed the hospital to continue to function as a healthcare facility.
- The intense demands on staff, for a protracted period after handover affected the Board's ability to assure its statutory responsibilities to its staff under the European Working Time Directive Regulations.
- Deficiencies in the hospital and IT systems that were consistently emerging after handover took significant time involvement of the in house team and was a distraction to their attention to other essential technical issues and obscured their focus on their oversight.
- The intensity and scale of protracted demands experienced by the in house team didn't allow sufficient time for them to properly review actions and priorities.
- It appears that there was an unintentional but inadequate response to the actions recommended in the 2015 L8 Risk Assessment.
- There was no recommended, specific management structure of Responsible Persons, Authorised Persons and Competent Persons in place and the required levels of training to allow the formal appointments to be made had not taken place. This may have contributed to confusion in roles and responsibilities.
- There is evidence that a 'review of water systems' was taken for the whole QEUH campus, which included the Retained Estate and actions arising from the 2015 L8 Assessment recommendations, formed part of the resulting Action Plan after the Review concluded, around mid to late 2016.
- Work relating to the Action plan was led by Jim Guthrie and subsequently supported by the Compliance team, until he left his position at the QEUH for a new position in the RAH in February 2017.
- The responsibility for the Action Plan was transferred to Tommy Romeo when Jim Guthrie went to the RAH. There was a handover between Jim and Tommy, but Tommy's area of expertise was in Electrical Systems and was relatively inexperienced in Water Systems at that time and he had not received any formal training in water systems.
- The much needed review of the Retained Estate and creation of the site-wide Action Plan and the subsequent transfer of responsibilities are possible explanations for the paucity of completed actions against the 2015 DMA Risk Assessment, but it appears that actions were actually being progressed, perhaps coterminous with the time DMA were starting the follow-up survey to the 2015 Assessment.
- The level of the Board's response to the 2015 L8 Assessment possibly resulted from a mixture of contributory factors, such as:
    - Delay due to the inclusion of recommendations into a site-wide Action Plan;
    - Insufficient staffing levels at, and subsequent to handover,
    - A lack of clarity of roles and responsibilities, which was compounded by:
        - Key members of staff leaving and/or transferring from the QEUH campus.
- The scale of the demands on the technical staff, perhaps understandably, resulted in the absence of a periodic review of actions, which, if completed, may have exposed that urgent actions were outstanding.
- The cumulative effect of the above issues contributed greatly to the possibility of failures in the water system.

Strategic Conclusions

- The Board's governance oversight of Estates and Facilities issues could be improved.

- The resource levels provided by the Board appear never to have been accurately assessed and there is still evidence that resources being provided are insufficient to allow the Board to fully discharge its statutory responsibilities.

South Glasgow Hospitals Campus

Maintenance Strategy

NHS
Greater Glasgow and Clyde

18 March 2014

Executive Summary

The primary driver for this report is the assessment and proposal of a suitable maintenance strategy for the effective delivery of Hard FM support services for the New South Glasgow Hospitals Campus, excluding the Teaching and learning centre & Office block developments which will be addressed under separate FBC's.

In order to derive the most appropriate maintenance strategy for this new state of the art health care facility, several contributory factors have been taken into account, such as:

a. Business continuity

b. Statutory compliance

c. Good Practice in delivering services

d. Economic use of resource

e. Ability to deliver an effective service

f. The FBC assumptions and the current financial envelope in terms of affordability.

Having reviewed various maintenance methodologies and taking into account the above requirements along with the maintenance preparatory work included for within the construction project, the report proposes the adoption of a **"Business-Focused Maintenance Strategy"**, with an objective to achieve a level of maintenance which matches the organisation's strategic and operational service requirements, in terms of availability and quality.

Through risk assessment and targeting resources to mission critical systems and applying Condition Based Monitoring (CBM) techniques, labour intensive examination and assessment can be minimised, reducing expensive and unnecessary interventions and avoiding maintenance induced failures, while allowing selective and effective employment of the construction contract developed Planned Preventive Maintenance (PPM) regime.

The report stresses that the contractual warranty responsibilities for defects in the first 24 months after formal completion have nothing to do with, and does not include responsibilities for, routine maintenance.

This routine maintenance becomes the responsibility of the Board, including compliance with statutory, mandatory and business continuity requirements. It is therefore important to ensure that the maintenance strategy is developed for effective implementation at the point of formal hand over.

In developing a model to underpin the new campus, a best practice whole lifecycle cost model was developed based on data provided by Brookfield as part of the contract requirements (WLCC).

When the high level project WLCC model is utilised this identifies an annual hard FM LCC operating expenditure (Opex) of £7.873m excluding utilities, against the New South Glasgow Hospitals campus master plan, See fig 1 below.

Fig 1: Opex model.

Element	Cost (£m)
Staffing	3.923
Outsourced specialist support	2.819
Materials (Supplies)	2.819
Sub-total	**7.873**
Utilities	9.051
Total	**16.925**

Comparing this projected Opex against the assumptions and objectives of the NSGH project Full Business Case (FBC), which identified a LCC revenue cost of £4.6m (excluding Utilities), The FBC cost model having been based on the modelling completed by Ernst & Young on the Public Sector Comparator, which This identifies an Opex funding gap of **£3.27m** per annum.

Aligning the cost of maintenance with the FBC under an affordability model on today's rates, projects an OPEX requirement of £6.208m.

The current Operational estates Maintenance budgets from all of the demitting sites are £6.8m.

A saving of £1.0 has been committed to the board as part of the FBC leaving a financial envelope of £5.8m, resulting in an FBC affordability model (OPEX) shortfall of £0.408m.

It is anticipated that this can be managed operationally particularly in the first few years during warranty when breakdowns should be minimised.

Under this affordability model the estates OPEX budget requires to be augmented on an ongoing basis to address backlog formula requirements, HAI related matters as they arise and any extraordinary breakdown requirements. These challenges vary from site to site across the Board and the above model does not take cognisance of these factors.

However it should be noted that a best practice model if adopted, similar to the funding stream provided to external contracts would maintain the premises in optimum condition. This comes however with the additional costs described above.

Therefore on the basis of affordability the board requires to make informed decisions in respect of the prioritisation of ongoing funding to maintain the new SGH hospital in optimum condition.

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1. Introduction

The Development of the New South Glasgow Hospitals (NSGH) campus represents the largest investment in health services undertaken in Scotland to date, at a capital cost of £841,700m.

In order to ensure that this investment delivers the sustainable transformation of healthcare facilities expected of this development within NHS Greater Glasgow & Clyde, an effective Value for Money (VFM) maintenance strategy is required; the proposed strategy is based upon the projections of the NSGH construction contract Whole Life Cycle Cost (WLCC) model. Whole Life Cycle Cost modelling recognises all the costs associated with owning and operating these new assets over their entire life cycle.

This approach was specified for hard FM services under section 5.3 of the Employers Requirements (ER's) for the project, with the requirement for an "itemised Life Cycle Cost Plan (LCCP) for the new facilities"

The duration specified for the LCCP is 60 & 30 year capital replacement models, excluding the construction phase. The model applies a discounted cash flow rate of 3.5% to demonstrate value for money over the lifetime of the building for comparing net present values with alternative models of delivering a maintenance service to the building such as the backlog maintenance model which operates for the other major acute sites in NHS GG&C.

The Hard FM building Fabric\building Services & grounds maintenance revenue Life Cycle Cost (LCC) cost elements specified for development under the ER's are detailed in table 1 below:

Table 1: Hard FM Maintenance Revenue LCC

Cost Element	% of total	Cost \m²\annum
Management	12.50%	£3.78
Technical Staff	37.50%	£11.35
External support contracts	25.00%	£7.57
Materials	20.00%	£6.05
Equipment	5.00%	£1.51
Total	100%	**£30.26**

This value of £30.26\m²\annum represents hard FM maintenance LCC revenue model for both the Laboratory Medicine\ Adult & Children's developments.

As the LCCP was developed at bid stage 2009, allowance should therefore be made for inflation at a nominal 3%, producing an April 2013 revised LCC revenue price base value of **£31.17**\m²\annum.

It should be **noted** that:

a. These Life Cycle Cost Plans were both developed at the Invitation to participate in competitive Dialogue (ITPD), Employers Requirement stage and should be revised to reflect the actual operation & maintenance requirements of the final design solution for both developments.

b. These Life Cycle Cost Plans; forecast the hard FM maintenance cost associated with the following elements:

- Building fabric
- Fixtures & Fittings
- Building Services & infrastructure
- Associated Plant and equipment
- Grounds maintenance
- High Level (above 3m) cleaning requirements Internal & external.

c. Hard FM maintenance costs **not** included within the LCCP are:

- Furniture & equipment (i.e. Electric beds, transport trolleys, transport chairs, mobile patient lifting equipment, etc.)
- White goods.
- Portable & transportable electric equipment.
- HI&T infrastructure
- Patient connected Medical & diagnostic equipment, this falls under the remit of the diagnostic directorate and includes:
    i. Life support and monitoring equipment
    ii. Equipment for connection to MGPS\AGSS
    iii. Renal Dialysis machines & associated water filtration\purification plant
    iv. Radiography\diagnostic equipment
    v. Operating Theatre tables

Additional financial resources should be identified from the diagnostics directorate and secured to support elements not accounted for under the LCCP, as detailed above.

2. LCC Capital Replacement

The LCC Hard FM maintenance revenue projection values are dependent upon maintaining the property assets to Category "B" standard, as defined in the NHS SCOTLAND Property Asset Management System (PAMS).

Currently PAMS assess capital replacement on a backlog maintenance basis, identified from property and infrastructure dilapidation condition appraisal, which is then utilised for application and allocation of backlog maintenance funding. However consideration should now be given to new property developments across NHS SCOTLAND with WLCC models that could be populated directly on to PAMS providing future projections of LCC capital replacement requirements, allowing for more accurate & relevant financial planning and need focused funding allocations.

Failure to effectively address capital replacement programmes identified within the WLCC model may adversely impact on the future condition and maintainability of the NSGH within the set budget limits, potentially changing the balance from a predominantly Planned Preventative Maintenance (PPM) model to a breakdown\reactive maintenance model.

The average Capital replacement LCC per annum for the NSGH is detailed in table 2 below, Projecting a 30 year Capital replacement cost of £157,482,750 based on a pro-rata increase proportional to the increased building envelop from the contract bid stage. See Capital replacement expenditure profile for both the A&C and Laboratory Medicine in Figures 1 & 2 below, respectively.

Figure 1: A&C 30 year Life Cycle Replacement cost profile

Adult/Children's and Energy Centre

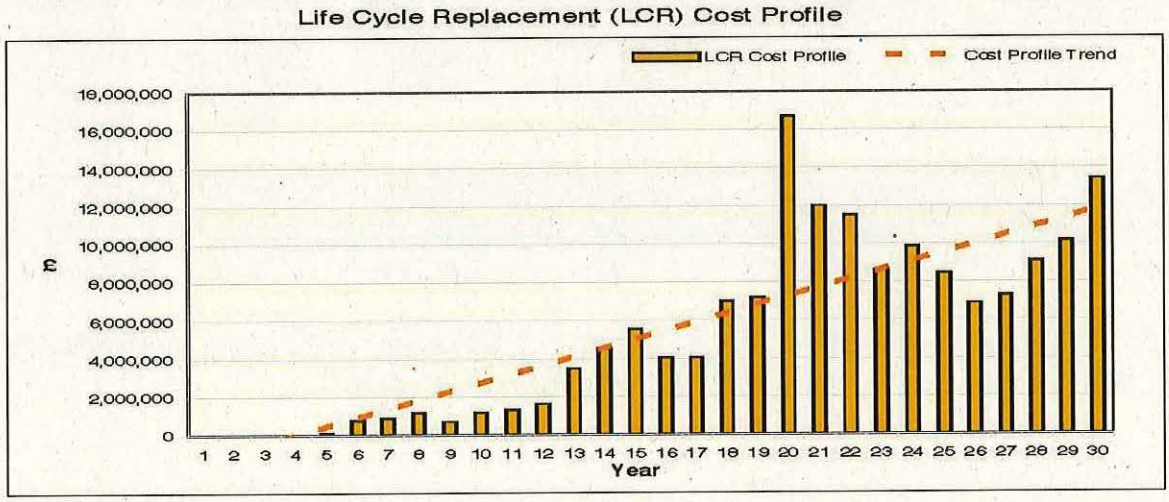
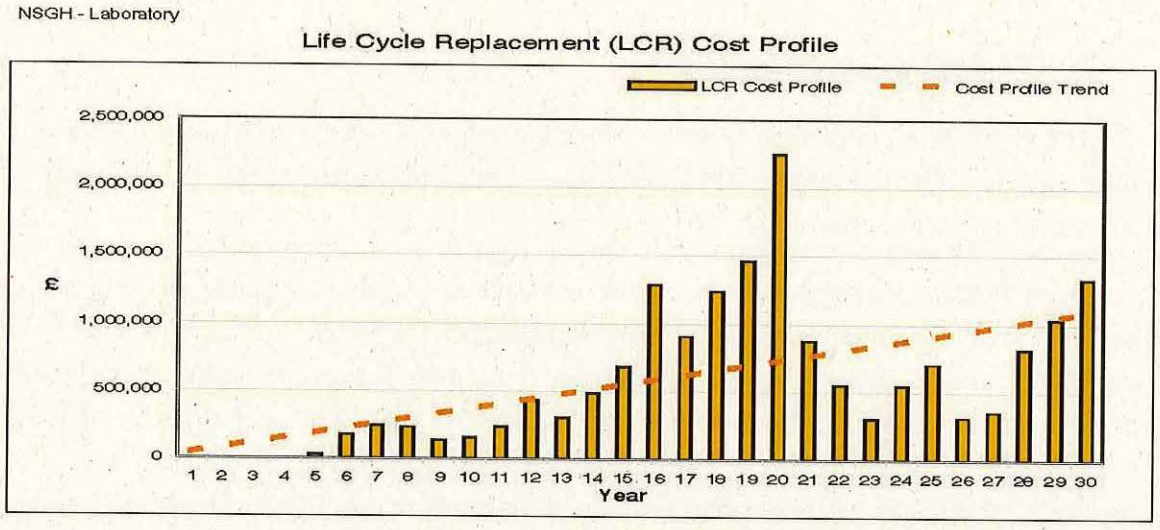


Figure 2: Laboratory Medicine 30 year Life Cycle Replacement cost profile



Life cycle replacement periods and work intervals are based on the assumption that the appropriate planned maintenance is carried out, in accordance with good industry practice and manufacturers recommendations.

3. LCC Maintenance Revenue budgets (Opex)

A high level projection of the NSGH Hard FM LCC Opex (see Appendix 1) has been developed from the WLCC hard FM & Grounds maintenance revenue model, projecting a 30 year Hard FM LC operational expenditure profile of £180,766,530 based on a pro-rata increase proportional to the increased building envelop from the contract bid stage.

Table 2: 30 year LCCP including Estates & Ground Maintenance revenue cost.

Stage	GIA	Building	Capital Replacement cost (£/m²)	LC Capital Replacement cost (£ PA)	Estates & Ground Maint LC Revenue (£/m2)	Estates & Grounds Maint LC Annual Revenue (£ PA)
1	25,500	Laboratory Medicine	24.65	628,575	30.26	695,481
3	171,000	A&C + Energy Centre	30.97	5,295,870	30.26	5,330,070
		Total (pa)		5,924,445		**6,025,550**

Note: Revenue figures include VAT & Capital figures exclude VAT.

4. Opex LCC Funding Gap

It is worth noting that the Full Business Case (FBC) for the NSGH development, projects a Hard FM gross revenue LCC element of £4.6m (P/A) for the Adults & Children's (A&C) with no LCC element allowance made for the Laboratory Medicine & FM Centre.

This therefore represents a funding gap between the FBC & the Contract Revenue LCC element of:

a. A&C development: £0.730m

b. Laboratory Medicine & FM Centre: £0.695m

Total A&C / Laboratory Medicine LLC model Gap: **£1.425m**

Other Opex LCC elements that have been included within the NSGH master campus plan are,

a. The Retained Estate, which includes the Neurology, Neurosurgery, Spinal, Maternity\Neonatal unit, Central Medical Block, Westmarc & Podiatry buildings

b. Car Parks

The proposed Teaching & Learning centre & the Office block developments are excluded from this maintenance strategy, as they are subject to separate Full Business Case models and planning assumptions.

By using the NSGH revenue LCC model as a bench mark for these retained estate operational requirements the additional Hard FM Opex cost elements represent £1.84m, increasing the funding gap to **£3.27m** (see Appendix 1 Campus master plan operational LCC Revenue Model)

FBC Affordability Model: Aligning the cost of maintenance with the FBC under an affordability model on today's rates, projects an OPEX requirement of £6.208m.

The current Operational estates Maintenance budgets from all of the demitting sites are £6.8m.

However a saving of £1.0 has been committed to the board as part of the FBC leaving a financial envelope of £5.8m, resulting in an FBC affordability model (OPEX) shortfall of £0.408m.

It is anticipated that this can be managed operationally particularly in the first few years during warranty when breakdowns should be minimised.

Under this affordability model the estates OPEX budget requires to be augmented on an ongoing basis to address backlog formula requirements, HAI related matters as they arise

and any extraordinary breakdown requirements. These challenges vary from site to site across the Board and the above model does not take cognisance of these factors.

Adopting the FBC affordability model including the identified funding gap, produces an Hard FM maintenance OPEX benchmark value of £23.61/m2 which is 24% less that than the GGC average benchmark figure.

However it should be noted that a best practice model if adopted, similar to the funding stream provided to external managed service contracts (PFI) would maintain the premises in optimum condition. This comes however with the additional costs described above.

5. Staffing

Maintenance staff: In order to scope the staffing resources required to deliver on the maintenance strategy, the projected maintenance budget figures for the full Campus have been utilised in conjunction with the Pierce management "Statutory Compliance Report" modelling technical staff resources requirements for delivery of a compliant estate, (commissioned by NHS GG&C 2009), which identified a technical staff resource requirement of 0.43WTE\1000m^2
The staffing levels produced using both models are virtually identical offering a level of validation and reassurance on identified staffing compliment of 99 WTE, (See appendix 2).

The LCC model staffing compliment identified has been revised in line with the FBC affordability model indicating a reduction of circa 25 WTE posts; with a revised staff resource ratio of 0.28/1000m^2 some 25% less than the WLCC benchmark. this will have an adverse impact on an effective and efficient delivery of service required to maintain a fully compliant estate.

In parallel to this exercise a staffing review is under way to address the proposed ASR development plans for the Gartnavel General Campus and the re-provision of rotary shift cover following the closure of the Western Infirmary acute services, it is anticipated that the changing model of clinical service delivery on site will allow for the rotary shift requirements to be absorbed at least partly in to the current staffing levels.

Management: In the absence of any independent analysis for the management structure, the management staff compliment has been determined using the WLCC budget figures for the management team, this budget figure was benchmarked against 20 similar projects & NHS properties under the WLCC model to produce this average management compliment of 22 WTE (see appendix 2), however it is proposed for this campus to develop a technical management team based on the complement identified against the A&C Gross Internal Area (GIA), circa 12 WTE.

The management team will be structured on the basis of geographic managerial responsibility, offering named point of contact for liaison with clinical\departmental service managers; in addition each manager will be nominated as responsible persons for a range of statutory\Authorised Persons (AP) duties covered under the NHS national Statutory

Compliance Audit Risk Tool (SCART) and generally grouped into their specific areas of managerial responsibility and or expertise (see appendix 3).

Over all this management structure has been developed to support the managerial, professional & technical and quality management requirements of the maintenance strategy (see appendix 4)

It should however be noted that each of the allocated Responsible Person duties involves substantial managerial time resource to ensure compliance duties and tasks are identified assessed and developed in line with statutory, NHS National and local Board policy and is effectively delivered by production of Standard Operating Procedures and record systems.

24/7 estates service provision: Due to the scale of the New South Glasgow Hospitals campus and the round the clock clinical service requirements, it is essential that the estates service is available 24/7 to provide both rapid emergency response to key utility and building services infrastructure failure, as well as scheduling access to areas not normally accessible during normal working hours to carry out Planned Preventive Maintenance PPM programmes, for example Operating Theatres.

The requirement has been addressed within the proposed staffing level, by a rotary shift team with a compliment of 20 WTE multi-skilled technicians providing a 24/7 service, the skill mix of this team has been determined to provide cover across the critical core electrical, mechanical & plumbing services ensuring that the service can be maintained in the event of sickness absence of any one member of the team, holidays will be covered by planned shift programming from a relief shift team, (see appendix 5).

The rotary shift team will be managed on a 24/7 basis by a Hard FM (Estates) rotary shift duty manager (compliment of 5 WTE managers) to provide a responsive out of hour's service, as a fully qualified Authorised person for the operation and control of key utility and emergency standby services including HV\LV, MGPS, Boiler management etc. Ensuring effective response management to any critical service failure; including operation of emergency standby plant, restoration of service and mobilisation of contingency plans as required, to maintain effective continuity of clinical service.

While managing & coordinating routine out of hours Planned Preventive Maintenance (PPM) schedules and effective response to urgent reactive maintenance requests.

The 24/7 hard FM service availability is such a key element to ensuring the cost effective continuity of clinical services; it has been retained intact across all of the maintenance strategy options and cost models.

6. Maintenance Strategy

In order to meet the Boards stated aims and objective within New South Glasgow Hospitals, Full Business Case (FBC) a business focused maintenance strategy will be adopted;

With prioritisation of maintenance aligned to continuity of core business activities, taking into account business risk, resilience and performance of the building services infrastructure, plant, equipment and the building envelop, ensuring the provision of a safe & comfortable environment suitable for the effective delivery of a leading edge health care service.

This strategy takes into account that the NSGH buildings have been specifically designed for the provision of modern health care service techniques and best practice, minimising risk by design e.g.

a. Control of Infection

b. Resilient utility service infrastructure

c. N+1 plant redundancy to support maintenance regimes and mitigate single point of failure without adverse impact on core service delivery.

While these measures provide a high level of control, reliability and resilience they introduce an increased requirement for maintenance activity to ensure that they are sustainable.

The Business focused maintenance strategy, addresses the maintenance requirements by utilising risk management as an effective basis for developing the preventive maintenance strategy, these risk assessments would then be applied to the application, prioritisation and modification (where appropriate) of the PPM schedule produced by Brookfield Multiplex Ltd

The Business focused Risk assessment tool will assess the required maintenance levels under the following categories:

Table 3: Maintenance Risk Categories.

Site assessed risk	Assessed maintenance level
1 - 10	Basic housekeeping only
10- 40	Level 1
40 - 70	Level 2
70 - 100	Level 3

Where the designated maintenance levels are defined as:

Basic Housekeeping:

- Inspect functional performance & plant condition.
- Cleaning.
- Lubricating.

Level 1, Legislative maintenance: intended to meet statutory compliance where applicable.

Level 2, Medium Maintenance Level: Provides a minimum six-monthly (more likely monthly), planned inspections on top of statutory compliance and is most likely to correlate with the Planned Preventive Maintenance programme.

Level 3, High Level Maintenance: Where plant & equipment failure could result in major risk to business functions, high level maintenance providing the greatest confidence in plant reliability and on-going performance. Minimum monthly inspections/service of critical plant items, including statutory compliance, with adaptation of the Brookfield Multiplex developed Planned Preventive Maintenance programme, which may be combined with condition-based monitoring (CBM) techniques.

Hospital acute services will normally require a maintenance level 3, with non acute services at level 2.

The benefits of Condition-base Monitoring are that expensive & labour-intensive routine maintenance activities are reduced and maintenance scheduling is improved. This is due to the greater understanding of the operating characteristics of plant items through trending and a more effective assessment of plant conditions.

Condition monitoring also allows preventive measures to be taken before costly breakdowns occur, reducing unplanned down time.

Delivery of the condition based monitoring elements will be achieved via a combination of Contract support with for example Schneider Ltd, via the integrated Building Management Systems (iBMS) / Energy Network Management Systems (ENMS), by the application of the proprietary Analytics Condition Based Monitoring (CBM) software tools as well as in-house CBM, utilising hand held instrumentation and analysis equipment to facilitate monitoring and trending of vibration, noise & temperature parameters associated with key plant items.

Key objectives

Key objectives of the maintenance strategy are:

a. Compliance with Statutory regulations & NHS mandatory guidance.

b. Ensure Health & Safety of patients, staff and the public and those who operate and maintain the plant.

c. Ensure the function, reliability & availability of plant, building services & equipment to maintain clinical service continuity.

d. Safeguard and optimise asset value

e. Ensure a safe and comfortable environment for Patients, staff & visitors.

7. Maintenance Plan

The NSGH property assets constitute an extensive range of large complex systems and services, which require to be quantified and evaluated, in order to develop a suitable maintenance plan to meet the Board's objectives.

The developer, Brookfield Multiplex Ltd are contracted to produce a full register of assets complete with ID tagging of each asset, along with a full planned maintenance programme of works that the FM & Estates managers can review to plan and establish their annual maintenance schedules and annual budgets. This delivered PPM schedule should be quantified taking into account:

a. Statutory requirements

b. Manufacturer recommendations

c. NHS Scotland Mandatory requirements

d. Incorporate requirements of the Board's Infection Control Team.

8. Maintenance Scheduling

Preparing a deliverable maintenance Schedule in line with the criteria set out in the maintenance strategy is dependent upon the handover of the A&C asset register, PPM schedule and Operation & Maintenance manuals (O&M), expected late 2014.

On receipt of this data and on completion of Business focused maintenance and Condition Base Maintenance tools training programmes, the Estates management team will evaluate the long term maintenance priorities based on the following criteria:

- Carry risk assessment to focus work, effort and resource where it is most required & beneficial in the delivery of the Business focused maintenance strategy.
- Identify key elements of the Boards H&S policy\ statutory compliance requirements from the NHS Scotland Statutory Compliance Audit Risk Tool (SCART).
- Allocate specific responsibilities to each member of the estates management team (designated responsible persons) and establish suitable action plans.
- Establish operation and maintenance policy e.g.
    - Level PPM (circa 40%).
    - Level of Condition based monitoring (Circa 40%) Predominantly BMS & plant status monitoring.
    - Level of Reactive Maintenance (Circa 20%).
- The conclusions of the system\core service specific risk assessments will be used to determine the most appropriate maintenance regime for each system in relation to its highest risk customer served by the specific system.
- Develop Board's existing Computer Aided Facilities Management (CAFM) information system, FM-First; for population with and management of the :
    - Asset Register.
    - PPM schedule.
    - Responsible person's remit.
    - Competent person's records.
    - Training records.
    - Responsibilities for record keeping.

- 24/7 Online defect reporting tool.
- 24/7 Emergency reports via manned help desk.
- Mobile device job allocation\feedback records.
- Specialist maintenance support contract activity
- Future migration of document management and records from Zutec to FM-first, (post warranty period 2017).

- Set performance targets in-line with GG&C score card KPI's to meet local and national benchmark data. Assess & establish alternative benchmark data, set new KPI's, consider for wider use across GG&C: e.g. Standard Response times\SLA's (see Appendix 6 sample document).
- Monitor performance against KPI's and SLA's.
- Produce standard monthly feedback reports for FM Senior Management Team (SMT).

Identify mix of maintenance service support between in-house delivery and specialist contract support.

- In-house provision by multi-skilled technicians with core trade specialism's, with a recognition that due to the Hi-tech nature of the building services and level of system integration, staff will require up-skilled with training beyond that of the traditional core trades.
- With this in mind it must be recognised that there are specialist systems employed within the campus that it would not be economically viable or technically responsibly to provide in-house, these services should be quantified for outsourcing, indeed there are some instances where only the manufacturer or manufacturers agent have the required knowledge, skill and \or exclusive access rights to genuine parts or intellectual propriety software.
- Work is ongoing with Procurement\CLO to assess legal options available under these circumstances:

Examples of such systems are:

a. Combine Heat & Power (CHP) Plant.

b. Automatic Guided Vehicles (AGV's)

c. Pneumatic Transport System

d. Energy Network Management System (ENMS)

e. High Voltage Switch Gear & Emergency Generator plant

f. Lifts & Escalators

g. Sustainable Urban Drainage Systems (SUDS)

Projected specialist service support requirements and high level indicative cost can be seen in Appendix 7, where the cost profile of these essential service support requirements will be managed from the projected £2.7m/annum to bring the cost in line with the affordability model OPEX.

9. Warranty & Maintenance responsibilities

While the construction contract includes a two year warranty period, during which Brookfield Multiplex Ltd (principle contractor) are formally responsible for any equipment (group 1 & 2), fabric, building service element or operational defects that may arise. It should be clearly understood that the principle contractor responsibility under warranty does include responsibility for routine maintenance.

It is also incumbent on NHS GG&C to ensure that routine service\maintenance is carried out in compliance with manufacturer's instructions in order to ensure the integrity & continuity of the service are maintained along with associated records.

Failure to carry out the manufactures recommended routine maintenance\service requirements represent a risk to the Board from potentially invalidating the warranty due to neglect. This is of particular importance when considering the high capital value and complex nature of many of the critical elements and systems designed in to the project.

It is therefore proposed that in order to maintain warranty integrity and minimise potential contractual disputes relating to warranty issues, particularly on the more specialist plant & equipment, that short term service support contracts be commissioned from critical plant installers. This approach has the advantage that:

a. Responsibility for the first 2 years defects and routine maintenance are vested in the same organisation, minimising the potential for disputes in liability for 3rd party providers.

b. This 2 year period provides a time frame for the Estates Management team to review the PPM schedule and align it with the maintenance strategy to achieve key objectives within the limits of the FBC OPEX.

In some cases this may require a waiver to tender under the Boards Standing Financial instructions during the warranty period.

10. Training

An effective Training plan and ring fenced budget is required to support the development of the maintenance strategy, implementation and delivery of the resultant programme. These training needs will include:

i. Business-focussed risk assessment tool – whole management team.

ii. Contract asset register, PPM schedule training – management & admin support

iii. Condition based monitoring techniques – Management team

iv. Condition based monitoring application methods – Management team & technical staff.

v. FM-first training

vi. Use of mobile devices in condition based maintenance

vii. Use & interpretation of hand CBM equipment.

viii. Specialist Training requirements for management and operation of key services, a full training needs analysis will be developed to addressed the following core requirements:

- HV & LV- Authorised persons & competent persons training
- Electrical First aid training
- MGPS - Authorised persons & competent persons training
- HVAC - Authorised persons & competent persons training
- Pressure systems Responsible person:
- Legionella responsible person Managers
- Legionella awareness – technicians\MA's
- BMS\controls training (Potentially included within service support contract)
- Lifts Responsible Person
- Lifts: Competent Persons training for the Emergency evacuation of trapped passengers.
- Environmental protection & Management in line with EU Directives:
    - SUDS Management

- Fuel Management
- Emissions management

The majority of the training issues identified in item (viii) above require refresher training every 3 years to maintain and certify the skill level and competence base required to provide these highly specialist services. Therefore the training budget must be ring fenced to meet the rolling schedule of annual training.

Conclusion

Having reviewed the Brookfield Multiplex Ltd Whole Life Cycle Cost (WLCC) Model and benchmarking this against both NHS national performance data & Scottish health sector Private Finance Initiative (PFI) performance metrics (£/m^2), it this the professional option of the author that the projected Hard FM operational revenue expenditure (Budget) profile represents a realistic model for the expected service level required of the Facilities department by the Board for the effective delivery of a well maintained and compliant modern hospital facility in to the future.

This is supported by a bottom up modelling exercise to identify and quantify specialist service support requirements for this state of the art Health care facility, incorporating by design; highly complexity building service integration, n+1 plant and service distribution resilience (redundancy), designed to meet current NHS guidance & best practice models.

It is however clear that there is a substantial gap in the planning and budgeting assumptions made in the project full business case compared with the high level WLCC model, resulting in the revision and development of an FBC affordability model, (see Appendix 2), in an attempt to align the WLCC model with the FBC objectives and assumptions for the projected Hard FM operating requirements and associated OPEX for the NSGH campus.

Within this model the FBC has been normalised to today's rates producing updated FBC hard FM revenue of baseline of £6.208m, comparing this against the current OPEX for the combined demitting sites of £6.8m would suggest that the FBC is comfortably deliverable within the existing OPEX profile.

However; additional saving of £1m has been committed to the Board as part of the FBC, leaving an FBC financial envelope of £5.8m resulting in an FBC affordability model (OPEX) shortfall of £0.408m.

The affordability model OPEX target has been set at £6.208m (see appendix 2) where it is anticipated that this can be managed operationally, particularly in the first few years during warranty when breakdown levels should be low.

However in order to achieve this the projected supplies OPEX has been cut by some 59% (£1.2m) and staffing by 12%, (£0.448m) from the WLCC model projections, potentially resulting in operational pressures as the maintenance strategy profiles are developed and implemented over the first two years of operation warranty period expires.

Under this affordability model the estates OPEX budget requires to be augmented on an ongoing basis to address backlog formula requirements,

- Non routine maintenance\major service items (5/10 yearly)
- HAI related matters as they arise
- Extraordinary breakdown requirements.

These challenges vary from site to site across the Board and the above model does not take cognisance of these factors.

However it should be noted that a best practice model if adopted, similar to the funding stream provided to external managed service contracts (PFI) would maintain the premises in optimum condition. This comes however with the additional costs described above.

Therefore on the basis of affordability the board requires to make informed decisions in respect of the prioritisation of ongoing funding to maintain the new SGH hospital in optimum condition.

New South Glasgow Hospitals Campus

Revenue LCC Model v's FBC Affordability Model

WLCC/m²/Annum	31.17						A&C FBC Affordability model		
Hard FM WLCC components.	% of WLCC/m²	A&C (£)	Laboratory Medicine (£)	Retained (£)	Car Park (£)	Total (£)	Revised Opex Total (£)	FBC Indexed Revenue Opex (£)	Funding gap (£)
Management/Admin	12.50	666,259	N/A	N/A	N/A	666,259	698,000		
Staff: (Based on GGC hard FM compliance staffing model 2009/10).	37.50	1,998,776	298,063	776,971	N/A	3,073,810	2,593,803		
External support contracts	25.00	1,332,518	198,709	517,981	17,455	2,066,662	2,066,662		
Materials	20.00	1,066,014	158,967	414,385	13,964	1,653,330	850,000		
Equipment	5.00	266,504	39,742	103,596	3,491	413,332	-		
Sub-Total	100.00	5,330,070	695,481	1,812,933	34,910	7,873,394	6,208,465	5,800,000	-£408,465
	CRC/ETS cost of Carbon								
Utilities @ National Procurement Scotland contract tariffs.	355,000	4,711,472	950,000	2,933,714	101,477	9,051,663			
Total revenue Budget Based on WLCC model	355,000	10,041,542	1,645,481	4,746,647	136,387	16,925,056			

Note: FBC Affordability model is equivalent to a 24% reduction of the WLCC model projections.

New South Glasgow Hospitals Campus

Appendix 1

Revenue LCC Model v's FBC Affordability Model

New South Glasgow Hospitals Campus
High Level LCC Staffing Model

Hard FM WLCC per m2	31.17									
Based on GGC hard FM compliance staffing model 2009/10.	% of WLCC/m²	A&C		Laboratory Medicine		Retained Estate		Car Parks		Totals	
		Projected Budget	WTE	Projected Budget	WTE	Projected Budget	WTE	Projected Budget	WTE	Projected Budget	WTE
Management/Admin	12.50	666,259	14.3	99,354	2.1	258,990	5.6	N/A	-	1,024,603	22
Staff: Based on WLCC model, verified against GGC hard FM compliance staffing model 2009/10.	37.50	1,998,776	64.26	298,063	10	776,971	25	N/A	-	3,073,810	99
Sub-Total		2,665,035		397,418		1,035,961		-	-	4,098,414	120.89

Appendix 3

Hard FM Operational Model Responsible-Authorised Persons Duties

NSGH

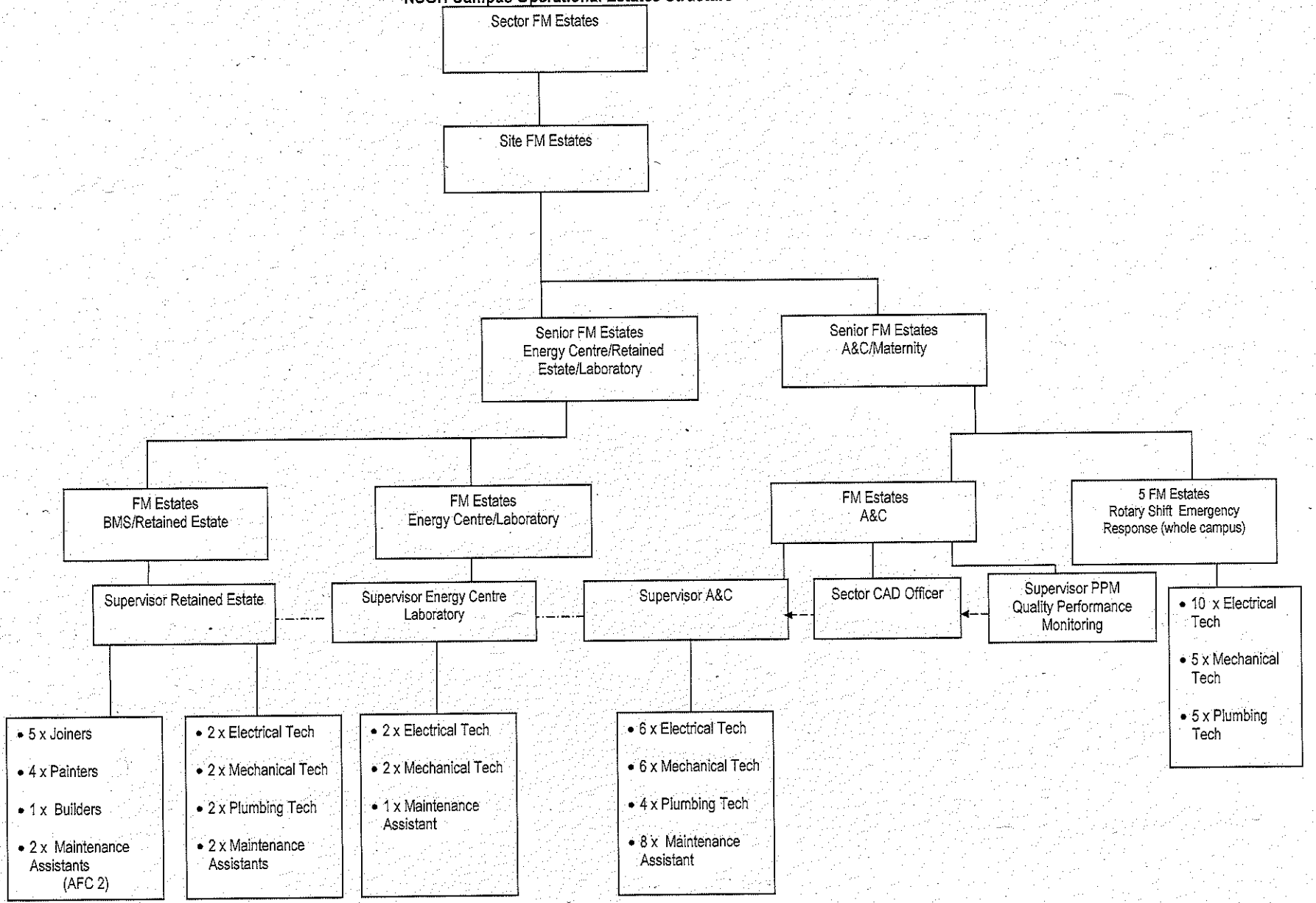
Estates Managers Structure

					Operational AP Duties (Training Require)															
	Post	Responsible person/AP	EAWR	SHTM 06:01	LV Authorised Person (AP) SHTM 06:02	HV Authorised Person (AP) SHTM 06:03	Natural Gas Safety	Oil storage regs	Legionella	Hot Water & Surface Temp (Safe)	Ventilation in Health Care Premises	LOLER	MGPS Authorised Person (AP) SHTM 02:01	Pressure Systems Safety Regulations 2000	Dangerous Substances and Explosive	Asbestos	Working at Heights Regulations 2005	Confined Spaces Regulations 1997	COSSH	Bed Head Services
1	Site FM Estates				✔	✔			✔				✔			✔				
		Zutec Document management administration																		
2	Senior FM Estates (A&C \Maternity)		✔	✔	✔	✔			✔	✔	✔	✔	✔	✔	✔	✔	✔	✔		✔
		Ventilation in Healthcare Premises (incorporating SHTM 2025)																		
		Medical Gas Pipeline Systems (MGPS) Senior AP																		
		Pressure Systems Safety Regulations 2000																		
3	Senior FM Estates (Energy Centre\Laboratory\Retained Estate)		✔	✔	✔	✔			✔	✔	✔	✔	✔	✔	✔	✔	✔	✔		✔
		Legionella Control of in Healthcare Premises Incorporating SHTM 2040 & HSE GN L8																		
		Hot Water & Surface Temperatures (Safe) Scottish Health Guidance Note SHGN																		
		Lifting Operations & Lifting Equipment (LOLER) Regulations 1998 (Incorp. SHTM 2024 (Lifts)																		
4	FM Estates Energy Centre & Laboratory medicine		✔	✔	✔	✔	✔	✔						✔	✔	✔	✔	✔		
		Electricity at Work Regulations 1989 (EAWR)																		
		Electrical Services Supply & Distribution SHTM 06:01																		
		LV Network Senior AP SHTM 06:02																		
		HV Network Senior AP SHTM 06:03																		
		Natural Gas Safety (Installation and Use) Regs 1998																		
		Oil Storage Regs 2006																		
		PPC Environmental Compliance mgt																		
5	FM Estate Retained Estate		✔	✔	✔	✔	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔	✔		
		Asbestos - The Control of Asbestos at Work Regulations 2006																		
		Working at Heights Regulations 2005																		
		Confined Spaces Regulations 1997																		
		Dangerous Substances and Explosive Atmospheres Regulations 2002																		
6	FM Estates (A&C + BMS Controls & Integrated systems)		✔		✔	✔			✔	✔	✔				✔	✔	✔	✔		✔
		Responsible Person BMS/Integrated services																		
		Energy Performance liaison with Energy team																		
		Bed Head Services																		
7 - 11	Rotary Shift Manager (5 Off)		✔	✔	✔	✔			✔		✔		✔			✔				
		Reactive & Planned Maintenance management, Emergency response & Out off hours site responsibility.																		

Notes:

Appendix 4

Facilities Directorate
NSGH Campus Operational Estates Structure



Appendix 5

NSGH Hard FM
24/7 Shift Roster

	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Total Hours
Shift 1: (Duty Manager + 4 Technicians)	Off	Off	7 - 1:30 (6.5hrs)	7 - 3 (7.5hrs)	7 - 3 (7.5hrs)	7 - 3 (8hrs)	7 - 3 (8hrs)	37.5 hrs
Shift 2: (Duty Manager + 4 Technicians)	7 - 12:30 (5.5 hrs)	Off	Off	11 - 7 (8hrs)	11 - 7 (8hrs)	11 - 7 (8hrs)	11 - 7 (8hrs)	37.5 hrs
Shift 3: (Duty Manager + 4 Technicians)	11 - 7 (8hrs)	11 - 7 (8hrs)	11 - 7 (8hrs)	Off	Off	3 - 11 (8 hrs)	(5.5 + 2.5 mandatory O/T hrs)	40hrs
Shift 4: (Duty Manager + 4 Technicians)	3 - 11 (8 hrs)	3 - 11 (8 hrs)	3 - 11 (8 hrs)	3 - 11 (8 hrs)	(5.5 + 2.5 mandatory O/T hrs)	Off	Off	40hrs
Shift 5: (Duty Manager + 4 Technicians)	7 - 3 (7.5hrs)	7 - 3 (7.5hrs)	7 - 3 (7.5hrs)	7 - 3 (7.5hrs)	7 - 3 (7.5hrs)	Off	Off	37.5 hrs

NSGH STANDARD RESPONSE TIMES

Appendix 6

Services		Task	Standard Response	Timescale (Response Time / Make Safe - Rectification time)	
				During Normal Business Hours 08:00 – 16:30	Out Of Hours 16:31 – 07:59
Hard FM	Estates	Room too Hot or Cold	Routine		
		Loss of Utility Service (See Note 3.)	Emergency		
		Light not working	Routine		
		Light Flickering	Routine		
		Tap dripping	Routine		
		Tap not working	Routine	Emergency = (30 min / 4 hours)	Emergency = (30min / 4 hours)
		Toilet Blocked	Urgent	Urgent = (2 hours / 24 hours)	Urgent = (Next BD by 10:00 / 24 hours)
		External Fire door Fault	Urgent	Routine = (Next BD / 3 BD)	Routine = (Next BD / 3 BD)
		Internal door damaged	Routine		
		Door handle broken	Routine		
		Door lock not working	Urgent		
		Ceiling tiles damaged\missing	Urgent		
		Flooring Trip Hazard	Urgent		
		Automatic Door not working	Routine		
		Fixed furniture damaged	Urgent		
		Sluice Fault	Urgent		
		Water leak (dripping)	Emergency		
		Water leak (pouring out)	Urgent		
		Window broken	Routine		
		Blinds broken	Urgent		
		Light switch not working	Emergency		
		Light switch broken (bare wirings showing)	Urgent		
		Power socket not working	Emergency		
		Power socket broken (bare wires showing)	Emergency		
		Lift – trapped persons	Urgent		
		Lift failure (without an occupant)	Urgent		
		Nurse call Hand set broken	Emergency		
		Nurse call system failure	Urgent		

NSGH STANDARD RESPONSE TIMES

Appendix 6

Services		Task	Standard Response	Timescale (Response Time / Make Safe - Rectification time)	
				During Normal Business Hours 08:00 – 16:30	Out Of Hours 16:31 – 07:59
Hard FM	**Estates**				
		Medical Gas Outlet fault	Urgent	Emergency = (30 min / 4 hours) Urgent = (2 hours / 24 hours) Routine = (Next BD / 3 BD)	Emergency = (30 min / 4 hours) Urgent = (Next BD by 10:00 / 24 hours) Routine = (Next BD / 3 BD)
		Nurse call Hand set broken	Urgent		
		Nurse call system failure	Emergency		
		Fire Alarm fault	Urgent		
		Intruder Alarm fault	Urgent		
		Door access system fault	Urgent		
	Grounds	Grounds – clear rubbish	Routine	Emergency = (1Hour / 4 hours) Urgent = (2 Hours / 24 hours) Routine = (Next BD / 3 BD)	Emergency = (1 hour / 4 hours) Urgent = (Next BD By 10:00am/24 hours) Routine = (Next BD / 3 BD)
		Grounds – clear ice /snow/gritting	Emergency		
		Street Lighting System failure	Urgent		
		Street Lighting Single failure	Routine		
		Roads\pavements trip hazard	Urgent		

Notes:

1. Response Periods & make safe-Rectification periods run concurrently.
2. Hard FM (Estates) 24/7 support.
3. Utility services include: Electricity, Hot or Cold water, Medical Gas Piped Systems (MGPS), Ventilation, Sprinkler and drainage services to wards\department or zones within.
4. In the event that a required parts\specialist support is not available an Extension of Time (EoT) to rectification will be sought from the Site Estates Manager. If approved; the status and duration of the EoT will be recorded against the Job reference number via the On-line reporting tool and a confirmation e-mail issued to the ward\departments generic e-mail address.

Specialist Support Contract Model

Plant\Equipment	Service	Manufacturer	Supplier	Estimated Value P/A (ex VAT)	Potential Manage service contract Group ()	S= Statutory M= Mandatory B= Busness Critical G= Good Practice	Cost models
BMS	Building automation & control	Schneider UK	Schneider UK	£ 250,000	(1)	B	Under review
ERM	Energy Remote Manager (metering management)	Schneider UK	Schneider UK	£ 25,000	(1)	M	Under review
High Voltage Switchgear							
HV Transformer	Annual visual\bi-annual service inspection	Schneider UK	Schneider UK	£ -	(1)	S	Move to In-house inspection
HV Switch gear	10 Yearly service inspection HV S&T	Schneider UK	Schneider UK	£ -	(1)	S	10 year backlog finding
HV Protection relays	3 yearly service\inspection\calibration & testing.	Schneider UK	Schneider UK	£ 8,333	(1)	S	Phased over 3 year period
LV Intake Switch gear & protection	10 Yearly service inspection	Schneider UK	Schneider UK	£ -	(1)	S	10 year backlog finding
LV Inspection & Testing	Final sub-circuit	WAGO	Mercury	£ 50,000	(1)	S	Phased over 5year period
ENMS (SCADA)	HV Energy Network Management System	Schneider UK	Schneider UK	£ 12,500	(1)	B	Essential annual support requirements
Earthing & Lightening protection systems specialist inspection\testing & verification.	Annual inspection\testing	Best Services Ltd	Best Services Ltd	£ 25,000	(1)	S	Essential annual specialist test provider
Energy Centre							
Boilers	Heating & Domestic Hot water generation	Bosch Ind	Bosch Ind	£ 10,000	(2)	S	Statutory annual gas safe requirements
CHP	Heating and Electricity production	MWM	Edina UK Ltd	£ 250,000	(2)	S	Essential annual specialist operator provision
Standby Generator	Emergency Power Source	FG Wilson	Dieselec\Thistle	£ 35,000	(2)	B	Essential annual specialist operator provision
Industrial Chiller Plant	Environmental Cooling source	Carrier	Carrier	£ 15,000	(2)	B	Essential annual specialist operator provision
Natural Gas	Gas Safe: Inspection & Testing (all Gas supplies & Appliances)	Kinetic Offsite	Mercury	£ 10,000	(2)	S	Statutory annual gas safe requirements
Fire protection							
Fire Alarm	Service support & statutory Test\inspection	Gent	Scotshield	£ 150,000	(3)	S	Statutory annual device\ system integrity tests (fire safety)
Fire Damper	Service support & Mandatory Test\inspection	Advanced air	Various	£ 200,000	(1) or (3)	S	Statutory annual device\ system integrity tests (fire safety)
IT frame room Fire suppression	Service support & Mandatory Test\inspection	TBC	TBC	£ 4,500	(3)	B	Statutory annual device\ system integrity tests (fire safety)
Heli Pad Fire suppression	Service support & Statutory Test\inspection			£ 10,000	(3)	S	Statutory annual device\ system integrity tests (fire safety)

Specialist Support Contract Model

Appendix 7

Sprinkler system	Service support & Statutory Test\inspection	Generic	Mercury	£ 25,000	(3)	S	Statutory annual device\ system integrity tests (fire safety)
Theatres\trauma							
Medical Pendants	Medical gas & Power supply	Starkstrom	Starkstrom	£ 90,000	(4)	B	Potential to maintain 50% per annum halfing annual cost, Warranty issues shoudl eb considdered
Operating lamp systems	Theatre task lighting	Starkstrom	Starkstrom		(4)	B	
Surgeons panels	Theatre control panel	Starkstrom	Starkstrom		(4)	B	
PACs panels	Imaging unit	Starkstrom	Starkstrom		(4)	B	
Theatre canopies\trauma isolation	Ultra Clean theatre services	MAT	MAT	£ 25,000	(4)	M	Manditory annual HAI requirement
Independent Ventilation Verification	Critical care area's	N\A	N\A	£ 50,000	(4)	M	Manditory annual HAI requirement
IPS\UPS	Theatres\Invasive procedure rooms\HIT Servers	Bender UK	CPS	£ 162,000	(4)	S	Statutory special locations requirements
Behead services							
Nurse Call	Integrated ward management	Static Systems	Static Systems	£ 35,000	(5)	B	Take minimum IT support contract, hard ware repairs adhoc?
Patient Entertainment system	Bed head TV (2 separate providers)	Children's Hosp: Airwaves. Adults Hosp: TBC	Children's Hosp: Airwaves. Adults Hosp: TBC	£ 10,000	(5)	G	Take minimum IT support contract, hard ware repairs adhoc?
Lifts & Lifting equipment							
Patient lifting equipment	Moving & Handling	Arjo	Arjo	£ 208,800	(6)	S	Statutory specialist support annual
Lift maintenance	Passenger & goods lifts\Escalators\AGV interface	Schindler	Schindler	£ 70,000	(7)	S	Statutory specialist support annual
Access equipment	Cradles\ MEWP's\Blocks & Chains\Anchor points	??	??	£ 10,000	(8)	S	Statutory specialist support annual
Statutory Inspections							
Zurich GG&C framework	Passenger Lifts\Escalators	Schindler	Schindler	£ 25,000	(7) or (8)	S	Statutory specialist support annual
	Patient lifting equipment	Arjo	Arjo		(6) or (8)	S	
	Access equipment	??	??		(8)	S	
	Access anchor points	??	??		(8)	S	
	Block & chains	??	??		(8)	S	
	Pressure Systems	??	??		(2) or (8)	S	
Security\DDA Systems							
	CCTV	Pelco	Boston Networks		(9)	B	Phase service proposal over 2 years, half annual costs
	Access Control	Comelit Group up	Boston Networks	£ 32,160	(9)	B	

Specialist Support Contract Model

	Rapid Response Alarms (Panic Alm)	Alarm Supplies	Boston Networks		(9)		years, half annual costs
	DDA Induction loop systems				(9)	B	
Water Management							
	Legionella Risk assessment (Independent)	N\A	N\A	£ 25,000	(10)	S	Annual Independant specialist
	Accredited Laboratory services (Water sample analysis & reporting)	N\A	N\A	£ -	(10)	B	Adhoc supplies budget
	Specialist water tank Cleaning	N\A	N\A	£ -	(10)	S	Supplies Budget
	Hydro-Pool Chemical treatment plant service	TBC	??	£ 5,000	(10)	S	Annual specialist service
Engineering systems	Sealed systems: water management analysis & chemical treatment management.	Peglar	Peglar	£ -	(2) or (10)	G	Supplies budget
Mains water filtration plant	Water supply quality	Elga	Elga	£ 7,000	(10)	M	Annual requirements
Hard FM Cleaning							
	External Window\Structal\curtain wall Cleaning	N\A	TBC Tender process	£ 50,000	(8)	G	18 Month cleaning cycle.
	Atria internal window cleaning				(8)	G	
	Labs external window Cleaning				(8)	G	
	Labs Atria internal window cleaning				(8)	G	
MGPS							
	Specialist Pumps\compressor plant	??	HPI	£ 20,000	(11)	M	Annuals specialist service requirement
	AGSS annual verification	??	HPI	£ 2,500	(11)	S	Annual H&S service\validation.
Local cooling equipment: Split A\C & Fan coil units.	Refrigeration inspection & testing + F Gas register	??	Mercury	£ 15,000	(2)	S	Annual inspection
Catering	Cold rooms\Chilled cabinets	??	CDS Wilman	£ 2,500	(2)	G	Annual specialist service
Automation							
Automatic Doors	**Theatres\patient circulation routes\main entrance\fire shutters**	??	??	**£ 100,000**	**(7)**	**M**	Annual requirement due to H&S and Buisiness continuity isses re AGV movements
AGV/PTS	**Goods & Material transport**	**Swisslog**	**Swisslog**	**£ 220,000**	**(7)**	**B**	Annual requirement due to H&S and Buisiness.
Patient equipment							
Electric Beds	Annual Service\electrical safety test	Hill-Rom	Hill-Rom	£ -	(6)	B	Provide training for In house support. However it should be noted that the volume of equipment would require a dedicated team to meet annual requirements.
Patient transport trolleys (A&E\MIU)	Annual Service	??	??	£ -	(6)	B	
Patient transport Chairs (A&E\OPD\Radiology)	Annual Service	??	??	£ -	(6)	B	
Grounds Maintenance							
	Landscape maintenance (Inc litter picking)	N\A	N\A	£ 30,000	(12)	g	Reveiw frequencies to achieve bast VFM
	Green Roof Maintenance/Including summer season irrigation	N\A	N\A		(12)	g	
	Planter maintenance, Including summer season irrigation	N\A	N\A		(12)	g	
	Gritting & Snow Clearing	N\A	N\A		(12)	g	
	Road Cleaning	N\A	N\A		(12)	g	
	SUDS & underground drainage: Annual survey\maintenance			£ 5,000	(12)	S	Biannal CCTV survey
	Surface water gulley clearing (vactor)	N\A	N\A		(12)	S	
Catering	Appliances service maintenance	??	CDS Wilman	£ -	N\A	B	Specialist service suppor/gas safe
ETFE Roof	Pressurisation & control	??	??	£ -	N\A	G	Provide training for In house support.

Specialist Support Contract Model

Sub-Total				£ 2,280,293			
VAT				£ 456,059			
Total				£ 2,736,352			
Notes:	1. Schedules do not allow service support\validation of Endoscopy Re-processor Units (ERU's) or Lab Autoclave						
	2. Schedules do not include Renal Dialysis water plant service support contract, consumable costs, this falls under the remit of Clinical Physics, Hard FM Technical support will be provided as required. Economy of scale could be achieved via managed service contract with joint leads & apportioned costs.						
	3. Schedule does not include service support, consumable costs for Theatre Operating tables, this falls under the remit of Clinical Physics.						
	4. Schedules do not include cleaning of Internal glazing, this falls under the remit of the Soft FM team.						

QEUH & RHC Commissioning\ Migration Programme

Estates Work Load

Period Jan – July 2015

1. *Building was not complete at handover: Monday following handover 200+ Construction workers required (Daily controlled access to the building to complete works).*
2. *Review and approve all Project contractor RAMS for ongoing constructions works (100's)*
3. *Commission Water pre-occupation Written scheme and Risk assessment under the requirements of L8*
4. *Continual flushing programme during commissioning period*
5. *Sanitisation of all departments 2 weeks before occupation.*
6. *MTHW: Commission and implement Pressure Systems Safety Regulations (PSSR) Written Scheme of Examination.*
7. *Establish Contract Failure to comply with PED requirements to CE mark manufactured pipework and (illegally placing the non compliant system on the market.) Continue to drive this issue forward over the next 2 years to ensure that the Board meets its statutory requirement under PSSR.*
8. *Lifting Equipment Written Scheme of Examination.*
9. *PPC Permit Application and compliance management*
10. *Patient Entertainment System (PES) Tender \Installation project Adult Hospital.*
11. *Service Support contract procurement (Maintenance Strategy Appendix 7).*
12. *Install all fixed equipment across new build.*
13. *Support & Facilitate installation and commissioning of 3rd party equipment.*
14. *Deliver programme of departmental changes of use from design*
15. *Accept Office Block & T&LF and support commissioning\occupation*
16. *Manage procurement and fit out of new Mop Laundry Facility with suitable equipment.*
17. *Manage defect reporting and logging process*
18. *Resolve Constant Drainage issues, surcharging of building with sewage, ultimately required all Sewer CCTV survey and aggregate removed from all man hole\out falls & main sewer back to Govan road.*
19. *Identify and address contract omission for Theatre shared layup prep interlock requirements.*
20. *Identify and raise defect concerns over non compliance of PPVL Isolation room facilities the adults Hospital.*
21. *Support Rework of isolation facilities Adult BMTU (Ventilation requirements)*

Element	Issue	Back-ground	Comments	Indicative Cost Pressure
PTS(Swisslog)	PTS system configuration problems.	Where persistent for the first year to 18 months. Several modifications and reconfigurations were carried out to stabilise the system during this time a second dedicated system was installed (12 Months ago) to alleviate the waiting time pressure on ED.	Over the past 6 months the system has stabilised with most system failures being the result of misuse: • Use of damaged carriers • Failure to lock leak proof carriers before transfer, resulting in: • System contamination • Rouge part affecting system sensors and operation.	Proportional 50% of total contract value. £125,000 + VAT per annum.
AGV(Swisslog)	AGV batteries	Batteries (Consumable) have a life expectancy of 3 years, materials & consumables are not covered under the support contract.	Batteries where replaced in 2016 due to an incorrect charging issue which was covered under warranty. Therefore we should budget for full replacement costs 2018/19 – 2019/20	Proportional 50% of total contract value. £125,000 + VAT per annum. Revenue cost pressure **Awaiting confirmation of** battery replacement costs from Swisslog, anticipated costs of circa £300,000 + VAT

Swisslog (Contract)	WTE cover	Initial contract proposals from Swisslog to provide joint PPM\reactive support for both AGV & PTS systems included for 2 WTE resident engineers, this was negotiated to 1.4 resident engineers to bring the cost within the budgeted affordability envelop. Due to the level of issues during warranty period Swisslog absorbed the cost of 2 -3 WTE resident engineers, but on 7th Dec 2017 they formally notified the Board that this was no longer commercially sustainable and are seeking to increase the contract Value by £ 55,719 in the 3rd year of a 3 year contract, back dated to the November, the start date for the 3rd year.	Recommendation, experience over the past 3 years has shown that 2 WTE resident engineers are essential to completion of the PPM and reactive maintenance to ensure continuity of service for both AGV & PTS systems. The knock on effect of not securing this specialist support would involve a high risk to service continuity for patient diagnostics, treatment and waiting time targets as well as core FM service delivery via availability of commodities, catering, laundry and CSSD distribution.	• Total Current contract value £250,000 + VAT • 2017/18 recurring revenue cost pressure Proposed Increase £55,719 + VAT • Revenue Current materials\consumable spend to date circa £60,000+VAT.

Replacement fire doors	Fire doors are not robust enough for hospital environment	• Door frames low impact resistance material (MDF)
		• Insufficient Impact protection of patient transfer route fire doors
		• Patient transfer routes:
		  ○ ED
		  ○ Theatres
		  ○ Radiology
			£750,000 investment was in door refurbishment protection\automation enhancements was released 2017/18, however the protective requirements were not included within the	Backlog Circa £1,000,000 Further investment required to address fire door conditions and enhanced protective measures.

		○ Link corridors ○ Patient transfer lift all • Not fitted with hold open\auto doors to steam line bed movements.	refurbishment specification. In addition the refurbished doors finishes were specified to original standard, none of the protection\automation enhancements where included in the PMI.	
Adult Main entrance doors	Entrance ability to cope with volume of traffic.	Designed for general access via large revolving door, supported by dedicated disabled access\egress via separate access & egress doubled door controlled lobbies. Problems relate to: 1. General traffic use disable access to access the building due to pressure on the revolving door, causing delays access\egress. 2. Disabled door lobbies, exit\entry routes are one way only for each function, despite large no entry\no exit signs for each function at the relevant doors, the public continue to enter in the wrong direction, when they realise they cannot exit the lobby via the second	Actions to date: Wind- breaks erected in, atrium to reduce wind chill effect. Additional heaters deployed at reception desk. Under floor heating set to full on mode. Space temperature monitored PO; raised for replacement pass doors, this will include a change in control away from dissabledbutton to auto detection control. This is	Revenue Cost pressures – Replacement pass doors/control arrangements £17,500 + VAT New entrance feasibility report\redesign £12,000 + VAT

		door, instead of returning the way they came in, they then force the 2nd door open. Despite repeated repairs this has resulted in the total failure of all 4 disabled pass doors. 3. This has resulted in higher pressure on the revolving doors, whereby to many people are entering simultaneously, resulting in doors cutting out on safety device, at which point the users force the central slide doors open causing total failure of the revolving door. 4. This results in extreme cold conditions within the atrium, affecting reception & voluntary staff as well as the level one dinning room.	on a 6-8 week lead time for door manufacture, installation planned for end Jan 2018. Feasibility study is underway; including foot fall assessment followed by redesigned entrance to meet traffic analysis requirements and simplify access egress arrangements and improves internal environment & comfort conditions. A capital bid to support these works is expected to be submitted in 2018/19 fiscal year.	
General flooring(Vinyl)	Floor damages	Caused by fire door issues gouging flooring materials.	Introducing potential infection control issues.	Potential Capital\Backlog cost pressure: Circa £300,000 + VAT
Adult & RHC Atrium flooring (Tiles)	Continual floor tile replacement resulting from impact damage.	Construction contract specification for floor tiles originally allowed for heavy duty tile thickness of 22mm, this was reduced to 18mm thickness	Tiles are not sufficiently robust to withstand foot fall and goods transfer, both NHS & retail activity.	Backlog\capital Replacement cost Circa £500,000. Full feasibility, specification & tender process required.

		under a value engineering proposal which was accepted by the Board.	Recurring costs Circa £25,000/Annum	
ETFE roof	Smoke extract feature failure, compromised the integrity of the atrium roof.	On 25th Oct 2017 as part of the smoke control system annual verification works by the Manufacturer the hot wire system safety features failed allowing partial burn off of 18 of the 20 roof panels allocated for this function. It was understood that mobilisation of replacement panels could be turned around within a week; this has not proven to be the case. Manufacturing has a 4-6 week lead time & installation Takes 4 weeks therefore recovery time is 8-10 weeks. Currently roof replacement is 60% complete, target completion date 22nd Dec.	The smoke burn of feature will remain disabled until such times as we have confirmed the cause, the control panel manufacturer has at our request instructed his insurer (AVIVA) of a pending claim for compensation and they have appointed loss adjusters and forensic investigators. The incident has been passed on the CLO to act on GG&C's behalf.	Current cost pressure £430,540.89 +VAT As Extra ordinary maintenance, expected to be recovered under compensatory claim for damages.
Lab Roof	Roof leak	Pursuing Multiplex as latent defect, which been back and forwards several times, most recently Multiplex have advised that this is not the same roof failure as the one raised as a defect during warranty and as such is not a contract defect	Roof repair and making good internal water damaged building materials must be completed by end Feb 2018 in preparation for	Roof repair budget cost Circa £30,000 + VAT Make good internal water damage cost Circa £25,000 + VAT

		but should be pursued under materials 30 year warranty. AECOM independent consultants where commissioned by the Board to assess the Cause of failure to ascertain if this should be treated as a latent defect, however they have found it difficult to secure manufacturers agents to undertake these works under roof system warranty conditions due to the lack of clarity in the PCD records and the various systems employed on this roof.	the Microbiology lab WASP automation project. Building services within the ceiling void will require down taking to facilitate access to the damaged building materials. Water damaged materials are generating mould\fungal spores which can adversely affect Lab processes\results. This is a particular risk to the new WASP system which estates have been advised cannot be effectively decontaminated?	Both works still to be tendered.
Medium Temperature Hot Water (MTHW) Pipework	Non Compliance with EU Pressure Equipment Directive (EUPED)	MTHW pipe work is designed to operate above the PED threshold and therefore is required to be certified with a CE mark, Multiplex\Mercury Failed to comply with this statutory requirements and place the system on the Market (in to Service) illegally. This was identified during GG&C's Preparation of Written Scheme of Works under the EU Pressure	In order to meet with NHS GG&C statutory obligations under PSSR, the Board commissioned a "Fit for Purpose " assessment via our appointed Competent Body (Zurich Engineering), this assessment identified numerous modifications required to allow Zurich to	2016/17 cost £35,000 + VAT Cross charged to project retention.

		Systems Safety Regulations (PSSR) assessment. Multiplex insistent for the best part of a year that they could achieve retrospective CE certification however they were unable to produce the require records of evidence for certification.	deem the system “Fit for Purpose” and assume legal responsibility for its design PSSR compliance. The last few elements of these works are under way for completion by end Dec 2017.	
Combined Heat & Power (CHP) operational configuration	CHP plant was brought on line one year late with loss of income as a result.	To date the CHP performance has failed to be achieved due to design issues with the interface to the boiler plant, whereby the boilers ether force the CHP to run under capacity or cause them to shut down.	Multiplex recent effort to address this energy performance issue has been to de-rate the Medium Temperature Hot Water Primary heating circuit 22% in order to hold CHP plant at full output, however this is having a detrimental effect on the secondary heating & DHW circuits at point of use resulting oin 100% heating demand 24/7 as the local Heat exchangers are now under-rated to meet their design criteria.	N\A

			In addition it appears that the system is constantly dumping heat due to the incorrect application of the dump diverter valve.	
Building Energy Performance	Contractual report on building energy performance has not been submitted on the due date Jan 2017.	Multiplex should have monitored physical meters and compared the performance against the sub metering profile to confirm building performance meets the contracted target of 83gCO2/m2/annum	Sub metering package has yet to be completed and demonstrated as complete and accurate to within ± 1% against the summation meters in line with target performance criteria. Contract includes for plant\system review\modification to align performance gap to target.	N\A
QEUH Glazing issues	Spontaneous failure of glazing units due to Nicol Sulphide Inclusion (NiS)	Several (5 off) exterior vision\spandrel glazing panels have failed on the east\south east elevations of the ward tower with 2 internal panels also failing due to NiS.	Where it was possible to retrieve the source failure section, analysis has confirmed NiS as the cause. Temporary Mitigations: East elevation Pavement has been closed off and scaffold protection has	Cost for replacement to date Circa £75,000 + VAT Cost for mitigations to date Circa £70,000 + VAT

			been deployed around the discharge lounge ambulance set down. Permanent covered walk way protection is being scoped by DoF.	
Cladding fire rating compliance	Non compliant Aluminium Composite Cladding.	Deployed on 1. 3 facets of the adult tower • East core tower • West Core tower • Helipad tower 2. Front elevation of the RHC, Trespa panels and insulation board.	Board commitment to replace Adult tower panels. Multiplex commitment to replace RHC panels. Multiplex Awaiting final instructions to proceed, lead time to start date approx 16 weeks, Installation phase approx 30 weeks.	TBC
Single room ventilation design.	Single room accommodation designed for 3 Air changes per Hour (ACH). Neutral pressure	SHTM 03-01 requires 6 ACH -ve pressure. This was supported in the Boards task log. (attached files)	No Viable option identified	Non Identified
Ward 4b (BMT) suitability	Isolation rooms do not meet the requirements for BMT • Dedicated Ventilation plant	24 rooms within ward 4b where retrospectively modified to accommodate Adult BMT patients, however the retrospective modification was restricted to the limitations of the original building services installation.	Further modifications have recently being instructed, replace en-suite suspended ceiling with solid ceiling and revalidate all 24 rooms.	Total cost Not Known. In year capital cost Circa £50,000+ VAT

	• 10pa +ve Pressure • 10 ACH		Regional directorate \ICD have consulted HPS\HFS for guidance on validating isolation facilities are suitable for BMT patient accommodation, HPS\HFS produced an SBAR detailing requirements and environmental proving protocol evaluate the isolation room conditions before migrating patients into the ward. While the enabling works and validations are all complete we are currently experiencing over heating issues that would appear to be related to cabling issues. Investigations are ongoing.	
Ward 2A (BMT) Positive Pressure Ventilated Lobby (PPVL) Patient Isolation issues	ICD\clinical concerns over PPVL facilities not being suitable for Highly Neutropenic patients	SHPN 04 supplement 1 includes a disclaimer that these facilities are not intended for Neutropenic patients. (note there are currently no specific national guidance for Neutropenic isolation facilities)	4 from 8 isolation suites are currently being converted to +ve pressure bed rooms, based on SHTM 03-01 theatre cascade ventilation principles. ICD & Clinical lead now suggesting all 8	Capital cost £75,000 + VAT

			rooms require up-grading to + ve pressure bed room.	
Ward 2A Teenage Cancer Trust (TCT) ward, Immuno-compromised patient accommodation issues.	Concerns over rooms suitability for Immuno-compromised TCT patients	Clinical concerns over 3 ACH for single rooms, no isolation of the unit ventilation from the general hospital.	This is evidenced by chest infections rate and high particulate counts and some positive result for fungal spores. Arrangements are under way to hold a workshop to review current installation limits and options to upgrade ward to suitable standard. This will require substantial reworking requiring ward closure or partial closure to facilitate refers requirements under Risk Assessment.	Capital costs TBC
ICU Positive Pressure Ventilated Lobby (PPVL), ID Patient Isolation issues	PPVL suite is not suitable for isolation of highly infectious patients i.e. TB\MERS	Feasibility under way to assess and scope requirements to convert minimum 4 from 10 of these facilities to –ve pressure isolation suites.	Draft feasibility report will be submitted for review and technical \clinical sign off by end Jan 2018, Once approved tender specification will be prepared by End Feb 2017 for issue March pending capital funding approval.	Capital Budget costs TBC within feasibility report.

Ceiling Vent Grilles (CVG)	Ceiling Void breach into clinical area corridors introducing potential IC risk.	CVG have been installed in all ward\OPD corridors under national guidance SHTM 02-01 for Medical Gas installations, investigations have established that these CVG are not required to meet this guidance as the base criteria is not applicable within the Medical gas installation within the QEUH installation.	HFS have been consulted to verify this opposition following which these CVG will be replaced by ceiling tiles to restore the integrity of the clinical space, particularly BMT area's	Non Recurring revenue cost pressure £5,000 + VAT
Fire Dampers	Fire damper controls	Estates are experiencing problems securing adequate support from the damper control manufacturers UK agent Entropic Ltd (only one in UK). Despite providing a quote for validation of the control system and damper status health check, Entropic Consistently resist efforts to secure inspection & testing compliance detail and commitment to site visit. In addition BMS graphic monitoring arrangements do not utilise unique id of each damper, this requires to be augmented	External enquiries to other providers have return concerns about the lack of documented compliance and commissioning certification of the smoke control system via CE mark and Declaration of Performance requirements and commissioning certification? These concerns have been raised at recent Defect review meetings with Multiplex. Entropic provided a quotation for annual physical damper inspection.	Recurring Revenue cost pressure Proposed cost for control service inspection 3,500 euro. £660,000\annum Recurring Revenue Cost Pressure £155,000 + VAT\Annum.

			Separate QQ exercise returned one quote only. Arrangements are underway to implement maintenance programme for physical inspection and testing during 2018, programme will take full 12 months to deliver.	Non Revenue cost pressure BMS Graphic update Circa £25,000 + VAT non-recurring.
Ward 4b Over heating	BMS KNX Control issues	Investigations into overheating issues have been ongoing for the past 3 weeks, mechanical elements of all control valves have been replaced without success, KNX controls engineers have been carrying out diagnostics and concluded that there is an induced voltage on the control signal line, causing the control valves to sit 20-40% open even when the system is not calling for heat. Note this issue has also been identified in RHC resus unit, resulting in on going over heating issues	Note Cabling was not part of the Schneider controls package, therefore this is not a fault covered under the maintenance support contract. Investigations are on-going, current thoughts are that control cable is self inducing a voltage on the control pair from the 24v integrated power pair, the KNX cable should be Twisted Pair (TP), however first impressions are that the cable used is not TP standard, if confirmed this	N\A at this time.

			would potentially be a Latent defect due to non compliance with SPEC? TBC Implications, KNX are the back bone of the integrated BMS strategy, Schneider are recommending replacement with screened TP cable, at major disruption \cost.	
Asset tagging	Asset tagging of the A&C buildings is now complete, however the Lab building assets have not be tagged	Multiplex insist that the lab asset tagging is not included within the contract specification.	This is under review by the Board technical advisors.	N\A
High Voltage Maintenance programme	Service support contract not in place due to budget affordability cost pressure	Budget allocation does not accommodate this support cost.	First full service inspection due 2017/18	Revenue Cost pressure £170,000+VAT\Annum over a 5 year plan
Medical gas pendants, operating lights and surgeons panels.	Service support contract, not in place due to budget cost pressure	Budget allocation does not accommodate this support cost.	Contract break down: • 59% Operating lights • 33% medical pendants • 8% Surgeons panels	Revenue Cost Pressure £145,573+ VAT /annum, over a 5 year contract.

Dear Parent / Carer

We have been giving you regular updates on the measures we have been taking to enhance the environment on the ward.

As you are aware we have already taken a range of measures including a programme of enhanced cleaning.

We have undertaken extensive testing of all the water systems in the ward and there still remains no source to link the infections to the ward environment or our infection control practices.

As a precautionary measure we are continuing to undertake further investigations and testing and to facilitate these we will continue to divert a small number of admissions. Outpatients and day cases are continuing as normal

We also undertook a range of audits of infection control practices within the ward. The results from these audits were within the accepted limits and our plan is to continue these on an ongoing basis.

Prophylactic antibiotics are being prescribed to patients on the ward and we continue to work closely with Health Protection and Health Facilities Scotland.

We would once again like to thank all the parents for their continued support whilst these measures remain in place and further investigations continue.

We would also ask the parents and visitors to continue to assist us by adhering to our advice on good hand hygiene practice when in the ward.

As you are aware our clinical, nursing and infection control staff are available if you wish to discuss anything further.

Friday, August 23, 2019

NHS GREATER GLASGOW AND CLYDE UPDATE ON WARD 6A

There are no further confirmed cases of the unusual infections which prompted a review of infection control practices and the environment of Ward 6A.

There is nothing to link the infections to the ward and the investigation into one of the cases has been closed down.

Investigations continue on the other unusual cases.

A further meeting has been set for early September, when a decision will be taken on re-opening the ward.

ENDS

For further information either telephone [redacted] or email [redacted]

REPORT ON CUPRIAVIDUS INFECTION AT QUEEN ELIZABETH HOSPITAL UNIVERSITY GLASGOW

Introduction

This report is prepared by Professor Thomas John Evans MA, PhD, MBBChir, FRCP (Lond. & Glasg.). I am Professor of Molecular Microbiology in the University of Glasgow and Honorary Consultant in Infectious Diseases and General Medicine for Greater Glasgow and Clyde Health Board. I have been a Consultant in Infectious Diseases and General Medicine since 1996. I am on the Specialist Register of the General Medical Council in Infectious (Communicable) Diseases. I have first-hand experience of treating adult patients with *Cupriavidus spp.,* as well as other infections in immunocompromised patients. I have research interests in serious bacterial infections. I am expert in the analysis of bacterial genomes. The opinions set out below are based on my own experience in the practice of medicine, published studies of patients with these infections, and genomic data provided to me from the Scottish Microbiology Reference Laboratories.

Declaration of Interest

I have not been involved in any way with the clinical care of any patients currently the focus of the ongoing Inquiry into water-borne infections within the Queen Elizabeth University Hospital Glasgow (QEUH) or the Royal Hospital for Children (RHC) Glasgow, nor was I involved in any way with the infection prevention and control investigations for these patients. I have not had any role in the design or planning of these hospitals. I am employed by the University of Glasgow, and I have an honorary contract with Greater Glasgow and Clyde (GGC) Health Board as a Consultant in Infectious Diseases and General Medicine. The analysis carried out as part of this report was funded directly by the Hospital Acquired Infection unit within the Chief Nursing Officer Directorate of the Scottish Government. The funders played no role in the planning, execution, or preparation of the results presented here.

1. Presence of Potentially Pathogenic Bacteria in Water and other Environmental Sources

1.1 Bacteria are ubiquitous microbial life forms found widely in the environment. Most bacteria do not cause human disease, but a number can produce infections in normal individuals, while others can produce disease only in an individual with a condition rendering them immunodeficient.

1.2 Drinking water is not sterile, but a variety of quality indicators are adopted within the UK to ensure its suitability for human consumption. These include absence of specified pathogens, freedom from faecal contamination and limits on the numbers of bacteria that can be cultured from water samples at different temperatures. Water within facilities managed by GGC is regularly tested in accordance with the criteria set in the relevant guidance. If specific pathogenic bacteria that are listed in the National Infection Prevention and Control Manual Appendix 13 (https://www.nipcm.hps.scot.nhs.uk/appendices/appendix-13-mandatory-nhsscotland-alert-organismcondition-list/) are detected in clinical infections, a possible link to the environment should be considered. Full details of the regular and incident triggered water sampling in the Queen Elizabeth University Hospital (Adults) and Royal Hospital for Children

(RHC) are contained in the separate report 'Microbiological testing of water and environmental samples from the Queen Elizabeth University Hospital (Adults) and Royal Hospital for Children, 2015-2020' by Dominique Chaput.

1.3 The most significant clinical events arising from potential water contamination were with the pathogens *Stenotrophomonas maltophilia, Enterobacter* species and *Cupriavidus pauculus.* This report considers *Cupriavidus* species*;* a separate report considers the infections caused by these other bacteria.

2. *Cupriavidus* species

2.1 The bacterial genus *Cupriavidus* comprises a range of Gram negative bacterial species, found widely in the environment, some of which can rarely cause human infections, typically in those who are immunocompromised. The commonest identified species causing human infection is *C. pauculus*. This species is widely found in soil and water, including tap water[1], and has rarely been reported as causing human infections; a recent review found only 32 such cases reported worldwide [2]. Most of these reports have been from patients receiving cancer chemotherapy with indwelling venous catheters, artificially ventilated on intensive care units, having underlying immunodeficiencies, or multimorbidity[3, 4]. It has also been reported very rarely in apparently immunocompetent individuals[2].

2.2 Whole genome sequencing provides an unparalleled ability to provide unequivocal identification of a microbe. A fair analogy would be to DNA fingerprinting of human samples used in forensics, which can provide robust evidence of the presence of a specific individual at a particular location or in a particular sample. However, bacteria have genomes about 1,000 times smaller than humans, so intrinsic variation in genome sequence between different bacterial isolates of the same species is less. However, bacteria (with very short intergenerational times) do undergo some sequence diversification over time. Small changes will accrue in the core genes (present in 99% of members of the species) over time. These are evidenced by single changes in a specific base in the DNA sequence, so-called single nucleotide polymorphisms (SNPs) or small insertions or deletions of a piece of DNA. These changes can act as a molecular 'clock', allowing an estimate of the evolutionary time that has elapsed since 2 isolates diverged. This varies between different species of bacteria, and will depend on both a 'background' rate of change, selection pressure on mutations due to changes in fitness, and generation time of the different bacterial species. These have been estimated for a number of bacterial species by Duchêne et al [5]. Because of paucity of data, there is not a direct measure of the evolutionary rate of change for *Cupriavidus* species. However, based on the rates for similar bacteria calculated by Duchêne et al, a reasonable estimate for this species would be a rate of 10^{-6} changes per base site per year. The genome size of *Cupriavidus* is ~ 5.8 x 10^6 bases, so on average every year 2 identical isolates of this organism would be expected to differ by ~ 6 SNPs.

More diversity will accumulate in the accessory genome, where introduction of genes by horizontal gene transfer can produce a larger scale difference after such an event. In analysing possible transmission events, greater diversity between strains increases the discriminatory power of whole genome sequencing to identify very similar strains that may have a common origin. If all sequences in the whole population were very similar, then the ability to identify transmission of a strain from one source to another is clearly limited.

Because of the high diversity between the sequenced isolates considered here, SNP differences were made by direct comparisons of pairs of bacteria, as described in the technical appendix.

3. Analysis of Clinical and Environmental Samples from the QEUH/RHC

3.1 In the period 2015 – 2020 a total of 485 isolates of *Cupriavidus* species were isolated from QEUH Adults and RHC water samples. As outlined in the report on the water sampling numbers and results, over this period a total of 10,311 water samples were analysed by the environmental laboratory (excluding those tested only for Legionella). Of these 10,311 water samples, 6,183 looked specifically for Gram negative organisms including *Cupriavidus* of which 275 (4.4%) were positive for this genus. 56 isolates of *Cupriavidus* species were isolated from other environmental sources such as drains. 8 isolates were from human blood cultures. Of the 8 human samples, there were duplicate sets of samples from 2 patients on the same occasion. Accounting for these duplicates gives a total of 6 human isolates. Of note, prior to March 2018, in general, isolates of *Cupriavidus* spp from water and other environmental sources were not routinely stored and hence such samples are not available for whole genome sequencing.

3.2 We analysed 133 of the *Cupriavidus* isolates that had been subjected to whole genome sequencing and were supplied by the Glasgow Reference Laboratory. This allowed us to assign each sample to a specific bacterial species and to compare sequences between human and water or environmental isolates. For the purpose of this report, the term "environmental" is used below to include isolates obtained from the water supply or from other environmental sources. 75 of these sequenced genomes were unequivocally identified as *C. pauculus* – in this group there were 4 human blood culture isolates. Other species unequivocally identified were *C. metallidurans* (28 samples), *C. gilardii* (19 samples), and *C. basilensis* (5 samples). None of these species were present in human isolates. 6 additional isolates did not match any known *Cupriavidus* species. Compared to each other, these samples had very high overall sequence identity (> 95% overall sequence identity) showing they were all from the same species. However, when comparing them to the sequences of isolates that unequivocally matched to *C. pauculus*, they showed only ~ 50% overall sequence identity, and even lower identity to isolates identified as *C. basilensis* (~28% identity). Bacterial species in general show ~ 95% sequence identity between different members. On that basis, the 6 sequences described above must belong to a new *Cupriavidus* species, which will be submitted for formal naming. There were 4 human derived sequences within those 6 sequences – these were 2 sets of duplicates from 2 patients samples at the same occasion.

3.3 As all the human isolates were *C. pauculus* or the new *Cupriavidus* species, we focussed on these species. The 75 *C. pauculus* isolates were highly diverse. Out of a total of >35,000 genes, only 1 gene was found in >99% of the samples, and only 153 in between 95% – 99% of the samples. The new *Cupriavidus* species were less diverse, partly because there were so few examples – of the 4 unique isolates of this species, out of 8,122 total genes, 5,169 were found in at least 3 of the samples.

3.4 The report on the *Stenotrophomonas* isolates outlines the different considerations required when trying to determine whether a human isolate most likely came from a

environmental source. As stated in that report, evidence of transmission of a strain from an environmental source to a patient would need to demonstrate high sequence similarity between strains that were isolated within a reasonably close time frame.

3.5 All the *Cupriavidus* spp genome sequences were analysed and a family tree of their relatedness to one another was constructed. Of the 6 unique human isolates, 2 were isolated prior to 2018. One was isolated on 16/2/16; the clinical details note this was thought to be a contaminant. The other was isolated on 22/9/17. One of the sequenced samples was from Glasgow Royal Infirmary and not considered further here. As noted above, water sampling prior to 2018 was not as extensive, and environmental organisms isolated before that period were not usually subjected to whole genome sequencing. The numbers of samples that exceeded the various thresholds are shown in 'Microbiological testing of water and environmental samples from the Queen Elizabeth University Hospital (Adults) and Royal Hospital for Children, 2015-2020' by Dominique Chaput.

3.6 *C. pauculus human-human pairs.* Firstly, we compared the genome sequences of the human *Cupriavidus pauculus* isolates to determine if they were so closely related as to suggest a common origin. The 4 human isolates of *C. pauculus* were analysed. The closest related pair were isolated on 22/9/17 and 11/3/21, a time interval of 3 years and 5 months and had 144 single nucleotide differences between them. Thus, on balance of probability, there is no evidence to support a common origin of the human *C. pauculus* isolates.

3.7 *C. pauculus environmental-environmental pairs.* A large number of environmental isolates of *C. pauculus* were isolated between February and March 2018. These were all very closely related with SNP differences ranging between 1-30. Similar close relationships were shown with sequences of environmental isolates of *C. gilardii* and *C. metallodurans.* These isolates therefore are highly related and present in the environment during that period. However, water sampling in February and March 2018 was very intense, accounting for 191 of the 485 total samples of *Cupriavidus* isolated from the water system (39%). It is thus not possible to say with confidence how persistent these strains are within the water system.

3.8 *C. pauculus human-environmental pairs.* We then compared the most closely related pairs of isolates between human and environmental samples. The closest related pair showed 102 SNPs in their aligned sequences. The time interval between their isolation was 2 years and 1 month, with the human sample being isolated first on 16/2/16, and the environmental sample on 14/3/18. Another environmental sample obtained on 13/3/18 showed a difference of 108 SNPs from the human sample. On balance of probabilities, therefore, there is no evidence to support a transmission link between these pairs of human and environmental isolates. However, given that there are no environmental samples to compare before 2018, this does not permit an analysis between that human sample and contemporaneous environmental samples. The next closest related pair differed by > 37,876 SNPs in their aligned sequences. The human isolate was obtained on 28/8/20 and the environmental isolate on 7/1/20, an interval of ~ 8 months. Given the very large number of SNPs between these two isolates, on balance of probabilities there is no evidence to support a transmission event from the environment to human for this pair of isolates either.

3.9 *New species Cupriavidus human-human Pair.* There were only 2 unique human samples of this species. The pair differed in their whole genome sequence markedly, with > 2,000 SNPs between their aligned sequences. They were isolated with an interval of 2 years. Given the sequence difference between these isolates, there is no evidence supporting their origin from a common source.

3.10 *New species Cupriavidus human-environmental pairs.* All of these pairs were in the period with more extensive water sampling. The closest related pair of human and environmental isolates differed by more than 10,000 SNPs in their aligned sequences. The interval between their isolation was 1 year and 11 months, the human sample being isolated first on 5/2/18 and the environmental sample on 14/1/20. The next closest related pair of isolates from a human and environmental source differed by > 100,000 SNPs in their aligned sequences. The time interval in their isolation was 1 year and 10 months, with the environmental isolate being isolated first on 26/3/18 and the human sample on 28/1/20. Taken together, on balance of probability, there is no evidence of any transmission event from the environment to human in this novel *Cupriavidus* species.

4. Conclusions

4.1 There are relatively few (6) human blood culture isolates of *Cupriavidus* spp to compare with environmental samples. For 2 of the human isolates, they were in a period prior to extensive water sampling and sequencing.

4.2 There is no evidence of a common origin of the human blood culture isolates on balance of probability.

4.3 For the 4 human isolates obtained in the period 2018 onwards, there is no evidence of any transmission event from the environment to human, on balance of probability. Likewise, there is no evidence to support transmission from a human source to the environment.

4.4 For the 2 human *Cupriavidus* isolated from blood samples taken before 2018, there are no direct comparisons possible with environmental samples taken at around the same time. It is not possible to comment therefore on whether there were closely related environmental isolates to these human samples.

4.5 One important consideration is whether the sampling 'missed' a water organism that spread directly to a patient. The water sampling strategy showed that out of 10,311 samples, only 485 such samples grew *Cupriavidus* species. Of these 10,311 water samples, 6,183 looked specifically for *Cupriavidus* of which 275 (4.4%) were positive for this genus. For human isolates obtained after March 2018, the water sampling was more intense and more *Cupriavidus isolates* were stored and sequenced. In this period, therefore, the sequence data are highly representative of the *Cupriavidus* species isolated in environmental samples. It is therefore unlikely that during this period the sampling did not capture a significant presence of *Cupriavidus* strains, unless they were extremely transitory. For the 2 human cases isolated prior to this date, the sampling was not so intense and sequences are not available for any

Cupriavidus that might have been isolated. It is not possible, therefore, to comment on whether there were closely related environmental isolates to these human samples.

4.6 I conclude on balance of probability that for the 4 cases of bloodstream infection with *Cupriavidus* detected from 2018 onwards, these did not originate from the environment at the QEUH/RHC. Their origin remains uncertain, but given the known presence of these organisms in the wider environment, including public water systems in Glasgow[6, 7], there are multiple other possibilities.

4.7 For the 2 human *Cupriavidus* cases of bloodstream infection prior to 2018, it is not possible to know whether their origin was from the water supply within the QEUH/RHC or elsewhere, as there is not enough data to draw a conclusion.

Professor T J Evans MA PhD MBBChir FRCP

March 5th 2023

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REPORT ON ENTEROBACTER INFECTION AT QUEEN ELIZABETH HOSPITAL UNIVERSITY GLASGOW

Introduction

This report is prepared by Professor Thomas John Evans MA, PhD, MBBChir, FRCP (Lond. & Glasg.). I am Professor of Molecular Microbiology in the University of Glasgow and Honorary Consultant in Infectious Diseases and General Medicine for Greater Glasgow and Clyde Health Board. I have been a Consultant in Infectious Diseases and General Medicine since 1996. I am on the Specialist Register of the General Medical Council in Infectious (Communicable) Diseases. I have first-hand experience of treating adult patients with *Enterobacter spp.* infections, as well as other infections in immunocompromised patients. I have research interests in serious bacterial infections. I am expert in the analysis of bacterial genomes. The opinions set out below are based on my own experience in the practice of medicine, published studies of patients with these infections, and genomic data provided to me from the Scottish Microbiology Reference Laboratories.

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1. Presence of Potentially Pathogenic Bacteria in Water and other Environmental Sources

1.1 Bacteria are ubiquitous microbial life forms found widely in the environment. Most bacteria do not cause human disease, but a number can produce infections in normal individuals, while others can produce disease only in an individual with a condition rendering them immunodeficient.

1.2 Drinking water is not sterile, but a variety of quality indicators are adopted within the UK to ensure its suitability for human consumption. These include absence of specified pathogens, freedom from faecal contamination and limits on the numbers of bacteria that can be cultured from water samples at different temperatures. Water within facilities managed by GGC is regularly tested in accordance with the criteria set in the relevant guidance. If specific pathogenic bacteria that are listed in the National Infection Prevention and Control Manual Appendix 13 (https://www.nipcm.hps.scot.nhs.uk/appendices/appendix-13-mandatory-nhsscotland-alert-organismcondition-list/) are detected in clinical infections, a possible link to the environment should be considered. Full details of the regular and incident triggered water sampling in the Queen Elizabeth University Hospital (Adults) and Royal Hospital for Children (RHC) are contained in the separate report 'Microbiological testing of water and

environmental samples from the Queen Elizabeth University Hospital (Adults) and Royal Hospital for Children, 2015-2020' by Dominique Chaput.

1.3 The most significant clinical events arising from potential water contamination were with the pathogens *Stenotrophomonas maltophilia*, *Cupriavidus pauculus,* and *Enterobacter* species*.* This report considers *Enterobacter* species*;* a separate report considers the infections caused by *Cupriavidus* and *Enterobacter* strains.

2. *Enterobacter*

2.1 The bacterial genus *Enterobacter* encompasses a group of Gram-negative bacteria that are found within the natural environment, as well as able to cause human infections [1]. Their taxonomy has undergone extensive revision in the last 50 years. Recent accumulation of whole genomic DNA sequences of members of this groups has been instrumental in rationalising species designations within the *Enterobacter* genus. In general, members of a bacterial species have ≥ 95% average nucleotide identity of their genomes. This has led to re-assignment of some species names and new species have been identified on the basis of their genomic sequencing. There are now over 20 different species within the genus, and more are being added every year. They differ in their ability to cause human disease.

2.2 *Enterobacter* species are widely dispersed in the natural environment, being found in soil and water, as well as for some species in a close association with plants [2]. In addition they are normal members of the human gut microbiota; a 2022 study of 75 individuals in Sweden over a 1 year period found 100% of those studied had *E. cloacae* isolated in at least 1 of 4 faecal samples taken during the study period[3]. They can cause human disease, typically in those who are immunocompromised or after prolonged stays in intensive care units, where extensive antibiotic use can select for these organisms [4]. Bacteria can translocate from the gut into the bloodstream when patients are immunocompromised or have received chemotherapeutic agents that disrupt the gut epithelium [5]. *Enterobacter* are occasionally recognised cause of outbreaks within hospitals and healthcare settings, although an environmental source is often difficult to determine; in several reports, the origin of infection has been the patient's own endogenous gut flora [6, 7]. Colonisation of water sources/sinks within healthcare settings has been documented and could be the potential source of human infection [8]. In a review of over 2000 samples of clinical *Enterobacter* isolates from largely British hospitals, Gaston found only 2 cases where infections could be attributed to a common source[9].

2.3 Taxonomic classification of the different species within the *Enterobacter* complex has been confusing, as previous assignments made using biochemical or limited gene analysis have been proved to be inaccurate. Many *Enterobacter* species have previously been grouped as *E. cloacae*, but whole genome sequencing has shown this group consists of a number of different species. Hoffman grouped species termed *E. cloacae* into 12 distinct genetic clusters [10], and later analysis extended the numbers of genetically distinct clades into 18 groups (A-R) [11], more recently extended to 22 members with distinct species names [12], as well as related *Enterobacter* species that are not yet well defined. The majority of clinical isolates of *Enterobacter* are *E. hormaechei* [13].

2.4 It is important to appreciate that the genomes of bacterial species contain 2 classes of genes. Firstly, there are genes that are present in virtually all isolates, typically set at 99% of the total. These are termed the 'core' genome. Outside of this invariant collection of genes are other genes that are only found in subsets of the total population. These are called the 'accessory' genome. These genes typically will include genetic material transferred from other microbes usually of the same species, which can be virus-like entities known as bacteriophages, as well as circular genetic elements called plasmids. This type of acquisition of extraneous DNA is termed horizontal gene transfer.

2.5 Whole genome sequencing provides an unparalleled ability to provide unequivocal identification of a microbe. A fair analogy would be to DNA fingerprinting of human samples used in forensics, which can provide robust evidence of the presence of a specific individual at a particular location or in a particular sample. However, bacteria have genomes about 1,000 times smaller than humans, so intrinsic variation in genome sequence between different bacterial isolates of the same species is less. However, bacteria (with very short intergenerational times) do undergo some sequence diversification over time. Small changes will accrue in the core genes (present in 99% of members of the species) over time. These are evidenced by single changes in a specific base in the DNA sequence, so-called single nucleotide polymorphisms (SNPs) or small insertions or deletions of a piece of DNA. These changes can act as a molecular 'clock', allowing an estimate of the evolutionary time that has elapsed since 2 isolates diverged. This varies between different species of bacteria, and will depend on both a 'background' rate of change, selection pressure on mutations due to changes in fitness, and generation time of the different bacterial species. These have been estimated for a number of bacterial species by Duchêne et al [14]. Because of paucity of data, there is not a direct measure of the evolutionary rate of change for *Enterobacter* spp. However, based on the rates for similar bacteria calculated by Duchêne et al, a reasonable estimate for this species would be a rate of 10^{-6} changes per base site per year. The genome size of species of *Enterobacter* is ~ 5 x 10^6 base pairs, so every year 2 identical isolates of this organism would expect to differ by ~ 5 SNPs. This is a helpful estimate to assess whether 2 strains are essentially the same isolate that have only diverged in the recent evolutionary past.

More diversity will accumulate in the accessory genome, where introduction of genes by horizontal gene transfer can produce a larger scale difference after such an event. In analysing possible transmission events, greater diversity between strains increases the discriminatory power of whole genome sequencing to identify very similar strains that may have a common origin. If all sequences in the whole population were very similar, then the ability to identify transmission of a strain from one source to another is clearly limited. Comparing any gene differences, as well as single nucleotide polymorphisms (SNPs) in aligned areas of the sequences allows unequivocal ascertainment of the relatedness of different isolates.

2.6 In general, when attempting to establish transmission chains, it is the core genome variation that is analysed, as this has a more reliable variation with time than changes in the accessory genome. However, the ability of genome sequencing to provide information on possible transmission will be limited by how much variation occurs over time, defined as transmission divergence [15]. Additional information is key. In the context of the analysis performed here, to demonstrate possible transmission of a strain of *Enterobacter* from an

environmental source to a patient requires examination of the genomic sequences of environmental isolates and human isolates, as well as the time interval between when these different isolates were obtained. In general, therefore, evidence of transmission of a strain from an environmental source to a patient would need to demonstrate high sequence similarity between strains that were isolated within a reasonably close time frame. Because of the high diversity between the sequenced isolates considered here, SNP differences were made by direct comparisons of pairs of bacteria, as described in the technical appendix.

3. *Enterobacter* species isolated in Patients and the Hospital Environment

3.1 As outlined in the separate report on water sampling, between 2015 and 2020 10,311 water samples were tested by the Environmental laboratory (not counting those tested only for Legionella). 6 of these samples contained a species of *Enterobacter* and they were not analysed further. *Enterobacter* spp. are not one of the alert organisms specified by the National Infection Prevention and Control Manual Appendix 13. In addition to water testing, some environmental sampling was carried out in the QEUH and RHC, including swabs of sinks, drains, and other surfaces. This was not performed in a standardised or structured fashion. Samples were processed in the routine microbiological laboratories and in accordance with standard practice were not necessarily subsequently stored. The numbers of samples and their location are shown in the table below for the period 2015-2020 (see the separate report entitled 'Microbiological testing of water and environmental samples from the Queen Elizabeth University Hospital (Adults) and Royal Hospital for Children, 2015-2020').

Sample type	2A/2B	6A	4B	1D/PICU	other wards	Total
Drain	31	148	27	76	53	335
Shower	8	48	5	0	11	72
Sink	14	58	4	86	57	219
POU filter	7	148	4	64	17	240
Wet other	5	2	13	4	40	64
Chilled beam	12	89	0	0	21	122
Dry surfaces	2	13	3	69	117	204
other sample types	47	34	14	9	103	207
Total	126	540	70	308	419	1 463

The numbers of samples containing *Enterobacter* and the species assignment are shown below (wet other refers to samples taken below the sink drain):

	Drain	Sink	Wet other
Enterobacter cloacae	40	11	1
Enterobacter cloacae complex	0	1	0

Enterobacter hormaechei	2	0	0
Enterobacter kobei	5	0	0

3.2. 6 isolates of *Enterobacter* from environmental samples were serendipitously retained and whole genome sequences obtained. Species were assigned from the whole genome sequences using ribosomal multilocus sequence typing, a rapid and very accurate means of assigning a bacterial isolate to a species. The species isolated were *E. roggenkampii* (3 samples), *E. kobei* (2 samples), and *E. asburiae* (1 sample). Over this period, 29 patient samples were identified from blood cultures from patients within the QEUH/RHC. These were subjected to whole genome analysis. The species identified were *E. hormaechei* (14), *E. asburiae* (5), *E. roggenkampii* (4), *E. kobei* (2), *E. chengduensis* (1), *E. genomosp. O* (2), and *E. ludwigii* (1).

3.3 The whole genome sequences of these human and environmental *Enterobacter* isolates were assembled and a phylogenetic tree constructed to show their evolutionary relationships. As expected, the species as identified by ribosomal multilocus sequence typing grouped together.

3.4 We analysed the relatedness of samples isolated from environment only, from human only, and from both human and environment. Variation in the environmental samples would give an indication if there were dominant strains that varied little within the water system that would suggest persistence of a strain in the system such as might come from a contaminated source within the hospital. Variation in human samples would help identify if there were closely related strains from different patients suggestive of a common source. Finally, analysis of relatedness between human and environmental samples would help identify a possible transmission event from environment to human.

3.5 *Human-human pairs.* Comparison of human sequences was undertaken to ascertain if any of these clinical isolates had a likely common source. In general, the *Enterobacter* isolates were diverse and encompassed 7 separate species. There were some pairs of isolates that were more closely related. The most closely related pair were isolates of *Enterobacter genomosp. O*. which were virtually identical across most of their genome. These were from the same patient taken approximately 3 months apart. They differed by only 2 SNPs in their aligned sequences, which implies that they are essentially the same isolate. This species was not found in the environmental samples. Given the identity of the sequences isolated from the same patient in a relatively short time frame, the most likely explanation is that this *Enterobacter* species was being carried in the gastrointestinal tract of this patient and was incompletely cleared and gave rise to a recurrent infection. This has been reported on numerous occasions in the medical literature [16, 17], often resulting from the emergence of antibiotic resistance during therapy.

3.6 *Human-human pairs.* Another pair of isolates from the same patient (but not the patient described above) showed a reasonably close genome similarity. These were *E. hormaechei* isolates showing large amounts of genome similarity that differed by 10 SNPs over the aligned parts of their genome. These isolates were obtained just under 1 month apart. This amount of SNP difference in a pair of isolates obtained 1 month apart certainly shows they are closely related, although the estimate for SNP divergence of 2 identical

isolates over 1 year is ~ 5 SNPs as discussed in section 1.5. However, as discussed above, this could also represent continued carriage of one distinct isolate in the gastrointestinal tract of this patient.

3.7 *Human-human pairs*. Another pair of *E. hormaechei* isolates also showed significant similarity differing by 47 SNPs over the aligned parts of their genome. These came from 2 different patients, separated in time by 3 months. Again this degree of similarity is close, too great to support a conclusion that they are essentially the same strain, but likely 2 closely related but distinct strains.

3.8 *Human-human pairs.* A pair of isolates of *E. asburiae* from different patients, one from Ward 2A in the RHC and one from Ward 2B showed a high degree of similarly of only 2 SNPs. They were isolated 2 weeks apart in 2017. This would strongly suggest that they had a common source. There was only 1 environmental isolate of *E. asburiae* isolated in 2018 which was quite distinct belonging to a different sequence type.

3.9 *Environment-environment pairs.* Of the 6 isolates from environmental sources, only 2 showed a significant degree of similarity. These were 2 strains of *E. kobei* isolated from the U bend of a sink in the same ward in September 2018 that had 20 SNPs across their aligned genomes, again suggestive that they were closely related strains, which is largely expected given they were isolated from a sink in the same ward in the same month.

3.10 *Human-environment pairs.* None of the isolates from environmental sources were closely related to any of the isolates from patients. The closest match was between an isolate of *E. asburiae* from an environmental source in October 2018 and one patient isolate from January 2016, but the difference in SNPs was over 817. This unequivocally identifies them as quite separate.

4. Conclusions

4.1 29 bloodstream isolates of *Enterobacter* from patients in the QEUH/RHC between 2015-2020 were analysed. In 2 patients there were isolates obtained from the same given individual with intervals of 1 – 3 months. Detailed genomic analysis of these samples showed that in these cases, isolates from the same patient were very closely related (but not between the patients) and thus likely represent persistent carriage of these isolates in these patients. There were two isolates of *E. asburiae* that showed very close sequence identity with only 2 SNP differences isolated from different patients on adjacent wards within a 2 week period. This strongly suggests a common origin, but the nature of this is unclear. The number of sequenced samples of *Enterobacter* from the environment in this time period is very limited so the diversity of *Enterobacter* species within the environment of the QEUH/RHC within this period is unknown. However, given that *Enterobacter* species are widely distributed in the environment and within the normal human intestinal microflora, it is not possible to determine the exact origin of these isolates.

4.2 There is no genetic evidence of any transmission between environmental isolates of *Enterobacter* to humans. The numbers of environmental isolates that were fully sequenced over this period is, however, very limited.

4.3 The origin of the *Enterobacter* infections that were detected remains unknown. Certainly, none were related to the very small numbers of environmental *Enterobacter* isolates that underwent genomic sequencing. Adventitious sampling of a variety of sink outlets isolated some *Enterobacter,* but it is not possible to relate this to the appearance of infection in a patient, as the sampling was not systematic and the identity of the bacteria were not analysed by genomic sequencing.

4.4 Given that *Enterobacter* are widely found in the natural environment outside of healthcare facilities, and can be a component of the normal human gut flora as outlined in section 2.2, these are also potential sources of the human infections caused by these bacteria. On that basis, I conclude on balance of probabilities that the human infections from these *Enterobacter* species were not acquired from environmental sources within the QEUH/RHC.

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March 5th 2023

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REPORT ON STENOTROPHOMONAS INFECTION AT QUEEN ELIZABETH HOSPITAL UNIVERSITY GLASGOW

Introduction

This report is prepared by Professor Thomas John Evans MA, PhD, MBBChir, FRCP (Lond. & Glasg.). I am Professor of Molecular Microbiology in the University of Glasgow and Honorary Consultant in Infectious Diseases and General Medicine for Greater Glasgow and Clyde Health Board. I have been a Consultant in Infectious Diseases and General Medicine since 1996. I am on the Specialist Register of the General Medical Council in Infectious (Communicable) Diseases. I have first-hand experience of treating adult patients with *Stenotrophomonas maltophilia,* as well as other infections in immunocompromised patients. I have research interests in serious bacterial infections. I am expert in the analysis of bacterial genomes. The opinions set out below are based on my own experience in the practice of medicine, published studies of patients with these infections, and genomic data provided to me from the Scottish Microbiology Reference Laboratories.

Declaration of Interest

I have not been involved in any way with the clinical care of any patients currently the focus of the ongoing Inquiry into water-borne infections within the Queen Elizabeth University Hospital Glasgow (QEUH) or the Royal Hospital for Children (RHC) Glasgow, nor was I involved in any way with the infection prevention and control investigations for these patients. I have not had any role in the design or planning of these hospitals. I am employed by the University of Glasgow, and I have an honorary contract with Greater Glasgow and Clyde (GGC) Health Board as a Consultant in Infectious Diseases and General Medicine. The analysis carried out as part of this report was funded directly by the Hospital Acquired Infection unit within the Chief Nursing Officer Directorate of the Scottish Government. The funders played no role in the planning, execution, or preparation of the results presented here.

1. Presence of Potentially Pathogenic Bacteria in Water and other Environmental Sources

1.1 Bacteria are ubiquitous microbial life forms found widely in the environment. Most bacteria do not cause human disease, but a number can produce infections in normal individuals, while others can produce disease only in an individual with a condition rendering them immunodeficient.

1.2 Drinking water is not sterile, but a variety of quality indicators are adopted within the UK to ensure its suitability for human consumption. These include absence of specified pathogens, freedom from faecal contamination and limits on the numbers of bacteria that can be cultured from water samples at different temperatures. Water within facilities managed by GGC is regularly tested in accordance with the criteria set in the relevant guidance. If specific pathogenic bacteria that are listed in the National Infection Prevention and Control Manual Appendix 13 (https://www.nipcm.hps.scot.nhs.uk/appendices/appendix-13-mandatory-nhsscotland-alert-organismcondition-list/) are detected in clinical infections, a possible link to the environment should be considered. Full details of the regular and incident triggered water sampling in the Queen Elizabeth University Hospital (Adults) and Royal Hospital for Children (RHC) are contained in the separate report 'Microbiological testing of water and

environmental samples from the Queen Elizabeth University Hospital (Adults) and Royal Hospital for Children, 2015-2020' by Dominique Chaput.

1.3 The most significant clinical events arising from potential water contamination were with the pathogens *Stenotrophomonas maltophilia*, *Cupriavidus pauculus,* and *Enterobacter* species. This report considers *S. maltophilia;* a separate report considers the infections caused by *Cupriavidus* and *Enterobacter* strains.

2. *Stenotrophomonas maltophilia*

2.1 This Gram negative bacterium is ubiquitously found in a wide range of environmental reservoirs, including *inter alia,* domestic and healthcare water systems, some salad foodstuffs, soil, and river water[1]. In individuals with a normally functioning immune system the organism very rarely causes disease, but in the immunocompromised it can be the cause of serious infections with significant morbidity and mortality[1-3].

2.2 Gröschel et al carried out a global survey of 1,305 both clinical and environmental isolates of *S. maltophilia*, which has highlighted key genomic features of this organism[4]. It is important to appreciate that the genomes of bacterial species contain 2 classes of genes. Firstly, there are genes that are present in virtually all isolates, typically set at 99% of the total. These are termed the 'core' genome. Outside of this invariant collection of genes are other genes that are only found in subsets of the total population. These are called the 'accessory' genome. These genes typically will include genetic material transferred from other microbes usually of the same species, which can be virus-like entities known as bacteriophages, as well as circular genetic elements called plasmids. This type of acquisition of extraneous DNA is termed horizontal gene transfer.

2.3 The study of Gröschel et al found high diversity among global isolates of *S. maltophilia.* Out of a total of 17,479 genes present in the total collection analysed, only 7.3 % were found in > 99% of genomes. This demonstrates a very large diversity in this organism. They grouped the different isolates by similarity of their core genes and were able to distinguish 23 distinct lineages. These could then be subdivided further into sequence types (STs), based on differences between certain key genes. Strains from different lineages differed very markedly, but even within a lineage they found significant sequence variation. The average sequence similarity between different lineages was lower than the threshold conventionally adopted to group bacteria as belonging to the same species; future work may thus lead to reconsideration of the taxonomic classification of this group. They compared the strain designation with the origin of each isolate – whether from a human clinical source or from the environment. Two strains (Sgn1 and Sgn2 in their designation) were only found in environmental samples, while two others (Sgn3 and Sm11) contained significantly more environmental isolates than from other sources. Human-associated strains were found more commonly in a number of different strains, but there was not a uniquely human-associated strain. The most abundant strain detected (Sm6) was more associated with human-associated isolates. No plasmids were found in this collection. The authors of this study correlated the genomic similarity of human isolates with epidemiological markers of time and place of isolation. They identified a number of clusters of genetically related organisms isolated from patients within the same hospital over an 8 week period, suggestive of potential transmission

events. However, they did not identify related environmental isolates to these human samples, although the extent of environmental sampling was not clear.

2.4 Whole genome sequencing provides an unparalleled ability to provide unequivocal identification of a microbe. A fair analogy would be to DNA fingerprinting of human samples used in forensics, which can provide robust evidence of the presence of a specific individual at a particular location or in a particular sample. However, bacteria have genomes about 1,000 times smaller than humans, so intrinsic variation in genome sequence between different bacterial isolates of the same species is less. However, bacteria (with very short intergenerational times) do undergo some sequence diversification over time. Small changes will accrue in the core genes over time. These are evidenced by single changes in a specific base in the DNA sequence, so-called single nucleotide polymorphisms (SNPs) or small insertions or deletions of a piece of DNA. These changes can act as a molecular 'clock', allowing an estimate of the evolutionary time that has elapsed since 2 isolates diverged. This varies between different species of bacteria, and will depend on both a 'background' rate of change, selection pressure on mutations due to changes in fitness, and generation time of the different bacterial species. These have been estimated for a number of bacterial species by Duchêne et al [5]. Because of paucity of data, there is not a direct measure of the evolutionary rate of change for *S. maltophilia*. However, based on the rates for similar bacteria calculated by Duchêne et al, a reasonable estimate for this species would be a rate of 10^{-6} changes per base site per year. The genome size of *S. maltophilia* is ~ 4.8 x 10^6 bases, so on average every year 2 identical isolates of this organism would be expected to differ by ~ 5 SNPs.

More diversity will accumulate in the accessory genome, where introduction of genes by horizontal gene transfer can produce a larger scale difference after such an event. In analysing possible transmission events, greater diversity between strains increases the discriminatory power of whole genome sequencing to identify very similar strains that may have a common origin. If all sequences in the whole population were very similar, then the ability to identify transmission of a strain from one source to another is clearly limited. Because of the high diversity between the sequenced isolates considered here, SNP differences were made by direct comparisons of pairs of bacteria, as described in the technical appendix.

2.5 In general, when attempting to establish transmission chains, it is the core genome variation that is analysed, as this has a more reliable variation with time than changes in the accessory genome. However, the ability of genome sequencing to provide information on possible transmission will be limited by how much variation occurs over time, defined as transmission divergence[6]. Additional information is key. In the context of the analysis performed here, to demonstrate possible transmission of a strain of *S. maltophilia* from an environmental source to a patient requires examination of the genomic sequences of environmental isolates and human isolates, as well as the time interval between when these different isolates were obtained. In general, therefore, evidence of transmission of a strain from an environmental source to a patient would need to demonstrate high sequence similarity between strains that were isolated within a reasonably close time frame.

2.6 As outlined above, global strains of *S. maltophilia* are extremely diverse and < 10% of their gene content is shared by 99% of the strains. Thus, core genome variability will only provide a limited insight into the overall relatedness of 2 strains. Thus, direct comparison of

the total sequence of potentially related water/environmental-human or other pairs will give more insight into their overall relatedness and hence possibility of transmission. These comparisons will highlight any gene differences, as well as single nucleotide polymorphisms (SNPs) in aligned areas of the sequence. These differences accumulate over time as described above and thus will indicate if similarities between isolates are insufficiently close to substantiate a transmission event.

3. Analysis of Clinical and Environmental Samples from the QEUH/RHC

3.1 A detailed account of the water sampling strategy at the Queen Elizabeth University Hospital is set out in a separate report (Microbiological testing of water and environmental samples from the Queen Elizabeth University Hospital (Adults) and Royal Hospital for Children, 2015-2020). Of note, routine water sampling dramatically increased from later in 2018.

3.2 In the study period between 2015-2020 10,311 water samples were tested by the Environmental laboratory (excluding samples tested only for Legionella and samples tested by other laboratories, which did not report specific organisms), as detailed in the separate report on the water testing numbers. Out of this total, 76 isolates of *S. maltophilia* were found. The number of isolates of this organism versus the number of water samples in each year were: 2015, 0/127 samples; 2016, 1/286 samples; 2017, 0/383 samples; 2018, 26/2490 samples; 2019, 8/2147 samples; and 2020, 41/4878 samples. Of these 10,311 water samples, 6,183 looked specifically for Gram negative organisms including *S. maltophilia*, of which 71 (1.1%) were positive for this species. 40 isolates of *S. maltophilia* were isolated from other environmental sources such as drains. Although as outlined, different locations and extents of testing were carried out, there is no reason to suppose that this level of the presence of *S. maltophilia* in water samples is not representative. Over this time period, there were 23 isolates of clinical relevance isolated from blood cultures.

3.3 We were able to carry out a detailed analysis of the genomes of 84 these organisms and related them to available epidemiological data, notably time and place of isolation. 79 of these sequences were from samples at the QEUH campus (including the Royal Children's Hospital). Of these, 23 of the isolates were from blood cultures, and 56 from isolates of water samples and environmental samples taken from drains from a variety of outlet points (which represents 48% (56/116) of the total water/environmental *S. maltophilia* isolated at the QEUH campus). The human samples were collected between 2015-2020, the water and environmental samples from 2018-2020. For the purpose of this report, the term "environmental" is used below to include isolates obtained from the water supply or from other environmental sources.

3.4 We analysed the 84 isolates of *S. maltophilia* from environmental samples as well as clinical samples as described above and obtained high quality whole genome sequences. The sequences were carefully analysed and a family tree of their relatedness to each other constructed, together with 24 reference strains from publicly available databases. This showed that within this collection of environmental and clinical isolates there were representatives of all 23 groups as defined by Gröschel et al.. We observed very similar correlations between different groups and their source as defined by Gröschel et al. Thus

Sgn3 (7 samples), Sm4b (6 samples), Sm15 (3 samples), and Sm11 (12 samples) were only found in environmental-derived samples. Human-derived samples were not present uniquely in any group. The most abundant group isolated was Sm6 (15 samples from 84; 18% of total) of which 9 were from a human source and 6 from environmental sources; this was also the most abundant group identified in the study by Gröschel et al (413 of 1305 strains; 32% of total).

3.5 We analysed the relatedness of samples isolated from environmental only, from human only, and from both human and environmental. For these analyses we focussed on those obtained from the QEUH campus. Lack of variation in water samples would give an indication if there were dominant strains that varied little within the water system that would suggest persistence of a strain in the system such as might come from a contaminated water source within the hospital. Lack of variation in human samples would help identify if there were closely related strains from different patients suggestive of a common source. Finally, analysis of relatedness between human and water samples would help identify a possible transmission event from water to human.

3.6 *Environmental- environmental pairs.* In general these were very diverse with the vast majority of pairs having > 2,000 gene differences across the whole genome. Some samples were more closely related, with fewer than 50 gene differences. Some of these were clearly extremely closely related samples, with fewer than 10 gene differences and just a few SNPs differing in aligned areas. In general they were separated by relatively short time intervals – some from samples on the same day but others separated by a few months. The longest separation in time between 2 closely related environmental isolates was ~ 6 months between 11/12/19 and 17/6/20 of group sgn3. These isolates differed by just 4 SNPs, which over this time frame would be within the expected variation of one specific strain persisting over this time. We did not observe such strains persisting for longer periods.

3.7 *Human-human pairs.* These were more diverse than the environmental pairs. The closest pair of samples differed by 399 genes and had 969 SNPs over the aligned genomes. Additionally, these two samples were separated in time by ~21 months. There is therefore no evidence in these samples of a common source resulting in related clusters of human infections.

3.8 *Human- environmental pairs.* These were analysed for relatedness to provide evidence of possible transmission events from the hospital water systems to patients. Most of the comparisons between such pairs showed extensive differences with many thousands of gene differences. The closest related pair were from lineage Sm6 with 79 gene differences between them, and 46 SNPs difference in aligned parts of the genomes. The environmental sample of this pair dated from 4/12/19. The human sample of this pair dates from 24/9/17, which was 27 months earlier. In this time period, one might expect there to be ~ 11 SNPs between the sequences if the human isolate was derived from the environment at that time containing the isolate subsequently isolated on 4/12/19. The number of SNPs observed between these 2 isolates thus makes this unlikely, as although they are similar, they are insufficiently close.

Given that the human sample containing *S. maltophilia* dated from 24/9/17, this was months before more intensive sampling regimes were in place. A better indicator therefore

of possible transmission events is to compare samples taken in the period when water sampling was more intense (after March 2018) and when more isolates were available for sequencing. 20 of the 25 humans samples were obtained during this time frame. In this period, the diversity of human- /environmental isolates was more extreme than shown above. There were very few examples where a human and environmental isolate were classified into the same lineage and sequence type, and only 1 where the time interval between isolation of the samples was less than 6 months. The human sample of this pair was isolated on 30/1/20, and the environmental sample on 28/8/19. These two samples differed very markedly – over the aligned regions of their genomes, there were 2,001 SNPs. Thus, this difference shows the samples are very unrelated and rules out transmission of the bacterium from this environmental isolate to the patient. Another pair with greater time difference between them was a human sample isolated on 14/5/17 and a environmental sample isolated on 26/7/18, a difference of ~ 14 months. The observed SNPs between these 2 isolates was 178 SNPs, which rules out a potential transmission event from an environmental sample that had been present, but undetected since May 2017.

3.9 *Sequence diversity in water sampled at a single point in time.* We also wished to establish how much diversity existed in isolates of *S. maltophilia* obtained from a single water sample. 7 distinct bacterial colonies of *S. maltophilia* obtained from 1 water sample were sequenced and compared. This showed they were extremely similar, with 4577 genes found in over 99% of these isolates and only 17 genes differing between them. Within the core 4577 genes there was 1 SNP identified in just 1 sample.

4. Conclusions

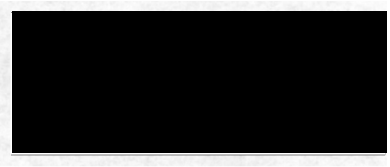
4.1 The range of *S. maltophilia* isolates obtained from environmental and clinical samples within the QEUH/RHC were very similar to a published analysis of such samples from hospitals across Europe. We did not find any isolates that were not part of the groups described by Gröschel et al.

4.2 The comparisons between the different isolates did not find any evidence of clusters of human cases related to a single source. In addition, there was no evidence linking any of the human cases to any of the isolates found in the environment. Likewise, there is no evidence to support transmission of the bacterium from human cases to the environment.

4.3 One important consideration is whether the sampling 'missed' an organism that spread directly to a patient. The water sampling strategy showed that out of 10,311 samples examined in the environmental laboratory form the QEUH campus, only 76 such samples grew *S. maltophilia*. Of the 6,183 water tests that looked specifically for Gram negative organisms including *S. maltophilia*, only 71 (1.1%) were positive for this species. For human isolates obtained after March 2018, the sampling was more intense and more *S. maltophilia* isolates were available for sequencing. It is therefore highly unlikely that during this period after March 2018 the sampling did not capture a significant presence of *S. maltophilia* strains, unless they were extremely transitory. Importantly, sequencing of 7 separate *S. maltophilia* isolates from one sample of water showed very low diversity. This would support the view that at any one time, diverse strains of *S. maltophilia* were not present in the water supply. For the 5 human cases isolated prior to this date, the sampling was not so intense and

environmental sequences are not available for any *S. maltophilia* that might have been isolated. Given the generally large differences observed between human and environmental samples in all cases in the period after March 2018, I would be of the opinion that on balance of probability it is very unlikely that human and environmental samples before this time would have shown a different pattern.

4.4 Overall, therefore, in my opinion, on balance of probability, none of the clinical cases of infections with *S. maltophilia* originated from water systems within the QEUH/RHC. It is not clear from where these clinical isolates might have originated, but given the known widespread distribution of this bacterium in the environment as outlined in paragraph 2.1, there are multiple other potential sources.



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March 5th 2023

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Technical Appendix

Assembly of Whole Bacterial Genomes

The raw reads for the bacterial sequences discussed in this report were supplied by the reference laboratory in Glasgow. As outlined in their separate report, DNA sequences of bacterial genomes were determined using the Illumina MisSeq platform generating paired end reads of 300 bp as fastQ files. These were pre-processed using Trimmomatic[1], which removes poor quality reads and any primer sequences. Reads were assembled using SPAdes[2], using default parameters. Contigs from SPAdes were annotated using PROKKA(3), using defaults and annotation flags as appropriate for the species genome being assembled.

Phylogenetic Analysis

Genomes were aligned with ROARY[4] and recombination regions removed using GUBBINS[5]. The core genome alignment was then used to construct a phylogenetic tree using RaxML[6] (from within Gubbins), using a generalised time reversible model of nucleotide substitution and 100 bootstrap replicates. Trees were visualised using Figtree (http://tree.bio.ed.ac.uk/software/figtree/).

Single Nucleotide Polymorphism (SNP) Detection

We chose a different method from that described in the report prepared by Professor Leanord and Dr Brown. This was to ensure an independent validation of their results. There is no 'absolute' method of SNP determination but analyses using different methods should give very similar results. We used the Snippy pipeline devised by Torsten Seeman (https://github.com/tseemann/snippy). Given the large variation present between the different isolates of *S. maltophila, Enterobacter*, and *Cupriavidus* species as described in the body text, we made pairwise comparisons between closely related isolates as determined in our phylogenetic trees described above. We used one member of the pair as a reference, using the Genbank file output from the Prokka annotation of the assembled reads. This was then compared to the raw reads of the other member of the pair to determine the SNPs between the two. SNIPPY aligns the reads using BWA aligner[7], and then determines variants (SNPs and short insertions and deletions) using FreeBayes, a Bayesian inference variant caller that calls SNPs based on their probability given the potential sequencing errors in the reads and the expected frequency of variation[8]. The default values for coverage (minimum 10 reads) and minimum fraction of reads containing the variant (0.9) were used. The minimum quality of variants called was set at the default value of 100, a probability of being an error of 10^{-10}.

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SCOTTISH HOSPITALS INQUIRY

Bundle 8 – supplementary documents for the Oral hearing commencing on 12 June 2023

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