

Prevention and management of healthcare water-associated infection incidents/outbreaks

HPS are aware of the limitations of current guidance in this area and are currently working towards delivery of comprehensive evidence-based guidance which will form Chapter 4 of the National Infection Prevention and Control Manual (NIPCM). In the interim, this **aide memoire** provides best practice recommendations to ensure clinical staff, estates and facilities staff, and Infection Prevention and Control Teams (IPCT) have an understanding of the preventative measures required and the appropriate actions that might be implemented in the event of a healthcare water-associated infection incident/outbreak. Evidence is derived from outbreak reports (Scottish and International), and the HPS Rapid Review of HAI outbreaks Associated with Healthcare Water Systems.

1. Infectious agents associated with incidents/outbreaks related to healthcare water

Table 1 includes the infectious agents which have been **identified in the literature**. **NB this list is not intended for use as an alert organism list**. The alert organisms list ([Appendix 13](#) of the NIPCM) should be used in conjunction with local Board surveillance data i.e. a greater than expected rate of infection/colonisation compared with the usual background rate for that healthcare location, and local teams should consider if further investigation is required.

TABLE 1: Infectious agents associated with incidents/outbreaks related to healthcare water (* denotes most frequently reported microorganisms).

<i>Achromobacter spp.</i>	<i>Aspergillus spp.</i>
<i>Acinetobacter spp.</i> (<i>A. baumannii</i> , <i>A. junii</i> , <i>A. Ursingii</i>)	<i>Candida spp.</i> (<i>C. parapsilosis</i> , <i>C. metapsilosis</i>)
<i>Burkholderia spp.</i>	<i>Citrobacter freundii</i>
Carbapenemase-producing <i>Enterobacteriaceae</i>	<i>Elizabethkingia meningoseptica</i>
<i>Chryseobacterium indologenes</i>	<i>Exophiala jeanselmei</i>
<i>Cupriavidus pauculus</i>	<i>Legionella pneumophila</i> *
<i>Enterobacter cloacae</i>	<i>Pantoea agglomerans</i>
<i>Fusarium spp.</i>	<i>Pseudomonas spp.</i> (<i>P. putida</i> , <i>P. fluorescens</i>)
<i>Klebsiella spp.</i> (<i>K. pneumoniae</i> *, <i>K. oxytoca</i>)	<i>Serratia marcescens</i>
Nontuberculous mycobacteria (NTM)*	<i>Stenotrophomonas maltophilia</i>
<i>Pseudomonas aeruginosa</i> *	<i>Staphylococcus aureus</i>
<i>Rhizomucor spp.</i>	

NB – this list is not exhaustive and does not include unusual or rarely reported microorganisms such as atypical Mycobacterium.

2. Sources of water-associated infection incidents

The source of water-associated infection identified from the literature includes:

- **Contaminated water systems:** tanks and reservoirs, pipe work, faucets/taps, sinks, wash-hand sinks, sink traps, drains, showerheads, shower hoses, baths.
- **Contaminated water-based equipment:** haemodialysers, bronchoscopes, nebuliser chambers, water-based heater-cooler units, hydrotherapy pools, ice-makers, humidifier reservoirs, water dispensers.
- **Contaminated water-based products:** disinfectant/antiseptic solutions made with tap water, bottled water, medications.

3. Causes of contamination

- Inadequate **design and/or management** of water systems that allow water stagnation and the build up of sludge, sediment, scale, organic matter and rust, all of which favour microbial growth and/or biofilm formation within the system. Biofilms act as a reservoir for a multitude of infectious agents facilitating their survival within water systems, and provide protection from control measures such as heat and chlorine.
- Inadequate **cleaning/decontamination** protocols or poor compliance with adequate protocols for water systems and water-based equipment.
- Inappropriate **practices/behaviours** of healthcare staff, patients and visitors, that increase the risk of contamination, for example disposal of food/drinks, body fluids in clinical wash hand sinks, storage of patient toiletries on sinks, preparation of IV drugs within splash zone of water outlets.

4. Transmission routes for water-associated infection incidents/outbreaks

Transmission routes identified in the literature include:

- **Direct contact**
 - Ingestion/inhalation of contaminated water.
- **Indirect contact**
 - Hands of healthcare workers via contaminated water, or infectious agents from a colonised/infected patient.
 - Contaminated environment.
 - Contaminated equipment (i.e. surgical devices, nebuliser cups, suction apparatus for ventilated patients, diagnostic equipment (e.g. bronchoscopy, ERCP), aspiration tubes for neonates, patient feeding items including containers for nutrition solutions, tube feeding equipment and milk bottles).
 - Water-based equipment (heart-lung machines and associated heater-cooler units used during cardiac surgery, humidifiers within oxygen therapy and drug delivery equipment, as well as air humidifiers and carpet cleaners).
- **Aerosolisation**
 - Contaminated body fluids transferred through clinical procedures that produce aerosols (i.e. open suctioning or wound irrigation).
 - Contaminated water generated from the process of water splashing on to clinical wash hand basins, drains, sinks, baths, shower cubicles, and when flushing toilets.

- **Aspiration**

- Contaminated drinking water in the airways which is a particular risk for patients with nasogastric tubes, stroke patients, those taking sedatives and narcotics and those with motor neurone disease.

5. **High risk patient groups/settings**

High risk patients are defined in the literature as those who are severely immunocompromised as a result of their disease, age or treatment. The healthcare settings most frequently reported in water-associated incidents/outbreaks, and therefore considered as **high risk settings**, include haematology and oncology units, bone marrow and stem cell transplant units, neonatal, paediatric and adult ICUs, and any other care areas where patients are severely immunocompromised through disease or treatment. Clinical judgement is required to assess individual patient risk for any patient not being managed in these high risk units. A local NHS board risk assessment should be undertaken to identify any additional healthcare settings where patients are extremely vulnerable to infection. This risk assessment should take account of surveillance data and any previous incidents in individual clinical settings.

6. **Types of infection caused by water borne organisms**

These include: bloodstream, respiratory (pneumonia, ventilator-associated pneumonia), skin and soft tissue (including insertion site infections around any invasive device), surgical site infection (endocarditis, wound infection), urinary tract infection (UTI) and disseminated disease.

7. **Definitions of water-associated incidents/outbreaks (refer to [Chapter 3](#) of the NIPCM)**

- A **single** case of infection or two or more cases of colonisation with an alert organism (as per [Appendix 13](#) of the NIPCM) in a **high risk setting/ patient** of which there is evidence of acquisition within that healthcare setting (i.e. occurring ≥ 48 hours after admission), will require investigation to exclude the possibility of linked cases (including historic), which could indicate an **outbreak**, or an ongoing contamination issue.
- In addition to this, the following scenarios may require further investigation depending on the clinical presentation and the infectious agent;
 - a single case of colonisation or infection **at any time** from point of stay in the **neonatal ICU**;
 - a single case of infection **in any setting** where the infection episode and/or causative infectious agent is very rare/novel or highly antibiotic-resistant.
- In all other situations, the trigger for further investigation would be two or more linked cases with the same infectious agent associated with the same healthcare setting over a specified time period.
- If further linked cases are identified, a more extensive investigation will be required to exclude all potential sources. If there is an indication of an association with water or water-related equipment, consideration should be given to conducting environmental sampling (including water testing).

8. Preventing an incident/outbreak

Water system maintenance:

- A Water Safety Plan (WSP) should be in place and reviewed by the Water Safety Group (WSG) on an annual basis and also when there are alterations, repairs, changes of use, building works, or critical incidents. The WSG in collaboration with unit staff should review all uses of water on the unit. For details regarding WSG roles and responsibilities, see [SHTM04-01 Part B](#).
- Infrequently used water outlets should be removed if appropriate; a flushing regime should be instigated if it is not possible to remove the outlet.
- Measures to prevent water stagnation and biofilm formation may include (in addition to tap flushing) installation of easier to clean sinks and plumbing, rimless toilets to prevent splashing, and sinks with deeper basins. For further information on design see [SHTM04-01 Part A](#).
- Staff should report any problems or concerns regarding the safety, maintenance, usage, and cleanliness of water outlets to the appropriate service e.g. estates and facilities department/ ancillary staff.
- High risk components such as flow straighteners and thermal mixing valves should be included in a decontamination and maintenance programme.
- To prevent splash back, water flowing from water outlets should not flow directly into drain holes but should impact on the basin offset from the drain hole. **Please note that HPS/HFS are in the process of developing further guidance for drain cleaning/decontamination requirements.**

Water outlet flushing:

- For all high risk areas the frequency and duration of flushing will depend on the usage and water pressure of the individual outlet, and on a risk assessment of the local unit taking into account local surveillance data and patient risk. **Please note that HPS/HFS are in the process of developing further guidance for outlet flushing requirements.**
- Outlet flushing should not cause splashing/spraying beyond the wash hand basin; if flushing creates splashing/spraying onto adjacent surfaces, the area should be cleaned/disinfected (as per [NIPCM Chapter 1](#)) to reduce the risk of contamination and slippages/falls.
- Daily outlet flushing should be scheduled to occur at a pre-agreed time that causes the least disruption to patient care and allows for cleaning/disinfection should there be any splashing onto adjacent surfaces. For example, flushing could be scheduled to take place at the time point immediately prior to scheduled domestic environmental cleaning in the care area.
- Responsibilities for outlet flushing will depend on the organisational structure specific to the healthcare setting and should be pre-agreed by the WSG.
- A record of all outlet flushing should be maintained; the standard operating procedure for this should be pre-agreed by the WSG.

Water testing:

- Routine water testing is not currently mandated in NHSScotland however it is recommended for *Pseudomonas aeruginosa* (as per the HPS [Addendum - Pseudomonas aeruginosa routine water sampling in augmented care areas for NHSScotland](#)) and compliance with the [HSE Approved Code of Practice LG & HSG274](#) for Legionella water testing is required.
- If routine water testing is undertaken, a total viable count (TVC) is sufficient for organisms other than *Pseudomonas aeruginosa* and *Legionella*; typing to species level should be limited to incident/outbreak investigations and undertaken if there are clinical cases.

- The procedures to be followed for TVC sampling are set out in SHTM 04-01 Part C: TVC testing protocol.

Care activities:

- Severely immunocompromised patients should **not** consume/use ice from automatic ice-making machines.
- Aseptic procedures (i.e. preparation of IV drugs) should not be performed in areas where there are concurrent procedures generating splashes which could contaminate a sterile surface.
- Potentially contaminated fluids of small volumes (i.e. body fluids, ET condensate, baby washing water <50 mls) must not be discarded into clinical wash hand basins; fluids should be directly emptied into a healthcare waste bag. Alternatively these small volumes may be absorbed by cotton wool balls before disposal into a healthcare waste bag. Larger volumes (i.e. bed bath fluids) should be discarded into a sluice or sink not used for hand hygiene.
- All sink areas should be free from clutter i.e. toiletries, cosmetics and other personal sundries. Staff and patients should be educated on the correct use of wash hand sinks for hand hygiene purposes only; this should include a procedure for the removal of waste foods/drinks/liquids.

9. Checklist for managing an incident/outbreak

In conjunction with [Chapter 3](#) of the NIPCM, the following actions should be considered. Please note that responsibilities may differ according to local policy.

Clinical staff
<input type="checkbox"/> Clinical cases have been isolated or cohorted if appropriate.
<input type="checkbox"/> Hand washing has been supplemented with alcohol based hand rub (ABHR).
<input type="checkbox"/> The provision of water-free care has been considered (waterless oral care, use of disposable sponges or wash cloths), use of detergent wipes for cleaning reusable patient equipment (<i>note that detergent wipes are not suitable for disinfection of reusable patient equipment</i>), and use of sterile water/boiled water for preparation of antiseptic solutions and drinking.
<input type="checkbox"/> Single use care equipment is in use wherever possible; other care equipment (<i>such as commodes, wash bowls, lifting equipment</i>) is dedicated to a single patient
<input type="checkbox"/> All reusable care equipment is decontaminated between each use using a cleaning agent with 1000 parts per million (ppm) available chlorine (av cl.) as per Appendix 7 of the NIPCM
IPCT
<input type="checkbox"/> A clinical risk assessment has been conducted for all patients within the area.
<input type="checkbox"/> A retrospective review of clinical cases/isolates has been conducted to identify any linked cases – this may require assessment of multiple units/areas.
<input type="checkbox"/> Environmental testing of the following components has been considered (<i>NB: water testing results are used to strengthen hypotheses, not to exclude links</i>). <ul style="list-style-type: none"> • Taps; • showers; • baths; • water-based equipment (haemodialysers, ice-makers, humidifier reservoirs); • drains; • points further back in the system (pre-outlet sampling).
NB: In addition to obtaining TVCs from water samples, typing to species level must be conducted. The purpose of typing is to include causative agents, not exclude them; the occurrence of false negatives could result in ongoing transmission.
<input type="checkbox"/> Historical microbiological water test results have been reviewed (if available).
<input type="checkbox"/> The water system risk assessment/water safety plan has been reviewed with input from Estates and Facilities.

<input type="checkbox"/>	Decontamination protocols for water-based equipment (e.g. water-based heater cooler units) have been reviewed.
<input type="checkbox"/>	The severity of the incident has been assessed using the HIIAT and reported to HPS as per Chapter 3 of the NIPCM.
<input type="checkbox"/>	HPS has been notified if there is an active ongoing clinical incident where the source is considered to potentially be tap water, regardless of HIIAT status.
<input type="checkbox"/>	The situation has been communicated to all staff including clinical, domestic, estates and facilities, IPCT members, and the microbiology department.
Estates & Facilities	
<input type="checkbox"/>	Flushing regimens and process documentation for the clinical area(s) affected has been reviewed.
<input type="checkbox"/>	If individual outlets have been temporarily taken out of service, daily flushing should be commenced (if not already in place) to prevent stagnation and exacerbation of the contamination.
<input type="checkbox"/>	Environmental cleaning protocols for the clinical area(s) affected have been reviewed with input from IPCT and domestic services.
<input type="checkbox"/>	An inspection of all point of use outlets has been conducted to identify any design flaws, faults, or signs of deterioration/contamination/colonisation/debris – this should include an assessment of water flow rate from outlets and corresponding impact points on basins/drains/shower trays to assess excess splash/spray.
Domestic services	
<input type="checkbox"/>	Staff have commenced enhanced cleaning of affected areas preferably at least twice daily (<i>use combined detergent/disinfectant containing 1,000 ppm av cl; include all hard surfaces, equipment, and frequently touched surfaces e.g. door handles, light switches, bed rails</i>)
<input type="checkbox"/>	Compliance with procedures for cleaning hand wash stations has been checked (spray bottles must not be used).

10. Remedial actions

The incident management team (IMT) in conjunction with the WSG would make the decision to undertake the following remedial actions appropriate to the level of contamination:

- Decontamination of fixtures and fittings (i.e. sinks, drains, taps).
- Replacement of fixtures and fittings following a risk assessment to identify how far back in the system the contamination is (i.e. showerheads, taps, drains, aerators, as per SHTM04-01).
- The instalment of point of use (POU) filters if the source of infection has yet to be identified, as a short-term control measure only; the decision to install POU filters must be balanced against the potential detrimental effects on water pressure and the additional management/decontamination requirements for their ongoing use.
- Temporary installation of portable wash hand basins, following a risk assessment and supported by a maintenance/decontamination programme.
- Disinfection of the entire water system which may involve one or more of the following: shock superheating/pasteurisation ($\geq 60^{\circ}\text{C}$), flushing, hyperchlorination, or silver hydrogen peroxide.
- Longer term control measures (if the system is identified as the source) which may include the use of chlorine dioxide, peracetic acid, copper silver ionisation, and Kemper waterproofing systems.