ESGLI GUIDANCE FOR MANAGING *LEGIONELLA* IN HOSPITAL WATER SYSTEMS DURING THE COVID-19 PANDEMIC

1. Why this guidance?

Whilst water systems may not seem to be high on the priority list during the COVID-19 pandemic it is important for the health and safety of patients, staff and visitors that water systems are managed safely. Evidence from China (Zhou et al., 2020) is that half of COVID-19 fatalities had experienced a secondary infection, this suggests patients are at increased risk of secondary infections whilst in hospital and for some months after recovery. In Europe just under 10% of community acquired cases of Legionnaires' disease die but for hospital acquired cases the death rate can rise to >25%.

It is important to remember that water delivered at water system outlets is not sterile, even when complying with drinking water standards[1]. In systems which are not well designed or managed, naturally occurring microorganisms, including *Legionella, and Pseudomonas aeruginosa* can increase to levels which can cause severe illness and even death in very susceptible patients and staff. Legionnaires' disease and the milder form, Pontiac fever, a flu like illness, is caused by the colonisation and growth of *Legionella* in water systems and associated equipment, including equipment used for ventilation and humidification. Aspiration[2] is another potential mode of infection especially in those patients with swallowing difficulties, nasogastric feeding tubes or when sucking ice.

2. What sort of buildings is this guidance aimed for?

This guidance is aimed at hospitals, temporary and converted buildings or parts of buildings and field hospitals [3] used for treating COVID-19 patients. The ongoing COVID-19 pandemic has a significant potential to increase the risks of waterborne infections, including Legionnaire's disease, over and above the inherent public health impact of the pandemic. It is therefore essential, that appropriate testing of both water systems and patients is carried out to protect both patients and staff from unrecognised outbreaks of waterborne infections including Legionnaires' disease.

3. Why is this guidance necessary?

The potential risks for legionellosis and other waterborne infections may well be overlooked when planning for a rapid extension in water system provision but this could have a long-term impact on public health during the pandemic as well as during the recovery and the gradual return to normal activities.

Factors which increase the risk of waterborne infections in highly susceptible patients and staff and as a result of the COVID-19 response include: -

- A rapid increase in the number of patients with COVID-19 who have increased susceptibility to co-infection with other pathogens including *Legionella,*
- Rushed planning, specification, installation, commissioning etc. of changes to water systems or, installing equipment for COVID-19 patients, such as additional point of use fittings, ventilators, humidification equipment, additional showers and clinical wash hand basins etc. without proper risk assessment and input at appropriate stages, from the hospital multidisciplinary water safety group (WSG) [4] RP and other competent water safety specialists as required,

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[1] The microbiological safety of drinking water is based on the absence of faecal indicators e.g. *E. coli*. There is no correlation between the absence of faecal indicators in drinking water and the presence of waterborne opportunistic pathogens that can colonise and grow within water systems including *Legionella* spp., *P. aeruginosa*, other Gram-negative waterborne pathogens and environmental *Mycobacteria* spp. Whilst waterborne pathogens may be present in small numbers in the supply water and often not detectable by routine methods, where conditions allow (warm water temperatures, the presence of nutrients etc.) they can grow within water systems and associated equipment to levels which may cause serious harm and sometimes death to susceptible persons.

[2] Where liquids or food goes down the "wrong way" when swallowing so it enters the lungs instead of the intestinal tract

[3] For care homes and dental practices see specific guidance

[4] A Water Safety Group (WSG) is a multidisciplinary group with all the skills and competencies required to support the design, specification, build, installation, commissioning and operation and with the relevant expertise to manage all water systems and associated equipment which store, contain or use water as part of the COVID 19 response. This group would normally be led by a Director of Infection Prevention and Control (or equivalent) and include representation from Estates Engineers, Finance, Microbiologists, Nursing Managers, Patient Support Services, those with specialist water quality requirements stakeholders such as Decontamination, Renal Dialysis, Dental Units, Intensive Care etc, Specialist Water Advisors, Water Treatment Specialists.

- Interruption or disruption to routine water maintenance due to: - staff shortages due to self-isolation, illness, family responsibilities, preparations for COVID-19., site closures / shutdowns and / or financial constraints etc.
- Temporary closure of buildings, parts of buildings or their restricted use leading to stagnation with water systems and associated equipment.
- Alterations and extensions to building water systems and the establishment of temporary healthcare facilities for COVID-19 patients over a short time period including the installation of additional point of use fittings, ventilators, mobile wash hand stations, humidification equipment, additional showers and clinical wash hand basins etc.
- Conversion of public buildings including hotels and conference centers to healthcare facilities (e.g. as isolation or recovery facilities).
- The introduction of contamination into systems and equipment for example; from pressure and leak testing of equipment fittings, components etc. by contaminated water during manufacture and failing to protect pipework, components, fittings etc. from contamination during the build and installation process.
- The installation and use of equipment installed for COVID-19 patients such as point of use fittings, ventilators, oxygen supply and humidification, additional wash hand stations (including mobile facilities) etc.
- The introduction of contamination into systems and equipment for example; from pressure and leak testing of equipment fittings, components etc. by water during manufacture and failing to protect pipework, components, fittings etc. from contamination during the build and installation process.
- Increased patient and staff occupancy putting a strain on the ability to provide sufficient hot and cold water with adequate temperature recovery times
- Difficulties in applying routine control measures, performing routine maintenance, monitoring, audit and supervision activities associated with healthcare and other public facilities due to movement restrictions, shutdowns, staff shortages due to illness or isolation and financial restraints,
- Reduction in testing for *Legionella* leading to under-recognition of contaminated sources, outbreaks, cases and clusters.

4. Where should I start?

Establish and / or consult with the WSG or other person (s) responsible for water safety (often referred to as the Responsible Person or RP) within the organisation, using external expertise where needed. This should be done before plans are put in place to make changes to the water system such as adding temporary wards, wash hand basins, showers etc. and / or where additional equipment needs to be installed or when a decision is taken to close buildings or parts of buildings. Where there are special water quality standards required, such as for dialysis, water used for humidification of incubators, ventilators, oxygen delivery etc. expertise should be sought from the relevant specialist discipline.

There should be a Water Safety Plan (WSP)[5] which includes up to date risk assessments and management plans for controlling risks from *Legionella* and other waterborne pathogens for all water systems and associated equipment. Where there is no WSP and risk assessments and / or management plans are not in place or up to date these should be developed or updated by the multidisciplinary WSG with external competent help where required. Where there are any planned alterations or installation of additional equipment, the risk assessments and proposed water management plans should be reviewed, updated and agreed by the RP/WSG or other persons responsible for water safety and documented. It is important this is done from the planning, design and specification stage to ensure water systems and associated equipment are specified, installed, commissioned, operated and managed safely by competent and experienced plumbers, engineers and all other relevant competent personnel following processes agreed by the RP/WSG. The RP/WSG should seek advice from appropriate competent and experienced external consultants where required. The RP/WSG should ensure there are processes in place to check any external help is

[5] A Water Safety Plan (WSP) is a documented approach based on identifying all relevant hazards and hazardous events leading to significant risks to public health from water within buildings, ensuring that effective controls and barriers are applied to minimize these risks to acceptable levels, with monitoring plans put in place to ensure the controls remain effective e.g. temperature and biocide monitoring regimes to ensure that safety is maintained. The WSP is supported by ensuring all relevant staff who may have an influence on water safety are suitably trained, there are audits and programmes in place to ensure there is appropriate supervision, audits, good communication, and surveillance, including of patients, so any waterborne infections would be promptly identified.

experienced and competent to carry out the required tasks and that all controls, to minimise the risks from waterborne pathogens, are effectively managed and monitored throughout the project to completion and system handover.

It is important that when there are plans for new, or modified water systems and associated equipment, precautions are taken to prevent the ingress of both microbial and chemical contaminants which could affect water quality both in the short and long term. RP/WSG review and approval should begin at the planning stage to ensure water systems and associated equipment are designed, specified, installed, commissioned, operated and managed safely by competent and experienced system designers, engineers, plumbers etc.

In addition, where hospital buildings, including offices, clinics etc. are closed or partially shutdown, water systems should be managed to ensure the future health and safety of those working on, or operating and maintaining water systems, as well as patients, visitors and staff.

Documentation should be in place that describes how patients, staff, visitors and others will be protected from the presence of waterborne pathogens including *Legionella*. If required, help should be sought from an experienced and competent water treatment advisor, public health or environmental health authorities.

Where national guidelines or legislation is in place then you must follow these. For example, in some countries, including the UK, cold water temperatures should be < 20 °C within two minutes of turning on the outlet.

5. Key points to remember

It is important to remember that *Legionella* and other waterborne pathogens of relevance in healthcare settings will grow in water systems to levels which may cause infection where: -

- the temperature of the water >25°C and < 50 °C. This does not have to be in the entire system, just relatively small areas at these temperatures will allow *Legionella* to grow; they can then contaminate and spread to other parts of the system and subsequently make it difficult to control their growth. It is therefore important to prevent the hot water from cooling below 50 °C and the cold from warming above 25 °C so a minimum of 55°C is maintained at all outlets in hot water systems and cold water can be delivered at ≤25 °C within 2 minutes of turning on the outlet (or the feeds into thermostatic mixing valves where these are fitted). Effective insulation of hot and cold supply pipework can help reduce heat transfer.
- where there is stagnation as a result of poor or no water flow.
- where materials are used which provide protective niches and nutrients for growth and biofilm formation including sludge, scale, rust, algae and other organic matter which may collect in the system pipework and calorifier particularly during periods of stagnation.
- where *Legionella*, *P. aeruginosa* and other waterborne pathogens are introduced from equipment, fittings, components and pipework which have not been adequately protected from contamination during the build and installation process or which have been pressure or leak tested with contaminated water (the international outbreak of *Mycobacteria chimaera* infections as a result of the colonization of heart heater coolers by the manufacturer is an example of this (Hedge et al., 2017; Kohler et al., 2015; Sax et al., 2015; Walker et al., 2017).
- where there is a means of creating and disseminating inhalable droplets such as the aerosols generated by evaporative air conditioning and humidification systems, operating taps, showering, flushing a toilet, or when using other equipment such as humidifiers, nebulizers etc.
- where there are patients susceptible to aspiration and / or compromised immune systems.
- where there are systems and equipment which can produce aerosols, which can be inhaled or water which can be aspirated. This includes birthing pools filled with water contaminated with *Legionella* or other waterborne pathogens
- contamination as a result of splashing from clinical sinks and wash hand basins can contaminate outlets, patients and staff, equipment, trolleys etc. left close to the sink. Clinical sinks; wash hand basins should not therefore, be situated too close to beds (at least 1 metre away). [6]

- [6] The risk of waterborne pathogens being spread by splashing is increased where sinks are used with drains directly below the outlet and where basins do not drain quickly.

- waste water used for patient hygiene etc and fluids, including the remains of antibiotic infusions should not be disposed of down the sinks as these provide nutrients for pathogens to grow within the drain (Edmonds et al., 1972).
- to avoid the blocking of toilets, drains and waste pipes which could lead to backflow from the waste water to the potable water system, wet/ sanitizing wipes should not be disposed of down toilets / waste sinks (sluices) etc.
- where there is the potential for contamination from poor quality source water and absence of point-of-entry (POE) treatment, for example where supply quality is:
    - not from a public utility
    - from a temporary supply
    - not of consistent potable quality
    - intermittent or through a bowser[7] or other supply method.

6. What to do if there are cases of Legionnaire's disease

It is important when there is a case of Legionnaire's disease associated with premises that:

- when water samples are sent to a testing laboratory, they are instructed to retain the concentrate and any isolates.
- any clinical isolates and lower respiratory specimens obtained from patients are retained for typing.
- both environmental and clinical isolates are referred for typing as per routine country specific guidance.

7. ESGLI recommends the following to keep healthcare water systems safe:

- There is a need to maintain awareness of the risks from infections due to water, including legionellosis, during the COVID-19 pandemic.
- Local and national guidance should be in place in order to reduce such risks – key technical recommendations appear below.
- Care must be taken to ensure control measures are maintained in all water systems despite the difficult COVID-19 situation e.g. temperature, the addition of biocides (where applicable), programmes for monitoring, sampling, flushing of infrequently use water outlets etc.
- Proper risk assessment must be undertaken, especially before changes and / or additions to water systems are being considered, including the performance of routine inspections.
- Healthcare professionals should remain vigilant to allow the detection of Legionnaires' disease in appropriate clinical circumstances.

8. Technical Guidance

8.1. When extending or modifying existing water supplies

When changes to water systems are planned it is essential that you consult the WSG or other person(s) responsible for managing the risks from legionellosis and other waterborne pathogens. For new builds or conversions, a risk assessment should be completed at the design and specification stage and reviewed by the WSG. Any recommendations should be addressed.

For existing buildings, the risk assessment should be reviewed and updated to reflect the current water system configuration, including any changes to usage, together with a review of other systems or equipment which have either been added or have reduced use or are shut down. Carry out any actions identified by the risk assessment review.

The risk assessment should consider whether the existing infrastructure can maintain sufficient flow, pressure and temperature following any planned extension. Where a large extension is made to existing water systems, they may result in inadvertent knock on effects such as low flow, reduced hot water temperatures, elevated cold-water temperatures and difficulties in achieving target levels of biocides (where applied). For expediency, the existing risk assessment can be annotated by hand or an addendum added to keep it up to date.

[7] A bowser is a mobile tank or tanker which transports and delivers potable water where there is no continuous supply.

8.2. Moving immunocompromised patients

When moving immunocompromised patients from their protected settings, a risk assessment should be carried out to ensure there is effective management of water systems and associated equipment to protect them from waterborne infections including from Legionnaire's disease (see below). Where there is doubt about the safety of water for these patients consider the need to protect them for example; by installing point of use (POU) filtration for their drinking and personal hygiene needs to protect them from waterborne infections.

8.3. Use of hotels or other facilities

Wherever possible, the standards of water system design, risk assessment and control that would otherwise be applicable for healthcare premises should be applied when providing care to COVID-19 patients. This should take into account the increased susceptibility of these patients to secondary infections including those resulting from exposure to contaminated water or aerosols derived from it. Before patients are admitted, a full review of the management of water systems should be carried out by competent risk assessors including of hot and cold-water systems, evaporative cooling towers and other systems which will remain in use to determine whether these have been historically well managed to control the risk of Legionnaire's disease. The review should include current risk assessments, schemes of control and monitoring records to ensure the water system has been managed safely to date. Care should be taken to avoid exposure of patients to aerosols from clinical sinks, wash hand basins should not be situated too close to beds (at least 1 metre away and ideally 2m) and waste water and fluids should not be disposed of down sinks or basins used for handwashing. The use of point of use filters should be considered where there are doubts about water safety for these patients. Suitable provision for temporary sinks for the disposal of waste water and other fluids disposal (sluices) should be made away from, but in the vicinity of patient care areas to minimize distances that the material must travel for disposal.

1. If the premises have been closed for longer than one week or where there is any doubt about the control of the water systems a precautionary water system disinfection should be carried out to achieve 50 mg/L free chlorine for an hour or equivalent.It is recommended that *Legionella* samples are then taken to verify the disinfection effectiveness from sentinel outlets a number of representative outlets, including and that may be used only infrequently. Samples should be taken no less than 48 hours after disinfection to reduce the risk of false negative sample results.
2. All outlets should be flushed and free chlorine checked to ensure the target level is achieved.
3. Top up with biocide where necessary.
4. Flush and refill and ensure the system maintains at least 0.5-1.0 ppm free chlorine throughout the system.
5. Ensure temperatures leaving the calorifier (or stored hot water vessel) reach ≥ 60 °C, and the temperature at the outlets or entry into the thermostatic mixing valves reaches ≥55 °C within one minute of turning on the tap. Return temperatures to the calorifier should be at least 55 °C on each loop of the return pipework.
6. The cold water should be below 25 °C at the outlets within two minutes of turning on the tap (taps should be run gently to avoid splashing).
7. Waste water used for patient hygiene etc and fluids, including the remains of antibiotic infusions should not be disposed of down the sinks as these provide nutrients for pathogens to grow within the drain (Edmonds et al., 1972) and can encourage the development of antibiotic-resistant bacterial communities.
8. To avoid the blocking of toilets, drains and waste pipes which could lead to backflow from the waste water to the potable water system, wet/ sanitizing wipes should not be disposed of down toilets / waste sinks (sluices) etc.

9. Temporary or partial closure of hospital buildings

If a building or part of a building is to be 'closed temporarily until the current pandemic is over, precautions need to be taken to ensure that the water systems can be re-instated without presenting increased risks of hospital acquired infections and patients, staff and contractors. Depending on whether the closure is short term. If systems are to be closed for longer time periods different strategies will be needed.

It is important to remember that the procedures followed now will have an impact on the safety of the water systems when they are returned to use and will influence how soon facilities can be re-opened without causing harm to health. During any change to water systems, including where there is a change in use of key personnel, risk assessments and schemes of control must be reviewed and updated to reflect the current usage and susceptibility of the population at risk. Where necessary get help from the RP/WSG and experienced and competent Specialist Water Treatment Advisors.

9.1. Short term closure

9.1.1. Maintaining the normal control regimes

If the building is to be closed for less than a month following the risk assessment the WSG may recommend the normal control regimes remains in place. If it is intended the building will be closed for longer, but needs to remain safe to re-open immediately, then follow steps below:

1. Maintain the control regime so that the hot water is circulating throughout all part of the system so that the flow temperature is maintained at ≥60 °C and the return on all loops is at ≥55 °C.
2. The temperature reaches all outlets at ≥ 55 °C within one minute and the cold reaches ≤25 °C after running the outlet (normal flow, avoid splashing) for 2 minutes. If using a biocide, maintain target levels throughout all of the system.
3. Operating the hot water generating plant and the increased residence time of hot water due to lack of use is likely to result in an increase in cold water temperatures so increase the flushing and monitoring of cold-water sentinel outlet temperatures to ensure they reach < 25 °C on a daily basis. Running the calorifier for a reduced time interval (at least 6 hours daily) may reduce temperature gain in the cold-water system.
4. Continue to apply biocides to water systems where biocide dosing has been applied prior to the COVID-19 crisis.
5. Flush gently (to reduce aerosols) all other hot and cold outlets (showers, taps, sluices and other outlets) at least weekly until they achieve the above temperatures. Where there are thermostatic mixer valves ensure the pipework feeding them achieves the same target temperatures. Flush all toilet cisterns, urinals, by-passes and any other points on the network.
6. Consider dosing with biocides where temperature control cannot be achieved or maintained.
7. Keep drinking water storage tanks with at least 0.5-1.0 mg / l of free chlorine
8. Adjust the monitoring regime to be able to verify these levels have been achieved at all sentinels and other little used outlets.
9. Ensure documentation is kept for inspection including: - reviewed and amended risk assessments (these can be annotated by hand) monitoring data and remedial actions, with evidence of who carried out the work, add time date and signature.

9.2. Other systems

10. Ensure all other systems on site such as evaporative cooling towers, hydrotherapy pools, birthing pools etc. follow their normal operating and monitoring procedures.
11. For temporarily closing hydrotherapy pools refer to https://www.pwtag.org/guidance-on-temporary-pool-closure/ .
12. Check what other systems are on site which could pose a risk of Legionnaires' disease and disinfect and either drain and dry thoroughly, or maintain your normal management regime where possible.
13. Disinfect before bringing into use again.
14. Where there are changes to use or the systems in place to control risks please ensure the risk assessment is reviewed by someone experienced and competent. there is useful advice for evaporative cooling and other systems within: - https://www.ecdc.europa.eu/sites/portal/files/documents/Legionella%20GuidelinesFinal%20updated%20for%20ECDC%20corrections.pdf

9.3. Managing systems to be shut down

It is not generally recommended to drain water systems in temporarily unoccupied buildings because of the damage that can occur to components of the system as they dry out, and also because it is usually extremely difficult to remove all water from the drained system; the moist conditions that remain allow continued biofilm growth and survival. However, if the decision is taken to follow this course of action, the water system will need to be recommissioned prior to reuse, which will involve cleaning and disinfection of the system and thorough flushing. If this route is taken, specialist advice and services should be sought from a suitable specialist water treatment company.

If it is likely that the building is to be closed for more than a month, or you have made the decision not to heat your hot water for energy conservation or have no-one on site, then follow one of these options:

9.4. Closing down without draining

15. Before closing the system down, turn off the calorifier, flush from the base, valve off the water supply and drain.
16. Where the system has not been disinfected recently or there have been problems with temperature or biocide control then consider carrying out a full system disinfection with flushing through to all outlets to achieve 50 mg/L chlorine or equivalent biocide for at least an hour.
17. Flush through and refill and check the biocide is at the highest target normal operating level at the furthest outlets.

9.5. Re-commissioning water systems

10. A risk assessment should be carried out before recommissioning and a commissioning plan developed. This is particularly important if this guidance has not been followed when closing systems down.
11. Carry out a full system disinfection of the cold-water system flushing through to all outlets to achieve 50 ppm free chlorine or equivalent biocide. Close the outlets and retain the biocide within the system for at least an hour checking that this level is achieved at the furthest outlets, top up when required.
12. Flush out and refill to achieve maximum normal operating target level of disinfection (equivalent to at least 0.5 ppm free chlorine).
13. Refill and reheat the calorifier to 60 °C and when the calorifier/ storage water has been heated to 60 °C throughout, the open valves and flush through all outlets sequentially taking care to avoid any scalding risk. Each outlet should be run for at least 5 minutes, maintaining a water temperature of 60 °C throughout this time period. It may be necessary to reduce the flow through each outlet (to ensure that there is sufficient supply of hot water from the calorifier) in order to maintain this temperature at all outlets.
14. Monitor temperatures and biocide levels where applicable, adjust where necessary, for at least 48 hours and then take samples from the sentinels.
15. When you are satisfied the hot and cold-water systems are under control then reopen the building.
16. Ensure you keep all documentation: reviews of risk assessments (these can be annotated by hand) including monitoring data for inspection, with evidence of who carried out the monitoring, add time date and signature.
17. Follow the advice for other additional waters systems or equipment as above.

9.6. Draining systems down

Any system which is drained, unless very small and simple and can be physically dried, will pose a risk when restarted as there will be remaining pockets of water and condensation which are sufficient to allow microorganisms including *Legionella* to continue to grow within the system.

18. Carry out a full system disinfection (see 11-13).
19. Where appropriate blow air through the system to dry as thoroughly as possible.
20. Before re-opening follow steps 10-17 as above.

9.7. Where biocides are NOT used or allowed

21. When drained down, blow air through the system to dry as thoroughly as possible.
22. Flush the cold system from every outlet.
23. Refill and reheat the calorifier to 60 °C.
24. When the calorifier/ storage water has been heated to 60 °C throughout, open valves and then flush through all outlets taking care to avoid any scalding risk as in step 13 above.
25. Monitor temperatures adjust where necessary, for at least 48 hours and then take samples from the sentinels.
26. Follow steps 20 to 22 as above.

10. References

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Please note

Whilst every effort has been made to ensure the accuracy of the material contained in this publication, all water systems are individual in nature as a result of their design, materials and usage. The authors do not accept any responsibility whatsoever for loss or damage occasioned or claimed to have been occasioned, in part or in full, as a consequence of any person acting or refraining from acting, as a result of a matter contained in this publication.

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