WATER BORNE PATHOGENS
Pseudomonas aeruginosa.

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With the publication of the enHealth Guidelines for *Legionella* control at the end of 2015, there has been much emphasis on this particular bacterium as a potential cause of disease in hospital patients. However, any facility that is producing a water quality management plan would be very unwise not to assess the risks for other waterborne pathogens at the same time as they carry out a risk assessment for *Legionella* within their premises.

It could be argued that some of the other waterborne bacteria actually cause a much higher burden of disease than legionella do. This is especially true of a bacterium named *Pseudomonas aeruginosa.* The *Pseudomonas* group of bacteria and some of their close relatives are renowned for proliferating in damp places within any environment. They are also particularly good at living in environments where there are very low levels of nutrients, for example in potable water. They have been found in a large variety of places within hospitals, including the tap fittings, showers, spa baths, sink and other drains, medical equipment, flower vases, damp cleaning cloths, swimming pools, on the surfaces of toys, mop heads, and on staff hands. Drugs themselves can also become contaminated, either at the production facility, as in the case of current recalls of nasal spray in the USA, or during preparation and storage within the health facility. *Pseudomonas* can also survive in disinfectant solutions if these are not changed regularly.

The disease burden and death rates from *Pseudomonas aeruginosa* are not officially recorded, like they are for *Legionella,* so the cost of infection from waterborne *Pseudomonas* within a hospital is very difficult to quantify. *Pseudomonas* is very commonly found causing a wide range of infections, from minor to fatal bloodstream infections. In normally healthy people, it causes ear infections (swimmer's ear) and folliculitis – sometimes known as "Hot Tub Folliculitis", an inflammation of the hair follicles that can be found after swimming in a contaminated hot tub or swimming pool. With its ability to survive and even grow in liquids containing disinfectants or very few nutrients, it can also establish itself in contact lens solutions, causing eye infections that can severely damage the eye.

Pseudomonas aeruginosa infection in a patient with an impaired immune system, for example those undergoing a bone marrow transplant, with cystic fibrosis and other at risk groups, can be catastrophic. It is a cause of blood stream infections, which can be fatal, along with lung infections, colonisation and sometimes infection of sores and wounds.

It is also a serious problem in burns units, and particular care should be given to include the risk from *Pseudomonas aeruginosa* and other similar pathogens when a risk assessment is carried out in these areas. *Pseudomonas aeruginosa* easily infects burn wounds and can cause very significant disease and mortality. Colonisation of these wounds by *Pseudomonas* can also slow down the healing process.

Along with the wide variety of infections and issues caused by *Pseudomonas*, it can also be very difficult to treat. The organism is resistant to many antibiotics, and the majority of antibiotics that can treat it cannot be taken in a tablet form but have to be administered IV. The cost of treating *Pseudomonas aeruginosa* infections can therefore be quite high.

In response to these issues, the UK has produced Guidance as part of the Safe water in healthcare premises (HTM 04-01) series specifically on *Pseudomonas aeruginosa*. HTM 04-01 Part C: *Pseudomonas aeruginosa* – advice for augmented care units gives advice on producing risk assessments for the augmented care areas of the hospital premises where *Pseudomonas aeruginosa* can cause particular harm.

The main areas that are targeted, and that should have a risk management plan for this organism are areas that contain the following at-risk patients:

a. Those patients who are severely immunosuppressed because of disease or treatment: this will include transplant patients and similarly heavily-immunosuppressed patients during high-risk periods in their therapy;

b. Those cared for in units where organ support is necessary, for example critical care (adult paediatric and neonatal), renal, respiratory (may include cystic fibrosis units) and other intensive care situations;

c. Those patients who have extensive breaches in their dermal integrity and require contact with water as part of their continuing care, such as in those units caring for burns.

Pseudomonas aeruginosa colonises and grows within a water system in a different manner to *Legionella.* While *Legionella* can colonise the whole water system, from hot water storage to the tap outlet, *Pseudomonas aeruginosa* is usually limited to colonising the tap fittings, drains and outlets of the water system, along with any damp areas and standing water. This is because *Pseudomonas aeruginosa* prefers the presence of oxygen to survive, (although it can survive in low/no oxygen environments). Understanding this is vital to producing a risk assessment and especially a sampling plan for a facility. *Pseudomonas aeruginosa* is also a very 'sticky' bacteria. It produces substances called polysaccharides, often in large amounts – a slimy, glue-like sugar-based substance that allows it to stick to pipes and other plumbing materials very effectively to form a biofilm. The presence of the sticky biofilm is also very effective at protecting the bacteria from chlorine or other disinfectants. *Pseudomonas aeruginosa* also grows at a much higher temperature than *Legionella*, and is very likely to proliferate within the system at the 42-45°C temperatures that are found after the Thermostatic Mixing Valves (TMVs).

Tapware and wastes are a particular risk for harbouring this organism. Experiments carried out in the UK in response to an outbreak in a neonatal unit showed that the more complex the tapware, the more likely it was to harbour biofilm and *Pseudomonas aeruginosa*.

Sensor tapware, with its' complex internal structure was colonised by biofilm containing *Pseudomonas aeruginosa* much more often than tapware that had simpler internal structures. Consideration should be given to the tapware being chosen for a particular clinical area, as it will need to be cleaned and serviced regularly and may need to be autoclaved to reduce the risks from *Pseudomonas aeruginosa*. Tapware in situ already should be cleaned effectively, and TMVs should always be regularly serviced and descaled.

Stagnant water is a risk for *Pseudomonas aeruginosa*, as low chlorine levels and lack of movement can lead to the build-up of biofilm and an increase in the numbers of bacteria at the outlet. Regular flushing will help prevent colonisation by *Pseudomonas aeruginosa*, along with many other organisms that may cause issues within healthcare facilities.

Pre-contamination of plumbing fittings should also be considered when producing a risk assessment for *Pseudomonas aeruginosa*. Fittings that have been factory tested using water and not dried before being packaged can harbour significant biofilm containing *Pseudomonas aeruginosa*, which can then be introduced into a water system. Sourcing fittings from reputable suppliers that only test with either potable grade water followed by a drying step, or those that are air tested should be selected. The positions of the sinks and associated plumbing and soap dispensers are also important. The waste should not be directly below the water outlet, to prevent splashing of water from the waste into the sink. Soap dispensers, and especially hand cream dispensers should also be positioned so that they do not allow soap or hand cream to drip onto the outlet, either from the dispenser itself or from hands. Soap, and especially had cream are a significant source of nutrients that can allow bacterial growth around and on a sink.

As with any risk assessment, the production of an effective assessment requires the input and cooperation of many specialist groups within the facility from engineering or estates, to infection control and clinicians. Of particular importance when producing a risk management plan for *Pseudomonas aeruginosa* is the input from, and the training of, the cleaning staff. Cleaning protocols are of vital importance when attempting to control *Pseudomonas aeruginosa* within a hospital, especially the cleaning of clinical handbasins. The drain of the sink is almost always contaminated with *Pseudomonas aeruginosa*, and cleaning protocols should be implemented to prevent transfer of bacteria from the waste to the tap outlet. Separate cloths should be used for wastes and taps. Disinfectants should always be freshly prepared, unused diluted disinfectants should also be disposed of at the end of the cleaning shift, and water used for cleaning and mopping should never be disposed of in a clinical sink. The ability of *Pseudomonas aeruginosa* to survive in disinfectants that have not been freshly prepared can be a significant issue within the hospital environment – wiping surface with contaminated water can lead to colonisation of large areas.

Within the ward itself, behaviour may need to be changed. Clinical handbasins must not be used to dispose of unused antibiotics or IV fluids, body fluids or other waste. This can act as a source of nutrients as the components of the waste coat the sink and pipework and can lead to rapid establishment of biofilm on the sink and associated areas. Disposal of antibiotics into handwashing sinks can also increase antibiotic resistance in bacteria.

Once the risk assessment plan has been produced, regular verification sampling can track the effectiveness of any control implemented. However, the sampling plan must be specific for *Pseudomonas aeruginosa*. As noted earlier, *Pseudomonas aeruginosa* is found in the tap outlet, and not in the main water systems. As such, any sampling plan for *Pseudomonas aeruginosa* should take into account that the first part of the water that comes from the tap when it is turned on should be tested, and the taps should not be flushed prior to testing. This can be difficult in busy ward areas where the taps are in constant use.

If colonisation has been found, there are several strategies that have been attempted in order to control colonisation. Point of use filters are the easiest and quickest to implement, and several hospitals have shown success in reducing *Pseudomonas aeruginosa* colonisation using this approach. At the St George Hospital in Sydney in 2010, use of one antibiotic that is used to treat *Pseudomonas aeruginosa*, Meropenem, was reduced by $22 772 in a 12-month period. Other approaches have included aggressive cleaning regimes for wastes, using disinfectants such as chlorine, quaternary ammonium-based products and acetic acid. Due to the complexity of the internal structure of some tapware, some hospitals have implemented removable tapware that can be either autoclaved or passed through a washer-disinfector to sterilise the outlet.

While *Pseudomonas aeruginosa* is a relatively ignored bacterium when Water Quality Risk Management Plans are being produced for healthcare facilities, there is no doubt it is an extremely important organism to control. For the health and welfare of any patients within the facility, it should always be considered when producing a plan.

References:

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