THE BACTERIA PUZZLE

LEGIONELLA AND PSEUDOMONAS BACTERIA HAVE A PRESENCE IN HOSPITALS AND AGED CARE FACILITIES AROUND THE WORLD. **KATE JORDAN** LOOKS AT WHAT NEEDS TO BE DONE TO CONTROL AND PREVENT FURTHER INFECTIONS.

Bacteria are an inevitable part of life. Many are benign or even beneficial to humans, but pathogenic bacteria are harmful and even deadly. Most healthy humans can easily fight these off, but people with compromised immune systems – those who are elderly, ill, or injured – are susceptible to bacterial infections that can prove fatal. Two of the most common pathogenic bacteria – legionella and pseudomonas – gain access and spread through hospitals and aged care facilities via the water system.

Legionella and pseudomonas are a worldwide problem and yet there is a marked difference in the level of defences throughout the world. Leading the charge is certainly the UK and Europe. The UK has a standard in place for legionella control in health and aged care facilities and is possibly the largest market for temperature controlled outlets.

One of the largest producers of these outlets is Australian – Reliance Worldwide supplies about a third of the British demand – and yet Australia is much less advanced in defending against bacterial infections in water supplies. Peter Flynn, Export Manager for Reliance Worldwide, estimates we're about 10 years behind the UK.

"In the UK, the standard used to allow six metres of tepid water. Then it went to one metre, then it went to 'we prefer you to put the thermostatic in the tap'," Peter recalls. "I don't even think we have a distance in our plumbing code, you can do anything you like."

There is hope though.

"If you'd asked me twelve months ago, I would've said the United States was not all that interested in legionella," Peter says. "Since about November last year, it's now a hot topic."

(For more discussion on Legionnaires control in the States, read Matthew Freije's article on page 42).

Reliance Worldwide is now seeing increased demand from the United States for thermostatic controls. When they'll see demand from their home country is hard to tell.

THE EFFECT OF TEMPERATURE ON LEGIONELLA

Temperature Range	Effect on Legionella
70-80	Disinfection range
66	Legionella will die in 2 minutes
60	Legionella will die in 32 minutes
55	Legionella will die in 5-6 hours
50-55	Legionella can survive but do not multiply
20-50	Legionella growth range
Below 20	Legionella can survive but are dormant

JUST ONE PART OF THE PUZZLE

One of the reasons there is a lack of movement on infection control is the sheer complexity of the solution. There is no one way to tackle bacterial infections; instead a myriad of tactics must be employed.

To explore the problem and the various solutions, we spoke to four experts in water supply. The first was Peter, mentioned above; next were Steve Gamble and Kevin Peel, Senior Product Manager and Associate Director of New Product Development respectively, from Rada Controls. Lastly, we spoke to hydraulic project engineer Antonio Lo Monte from Wood & Grieve Engineers.

THE PROBLEM

Before we can look at a solution, however, we must identify the problem: legionella and pseudomonas. Through Rada's research into developing new, low infection-risk outlets, Steve and Kevin became very familiar with both bacteria –

although they're quick to say they're not microbiologists. They gave us the run down on these pathogens.

Legionella bacteria cause Legionnaires Disease, a pneumonia-like illness treatable with antibiotics, but deadly to people with compromised health. It reproduces at temperatures between 20-45°C and is present in water around the world. Numerous studies can be found, which indicate Legionella bacteria can be detected in up to 30% of water systems. The Rada team carried out their own investigation and found the presence of Legionella bacteria in 9 out of 97 domestic houses tested.

In Australia, Legionnaires outbreaks are fairly frequent. While the most common source of infection is cooling towers, people have also been infected via internal water systems. One of Australia's first recorded outbreaks in 1979 was traced back to showers in a psychiatric hospital, in 2013, two patients at Wesley Hospital died from Legionnaires Disease contracted from the water system and as recently as April 2015, a patient died at Hervey Bay hospital.

Pseudomonas are a more recent development.

"Pseudomonas is the name given to a diverse range of many varied species, but it is pseudomonas aeruginosa in particular, which presents the highest risk to humans," Steve says. "If you're healthy with a strong immune system, not frail or elderly, then you are really unlikely to have a problem with pseudomonas aeruginosa."

Pseudomonas aeruginosa is, therefore, only really a problem in hospitals and aged care facilities – but that in and of itself is a problem. As people with weaker immune systems provide a host for the bacteria to multiply, they're treated with antibiotics – and while the infection is ultimately defeated, some of the bacteria develop a resistance to the drugs.

"In hospitals, it's now possible to have micro organisms that are multi-drug resistant. And they're the ones that will become nasty and problematic," Steve explains. "That's why, I think, it's escalated and will probably continue to escalate, and why it's now such a hot topic."

Pseudonomas are currently present in many Australian hospitals.

Legionella and pseudomonas – like many other bacteria – gain a foothold through biofilm. Some bacteria will land inside a fitting or pipe, form a biofilm and offer a foothold for other bacteria. As the biofilm strengthens, larger microorganisms – like amoebas and protozoans – arrive ➤

and feed off the bacteria. Legionella take advantage of these larger organisms. Once ingested, they live inside and breed, bursting free when the larger organism dies.

"That's one of the reasons why legionella is quite difficult to treat," Steve says. "In spite of the high sterilisation temperatures used during thermal disinfection routines, the biofilm offers the legionella bacteria a degree of protection from the thermal shock."

Given legionella and pseudomonas' ability to spread quickly, become multi-drug resistant, and kill the elderly and ill, it's important that bacteria control is addressed in hospitals and aged care facilities. As mentioned earlier, a multi-pronged attack is needed, covering the following four areas:

- Keep hot water hot
- Keep cold water cold
- Keep it moving
- Keep it clean

KEEP HOT WATER HOT

"The first parameter to consider is storage temperature – this needs to be maintained above the 60°C range to ensure the hot water storage vessels and calorifiers can't become a breeding ground for legionella," says Antonio, an hydraulic project engineer from Wood & Grieve Engineers.

This temperature requirement includes water in storage and in circulation. Antonio gives the example of poor design work in hospitals where the hot water pipes have long dead legs and reticulation doesn't pass close enough to isolated fixtures. These flaws can increase the surface area of the hot water and the time water spends in the line, cooling it to a dangerous temperature.

For many years, internal water systems in Australia have not been designed with these factors in mind. Peter explains, "In Australia, we've had things like warm water systems installed which will deliberately send warm water through the whole system, on the basis that you had to maintain the temperature at one point – in the basement – and you didn't have to maintain it anywhere else. Which is great, but then you've created an entire legionella risk through your whole system."

Once these 'warm water systems' are addressed, the mixing of hot and cold water needs to be taken as close to the source as possible. One way of doing so is to employ thermostatic mixing valves (TMVs). By mixing the hot water at the point of use, TMVs ensure the water can be kept hot for as long as possible, without the risk of scalding.

KEEP COLD WATER COLD

On the flipside, it's important to keep cold water cold – below 20°C. As with keeping hot water hot, a step towards achieving this is keeping cold and hot water separate; there is, however, an additional problem. The increasing use and

efficiency of insulation is inadvertently warming the water in the cold water system to a dangerous level.

"In parts of the UK, especially Ireland, they're fighting with the increasing insulation on modern buildings, especially when the cold water is getting sufficiently warm to be a legionella risk," Peter says. "I visited a couple of sites, one in Northern Ireland, where they were installing chillers on the cold water system to keep the water cold."

Chilling cold water – particularly in a cooler country like Ireland – is counterproductive to the cost-saving intentions of insulation, so building designers and hydraulic engineers are now looking to relocate the cold water supply.

"In some of these newer designs, they've relocated the pipework away from the central shaft into a separate area, where it is not heated," Peter states.

KEEP IT MOVING

Stagnant water gives bacteria a chance to settle and create biofilm. Ensuring there are no dead or slow spots in the system or fittings reduces the ability of bacteria to colonise.

Rada have kept this in mind when designing their new range of taps, which will be launched in Australia next year. As Kevin explains, the new designs are "Keeping the internal geometry of the product very, very simple, so you don't have any areas where water is trapped, where it never really flushes out properly."

They've also reduced the volume and increased the flow to keep the water moving by shrinking the size of the tap internally and externally.

While part of the equation is the physiognomy of the taps, there's a new element in hydraulic design: automation.

The Rada product series has built-in motors that can automatically flush either the tap or shower that hasn't been used recently. Controlled by an app on a tablet, the taps can be set for a duty flush at a regular time – down to once an hour – and to skip this flush if they have been used recently.

In addition to helping keep the water moving, the duty flush can assist with maintaining the temperature of the water – either hot or cold – in the lines.

As well as flushing, water can be reticulated within the system.

"Reticulation is another main component," Antonio says. "It is required here in NSW by NSW health that dead legs ➤

in the hot water reticulation system are maintained to an absolute minimum, the DOH nominates a minimum of 10 lineal meters or 2 litres of draw off. In our hydraulic designs engineers normally aim to have even less draw off than this."

KEEP IT CLEAN

The last tactic in the fight against biofilm is keeping the water system clean. This can begin even before the water has entered the building.

"Site filtration, UV disinfection and chlorination are used and advised methods for incoming cold water supplies to reduce the risk of breeding legionella and pseudomonas," Antonio states.

Once the system is installed, regular maintenance is needed.

"Storage tanks should be inspected regularly and cleaned and disinfected annually," advises Antonio. "A close eye also needs to be kept on automatic backwash filters and bag filtration systems."

The right materials can help keep the inside surfaces of the plumbing fittings clean. Rada aims to eliminate plastics and reduce the use of elastomers in their new range, as both of these materials give bacteria a place to live and often provide a food source.

"If you can optimise the product to make it entirely of metal, you'd be doing a good job," Kevin says. "Brass and copper are the favoured materials because they have antimicrobial properties."

Copper and brass are more expensive, but with the shrinking of the taps mentioned above, the amount of materials needed (and the cost) is also reduced.

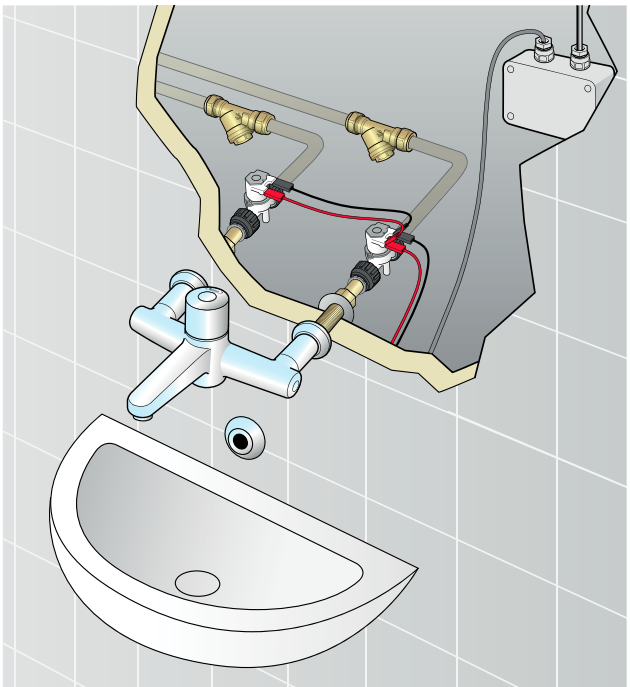
Perhaps the most challenging and labour intensive method of keeping it clean is thermal disinfection. Even with a thorough treatment system, legionella and pseudomonas can make their way into a building's water system – thermal disinfection is one method of killing these invaders.

The first challenge is keeping the water hot enough to kill bacteria. As discussed above, many of Australia's hot water systems are actually warm water systems and not capable of maintaining the temperature required: at least 60°C, but preferably above 70°C.

The second challenge is to avoid scalding anyone during the process.

"At the moment, it seems like a very manual process," Peter explains. "Maintenance staff stand in front of the shower and physically flush the system."

There are moves to automate the system and have it running when it's unlikely anyone will be using those outlets – for example, in the early hours of the morning. But in many of these facilities, it's impossible to ensure no one will be using the outlet. Peter gives the example of an older lady with dementia who might decide to have a shower at two o'clock in the morning.



A TMV installation depicting the hot and cold water inlets.

The Rada range has been designed to offer automated duty flushing, but the risks presented by thermal disinfection require a maintenance engineer to be present. Should they leave the tap unattended before the cycle has finished, a safety feature will terminate the disinfection cycle, if the tap's sensor senses a person's hands approaching. But this is high-end technology which will retrofit into most situations as long as a power cable can be located near to the tap or shower.

THE ONGOING PUZZLE

The battle against bacteria is certainly an ongoing one. As bacteria develop resistance to different antibiotics and adapt to new environments, we will need to change our defences to match. Plumbers and hydraulic engineers have many weapons at their disposal; it's a matter of finding the right ones for the situation. As Antonio states, "It is crucial that pre-filtration and treatment systems that are selected suit the end users' needs and methods, otherwise they just don't get used."

The same could certainly be said for the water distribution systems and other end use products. The tactics used must suit each individual battleground. ■

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