Looking deeper

The Journal of the Water Safety Forum

Issue 1 | April **2018**

Inside this issue

Advanced healthcare solutions from Armitage Shanks

Creating a new interactive forum on water safety

Looking Deeper Editor, **Susan Pearson**

Welcome to the first issue of Looking Deeper, a new journal that aims to hold a definitive conversation on the latest thinking on infection control and safety in relation to healthcare fixtures and fittings.

At Looking Deeper we want to engage with the current directions and trends that are most critical to the different groups of professionals looking after water safety in a variety of healthcare environments — by covering the latest research, sharing problems and solutions, holding discussions with leading experts in the field, providing updates on the latest guidance, covering events and much more.

A crucial issue that has been emerging recently, from conferences and published solutions on infection control issues, is the vital role of communication and understanding between the different teams involved in water safety, which can at times fall short. Looking Deeper will foster a forum that generates dialogues and understanding between specialist groups, highlighting the different areas of expertise and providing a view into each others' worlds.

More awareness of each others' concerns, for example between engineers, microbiologists, infection control staff and nursing staff, will inevitably lead to more effective infection prevention.

To this end we want to engage Looking Deeper readers in considering aspects of infection control that you might not usually think about — we want Looking Deeper to become an interactive exchange where discussions of engineering issues and bacterial growth will be understandable for those in charge of infection control, while articles on nursing and cleaning logistics will inform how engineers and microbiologists approach problems and solutions.

To achieve this we will avoid making features too 'technical' but will make sure we include links to practical details where appropriate.

Last but not least, alongside the Looking Deeper journal we will also be setting up a Round Table discussion group with an expert panel to focus on relevant topics around water delivery, sanitary-ware and fittings in relation to infection control and safety.

We intend these Round Table debates to contribute to the wider conversations on healthcare that will in turn help inform guideline changes and development of new products.

The first Round Table event will be held on 10 May 2018 and we will be reporting back on the discussions in Issue 2 of Looking Deeper (see page 16).

Contents

Editorial Contributions

Susan Pearson

Susan is an independent journalist and communications specialist with a background in biology, medical research and publishing.

She has been writing on medical issues for over 25 years and on waterborne diseases and water management since 2010. She is a frequent contributor to IHEEM's Health Estate Journal, the Clinical Services Journal and WMSoc's Waterline.

David Harper

David is a leading independent expert in the field of *Legionella*, waterborne contamination prevention and emergency response in both the UK and worldwide.

He has been involved in solving numerous Legionnaires Disease outbreaks, has been widely published in specialist journals and is a registered Expert Witness on *Legionella*.

Elise Maynard

Elise is an independent consultant to the water and medical devices industries and a former Chair of the Water Management Society (WMSoc).

She is a state-registered microbiologist & a Fellow of WMSoc, IHEEM, RSPH and IBMS. She chairs and presents at numerous international conferences.

Dr. Mike Weinbren

Dr. Mike Weinbren is a Consultant Clinical Microbiologist and Infection Control doctor currently based at King's Mill Hospital, Sherwood Forest Hospitals NHS Foundation Trust. He was the Director of Infection Prevention and Control at University Hospital Coventry and Warwickshire during Europe's largest PFI build in 2002-6, which experienced *Pseudomonas* outbreaks on the neonatal and adult intensive care units (ICUs) and a *Legionella* contamination of the water system. He is the Chair of the Water Working Party set up by the Healthcare Infection Society and was a member of the Working Party for HTM 04-01: 'Safe water in healthcare premises'.

In the news...

New national biofilms centre launched

The UK's world-class expertise in the research of biofilms has been recognised via the launch of a new National Biofilms Innovation Centre (NBIC), led by the University of Southampton. NBIC will be supported by a commitment of £26 million over the next five years, including £12.5 million funding from the Biotechnology and Biological Sciences Research Council (BBSRC) and Innovate UK.

Biofilms are formed by bacteria, sometimes alongside fungi, algae and protozoa, which become embedded in a slimy matrix that will stick to any damp surface. Biofilms are central to some of the most urgent global challenges and specifically are a leading cause of antimicrobial resistance (AMR) and the major cause of chronic infections, costing the NHS £2 billion per annum.

Image courtesy of the University of Southampton

The new NBIC will operate as a multi-site 'Innovation and Knowledge Centre', based at the University of Southampton, as the lead research organisation, in partnership with 14 universities, includng Edinburgh, Liverpool and Nottingham, three research centres and three major global academic partners, including the University of Copenhagen.

Electric bandages help combat antimicrobial resistance

Researchers at the Ohio State University Wexner Medical Center in the US have shown for the first time that 'electric bandages' can combat biofilm infection and also aid the fight against growing antimicrobial resistance.

The special bandages use weak electric fields to disrupt bacterial biofilm infection and could prevent infections and enable healing in infected burn wounds, in which bacterial biofilms represent a major complication.

The innovative dressing is based on bacterial reliance on electrostatic interactions to adhere to surfaces and works by becomes electrically active upon contact with bodily fluids, so no batteries or wires are needed.

The dressing has been cleared for prescription human use in the US "for several years" and is currently pending CE Mark approval for Europe and the UK.

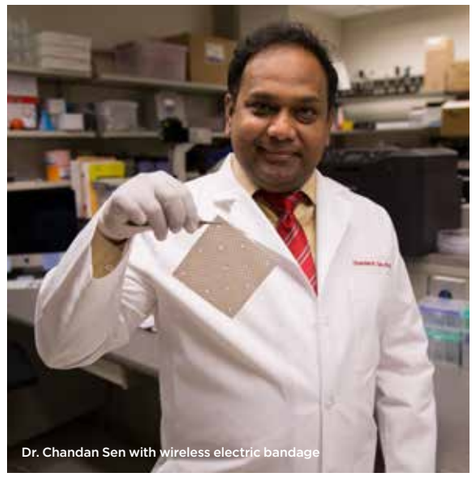


Image courtesy of The Ohio State University Wexner Medical Center

Dr. Chandan Sen with wireless electric bandage

Bacteria survive in ice-cubes but not whisky

New research from Italy has established that contrary to what most people expect, bacteria can survive below freezing — a thought that might make us slower to add an ice-cube to our drink!

A survey of ice cubes made for human consumption, known as 'food grade ice' looked for the presence of bacteria. This type of ice might be used to go straight into drinks or to keep fish cold on a seafood counter.

DNA analysis found *Pseudomonas* in most of the ice samples, while some samples were negative for the presence of certain types of bacteria. A total of 31 species were identified, with the most numerous groups including *Pseudomonas, Staphylococcus* and *Acinetobacter,* which include many human pathogens.

To check whether contaminated ice cubes can transfer the pathogenic bacteria to humans, the researchers added deliberately contaminated ice to different drinks commonly found at bars.

They found a consistent reduction in the growth of the bacteria in drinks such as whisky, vodka, Martini, tonic water and coke. Four different types of bacteria grew in vodka, while only *Acinetobacter* grew in tonic water. However, lovers of a fine Scotch will be pleased to know that none of the bacteria grew in whisky!

Share your thoughts with us in the next issue

To keep the conversation on water safety flowing we would really value your reactions to the first issue of Looking Deeper — we would appreciate hearing from you about what you liked, what you feel could be improved on, what topics you want to see discussed. We intend to publish some letters (with your permission) and would also welcome suggestions for contributions from our readers. You can contact us at **editorial@lookingdeeper.co.uk**

Dates for diaries...

Central Sterilising Club Annual Meeting
16/04/2018 Cardiff

HEFMA 10-11/05/2018 Cotswolds
www.hefma.co.uk/conference

Hospital Innovations
06/06/2018 UCL, London
www.hospital-innovations.com

European Healthcare Design 11-13/06/2018
www.europeanhealthcaredesign2018.salus.global/conference-show/european-healthcare-design-2018

Pall Medical — Armitage Shanks Water Hygiene Masterclass 13/06/2018, Warwick University
go.pall.com/uk-masterclass-2018

WMSoc AGM
19-20/06/2018 Drayton Manor
www.wmsoc.org.uk/conferences.php

HSJ Patient 1st
09/07/2018 Manchester
www.patientsafetycongress.co.uk/

CASE STUDY
How plastic pipework led to outlet contamination

by David Harper

Finding the solutions for high *Legionella* and *Pseudomonas aeruginosa* counts at water system outlets in a refurbished augmented care unit.

PROBLEM 1:

High counts of *Legionella* and *P. aeruginosa* were found in a new specialised augmented care facility when it was checked before it opened.

The new unit, at a UK NHS Hospital Trust*, was a 'stand-alone' building that had been completely refurbished to accommodate highly vulnerable patients. The work was carried out by an outside contractor and then handed over to the hospital's estates department. Their 'fit for purpose' check before the building could be brought into use found pre-and post-flush samples "in the 1000s" (CFU/100mL) at some of the water system outlets.

To put this into perspective, the Department of Health guidance 'HTM 04-01, Safe Water in Healthcare Premises, Part B' gives pre- and post-flush counts greater than 10 CFU/100mL as the highest level of risk. CFUS, or colony forming units, are the units used to count bacteria grown on culture plates from water samples. 'HTM 04-01, Part C: *Pseudomonas aeruginosa* — advice for augmented care units' provides guidance on the provision of services for the most vulnerable patients.

A check of the pipework established that plastic pipework had been installed for the hot and cold water supplies throughout the building beyond the mains water entry into a plant room. It seemed that the refurbishment had been carried out quickly and on a budget, with no Trust authorised project manager to oversee the contractors.

SOLUTION 1: *The initial solution was to replace all the plastic pipework with copper, which is generally used because of its anti-microbial properties. Copper pipes are more costly than plastic piping but should lead to a reduced need for water testing in future, and therefore less expenditure on water analysis down the line.*

PROBLEM 2:

However, further sampling still revealed high counts. Point-of-use (POU) filters were fitted to every water outlet, with a suggestion for chlorine dioxide water treatment, to allow patients to be moved into the unit. However, none of this provided a resolution for the engineering problem within the system, while the use of filters could become costly on an on-going basis.

Further scrutiny showed that many of the ward areas were not yet being used and the flushing regime for the water system, which prevents water from becoming stagnant and therefore favouring bacterial growth, was inadequate. An initial inspection of the inside of a shower head revealed a large amount of sediment including calcium scale and tiny bits of blue plastic from the original pipework. A check of several hand wash basins also revealed a huge amount of debris trapped behind the flow straightener (see picture 1).

This plastic debris would have been caused when the plastic pipes were removed, leaving jagged edges — or 'burrs' (see picture 2). These should be removed with a machine before new joins are made. If this is not done properly — as appeared to be the case here — the burrs remain on the inside of the pipe join and form a locus for biofilm to attach to inside the pipe joins where it is impossible to reach, even with water at the extremely high temperatures that would normally kill *Legionella* bacteria. 'Biofilms' grow on damp inanimate surfaces and are mucilaginous structures in which bacteria thrive.

SOLUTION 2: *All tap flow straighteners were removed in turn and the water run until clear. Where the flow straighteners — that are designed to prevent splashing — were not needed they were removed to prevent the collection of debris, after risk assessment of any potential splash risk.*

RESOLUTION:

Initial sampling, followed by further pre- and post-flush sampling five days later, after the system had 'settled down', showed no or negligible bacterial counts. Only one outlet tested 'positive' — in the kitchen — and thorough cleaning resolved this.

LESSONS LEARNED:

This type of scenario on a new build, which results in problems at outlets, is not uncommon. What is important, is to communicate the kind of problems that might crop up to project managers and those in charge of budgets. There needs to be a change of culture and thinking around design of water systems to take in the latest knowledge on the dynamic between water microbiology and systems' function and design. This would help eliminate the need for expenditure down the line on rectifying built-in faults.

* The Trust cannot be named for legal reasons.

Picture 1. Debris on hand wash basin tap nozzles

Picture 2. 'Burring' on cut plastic piping

Studying past outbreaks is crucial to prevent patient infections

Susan Pearson talks to **Dr. Mike Weinbren** about reducing deaths from waterborne infections through better understanding of past waterborne outbreaks.

Image courtesy of H&V News: Combating *Legionella*

Dr. Mike Weinbren is a Consultant Clinical Microbiologist and Infection Control doctor at King's Mill Hospital, Sherwood Forest Hospitals NHS Foundation Trust. He has been a member of the working party for HTM 04-01: 'Safe water in healthcare premises' and is the current Chair of the Healthcare Infection Society's Water Working Party set up to create guidance for infection control teams.

Dr. Weinbren argues that the numbers of waterborne infections in healthcare facilities are too high, with a large proportion going undetected and many being preventable.

Why has it taken us so long to understand transmission of waterborne pathogens to patients?

You really need to go back long before the Northern Ireland incident, the high profile case of four neonatal deaths from *Pseudomonas aeruginosa* infections in 2011/2012 tracked down to contaminated taps, which directly led to the Department of Health's HM 04-01 document, the first guidance to be written for *P. aeruginosa*. Neonatal deaths from *Pseudomonas* were not new, they had been happening for years, but Belfast was different in one particular respect — it attracted national and international media attention. Overnight, the periphery of water systems became recognised as a risk. Belfast was not a local failing, it highlighted a failure across strata of the health service; the evidence had been available since 1967 (see below) but no-one wanted to listen — an important omission in the subsequent public enquiry.

The peripheries of water systems are a unique interface between the water system and the drainage system, giving two different source areas of infection. We now accept that *P. aeruginosa* is not part of the normal neonatal flora. Up until Belfast, *P. aeruginosa* was present on many neonatal units and went unquestioned. So knowing if control measures are working on a neonatal unit is easy because any isolation of *P. aeruginosa* is abnormal. However, on adult ICUs *P. aeruginosa* may be part of the adult normal flora, making it much more difficult to identify transmission. No 'accepted' level of *P. aeruginosa* infections on adult ICUs exists beyond which transmission should be suspected. Only when organisms are different in some respect, such as when they are antibiotic-resistant, is an investigation conducted and the link to water systems made.

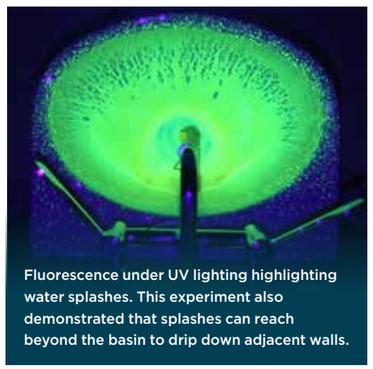
Most of the literature on outbreaks on adult ICUs relates to highly resistant organisms, with carbapenamase-resistant organisms now appearing in water. While everyone is rightly fearful of them, to some extent they can be considered 'friends' because they are highlighting deficiencies in our use of water systems, giving us the opportunity to learn about epidemiology. However, these organisms are no more likely to be transmitted than other 'sensitive' [to antibiotics] organisms — so the argument is that we are missing all the other organisms that blend into the background.

We need to learn from outbreaks and disseminate lessons learnt. History shows us that it can take time for people to accept new information and change their ideas about how things are done, a phenomenon known as the 'Semmelweiss reflex'. When Semmelweiss, the 'father of hand washing', first put forward his ideas, they were thrown out because his new evidence contradicted established norms.

Likewise, over a century later in 1967, the biochemist Joachim Kohn, based at Queen Mary's University Hospital, Roehampton, stated in response to a leading article on *P. aeruginosa* in the 'British Medical Journal' that, despite the prevailing medical folklore that organisms went from patients to sinks but not vice versa, he had evidence that pathogens can in fact be transmitted from sinks to patients. He was roundly chastised for this view by the microbiology community — it required the neonatal deaths in Belfast to highlight this transmission route.

How do waterborne pathogens get transmitted to patients?

Hand wash basins are often the source of problems on ICUs. Hand washing is the most important intervention in infection control, however, the risks from incorrect usage and placement of hand wash basins needs to be recognised more widely. People do not always use hand wash stations properly — in many hospitals, elbow-operated taps are not set at the right angle so they cannot be elbow-operated as intended and people use their hands instead, introducing contamination and re-contamination after washing.



Fluorescence under UV lighting highlighting water splashes. This experiment also demonstrated that splashes can reach beyond the basin to drip down adjacent walls.

But it is not just hand wash basins that can be problematical — even kitchen sinks have been implicated. For example, patient infections with carbapenamase-resistant organisms have been linked to kitchen sinks at a number of hospitals. We have to look at the whole design of water systems. For instance, drains in hospitals may be creating a super-highway for organisms to spread. Highly resistant organisms live in the bowel — yet main sewer pipes may be linked to the kitchen sink and the rest of the water system and may be vulnerable to feedback flow.

An outbreak that highlights the potential of hospital waste systems to act as a reservoir of hospital-acquired pathogens involved a multidrug-resistant *P. aeruginosa* at an NHS Trust.

At least 85 patients became infected at locations across the hospital between 2005 and 2011, with a 40% mortality rate. Extensive environmental sampling revealed the organism only in waste-water systems. The many factors that may have contributed to the contamination of clinical areas included faulty sink, shower and toilet design, clean items stored near sluices, and frequent blockages and leaks from waste pipes. Blockages were due to paper towels, patient wipes, or improper use of bedpan macerators. Control measures included replacing sinks and toilets with easier-to-clean models less prone to splashback, educating staff to reduce blockages and inappropriate storage, reviewing cleaning protocols, and reducing shower flow rates to reduce flooding. These measures resulted in significant reductions in cases.[1]

What do you think needs to happen to reduce waterborne infections in healthcare facilities?

Some hand wash basins have surfaces next to them where equipment is being prepared and is at risk of splashing — we need to think about introducing sensible solutions, for example, not preparing things next to basins and introducing screens between basins and surfaces. In 1995 total parenteral nutrition (TPN) was contaminated from a hand wash station in a pharmacy sterile services department causing child deaths. Hand wash stations have now been removed from sterile areas in pharmacies and in recognition of the risk from water, hand wash stations have been removed from their sterile service departments with a philosophy that hands are washed before entry to the area. There are many hospital areas where hand wash basins are unnecessary such as where clean equipment is stored.

We need the outlet manufacturers who are listening and delivering new products alongside infection control personnel, architects and hospital builders to design solutions that bypass the problems inherent in peripheral water systems. Design is not the difficult part. I have yet to find any architects or hospital builders who want to build safer hospitals. However, there is enough evidence out there of the types of risks posed by water systems — prevention of infections must be part of the agenda in reducing antibiotic resistance and preserving antibiotics.

Conclusion

We must go back and study and learn from major incidents — we have had evidence since Kohn's work in 1967, which was not acknowledged, and from many subsequent outbreaks, yet infections transmitted via water still occur and disappear under the radar. It is crucial that we now work closely with hospital builders so that healthcare water systems have safe designs. Not only would money be saved during construction, costs will be reduced over time and, most importantly, patients will be safer.

Reference

1. Breathnach A.S. *et al*, "Multidrug-resistant *Pseudomonas aeruginosa* outbreaks in two hospitals: association with contaminated hospital waste-water systems, *J Hosp Infection* **82**: 19-24, 2012.

Water temperature and delivery devices in hospitals

by Elise Maynard

We often take water for granted, we use it for washing, bathing, showering and drinking — and while at home setting the right temperature we want is often quite straightforward, within a hospital or healthcare premises it can be a different matter.

Water temperatures in healthcare settings are kept high to help reduce the risks of the growth of bacteria such as *Legionella*, which causes Legionnaire's Disease. However, water circulating around a large building via complex plumbing systems at temperatures as high as 65°C creates a potential danger of scalding for vulnerable patients, while these high temperatures also make effective hand washing more difficult.

This is the reason why thermostatic mixing valves (TMVs), valves that blend hot and cold water to provide constant temperatures, were brought into healthcare facilities many decades ago. Today the use and application of TMVs is covered in Health Technical Memorandum (HTM) 04 – 01 "Safe water in healthcare premises" with the aim:

1. To help reduce the risk of scalding by full-body immersion, for vulnerable patients (designated as 'never'-events).
2. To help facilitate effective hand washing, which is "best performed under running water at a safe, stable and comfortable temperature".

To further protect the user, a supplement to HTM 04-01 "Performance specification D 08: thermostatic mixing valves (healthcare premises) 2017 edition", defines how the manufacturer must prove their product's thermal compliance by gaining approval for their taps under the NSF/ Buildcert TMV3 scheme. Within the scheme and in response to NHS user feedback, thermostatic taps have now been designed to provide a reliable consistent controlled temperature and incorporate safety features to ensure that the tap is shut off instantly when there is an interruption in the cold water supply.

Recently there has been a school of thought questioning whether thermostats should be used as much as they are: by reducing water temperatures to a comfortable temperature for hand washing and safe scalding prevention, some argue that the lower temperature will give bacteria a better environment to breed in, causing a potential danger to patients with a weak immune system. Some TMVs may encourage bacterial growth because of a complicated design with numerous surfaces, which may be made of materials, such as polymers and rubbers, that themselves promote bacterial growth. In addition, internal water chambers may cause small relatively static reservoirs of stagnant water that again favour proliferation of micro-organisms.

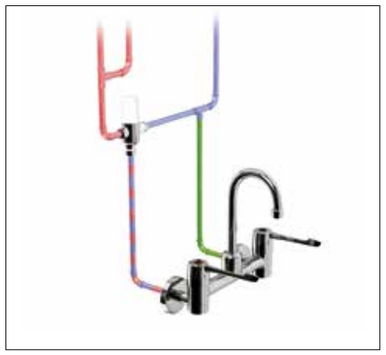
There are also arguments that say thermostats are expensive to buy and maintain and more basic taps would cut down costs within a budget-constrained NHS.

Some innovative manufacturers, understanding the issues involved, have been designing out complexity by creating a simpler structure within the tap body, reducing the amount of plastic components and increasing the amount of brass, as it has natural antimicrobial properties. New thermostats have been designed to have more brass content and a simple one-piece design. In addition, some products include smaller waterways to reduce the amount of water left in the tap; these smaller waterways create greater velocity which reduces bacteria attachment.

Smoother bore waterways have also been introduced to make it more difficult for bacteria to cling to surfaces.

Certain manufacturers have incorporated an integral thermostat within the fitting for many years, set in the body close to the point of delivery, thus cutting out dead legs and reducing warm water left in the fitting. Self-draining spouts, which evacuate any water remaining after use, are another hygienic feature. Furthermore, for easy thermal disinfection, cartridges that have a built in thermal cleanse feature are also available. Tap mixers that can be fully dismantled for disinfection, with internal components designed to withstand 90°C and detachable spouts designed to withstand autoclaving temperatures of 135°C can provide a very cost-effective method of maintenance.

All taps, regardless of whether manual or thermostatic, are required to be risk assessed for infection/scald risk and maintained appropriately. Therefore products which have full access to fittings from the front of the panel, fast isolation of water supply and rapid access to filters, check valves, regulators and thermostat, will make these easier to risk assess and maintain.



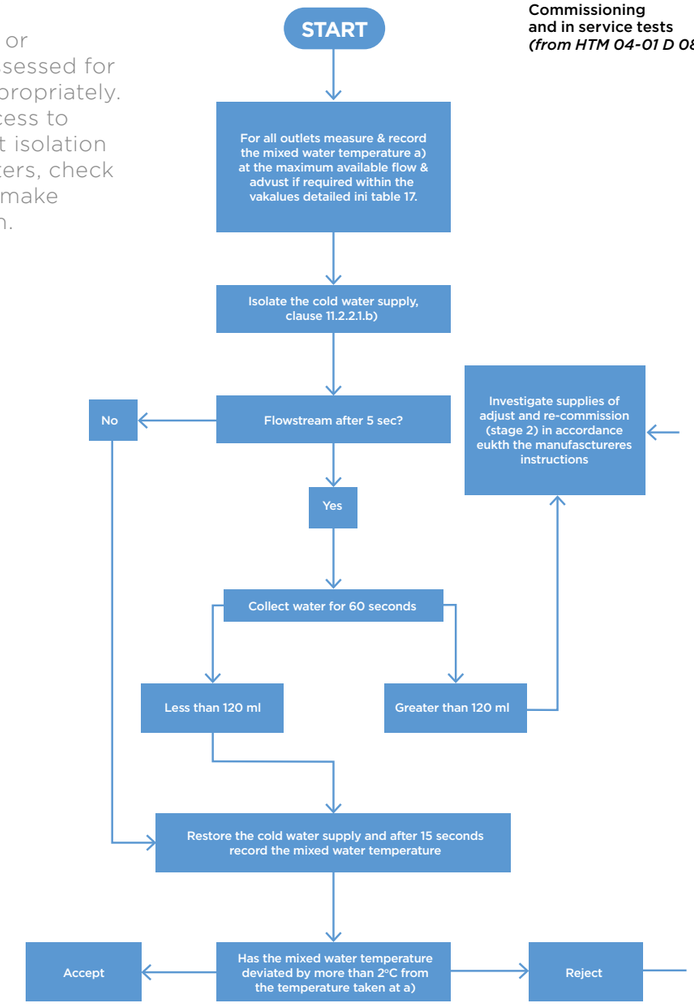
Traditional swan neck tap showing dead-leg created by separate TMV

Modern tap with integral TMV close to point of discharge

The HTM 04-01 D 08 supplement now requires a less onerous testing routine, with an average testing procedure of between one and two minutes for some of these new products (see diagram).

The task of risk assessing what fitting should be used is not easy and there is no perfect solution, so it is advisable to check for a range that has been designed especially for healthcare premises, with the aim of addressing a multitude of potential dangers — e.g. assurance of safe temperature water delivery for all users and multiple built-in safeguards to reduce the opportunity for bacterial growth — so that with a good cleaning and flushing regime, those dangers are reduced further still.

Commissioning and in service tests ***(from HTM 04-01 D 08)***



Sensors for Water Interest Group (SWIG)

Water and Health Workshop

31 January 2018

Exhibition and Conference Centre
University of the West of England, Bristol

This workshop provided an overview of waterborne disease followed by presentations showcasing the latest devices and sensor technologies that are able to rapidly detect microbiological and chemical contaminants.

The keynote presentation was delivered by Professor Nigel Silman, Senior Business Development Manager and technical consultant for Public Health England (PHE). He gave some sobering statistics regarding the disease burden linked to water worldwide and then discussed the numbers of outbreaks specifically in Europe. These are likely to be considerably under-reported and are linked to both high and low rainfall. He presented research from PHE that had utilised some of the newer diagnostic tools and recognised that as some clinical devices are now being used at home, so it is reasonable to expect that will be mirrored for certain environmental tests.

Elise Maynard, Council member, Water Management Society, presented some of the new rapid microbiological techniques that are being utilised for the detection of *Legionella*. Building on the introduction that Professor Silman had made, she described the work that WMSoc have been doing to try to identify how, where and when some of these new tests should be used. She described how a large study by PHE had been used to provide evidence to the Health and Safety Executive (HSE), sufficient for them to put a statement regarding the use of quantitative polymerase chain reaction on their website. Some of these rapid tests are more suited to the end-user, but this will require evidence of training and quality control.

Dr. Robert Pitchers, who manages the microbiological advisory service of WRc PLC, discussed the drinking water directive and the desire from industry to see new methods being included in the next revision. This could have real benefit for operational purposes — he mentioned that molecular techniques are becoming widely accepted, but also noted that they do not provide a measure of infectivity. He also cautioned not to ignore the value of simple tests such as turbidity or chlorine residuals.

Dr. Stephen Gundry was a Professor of Environmental Engineering at the University of Bristol and has since conceived and developed an on-site test for *E.coli* in water sources. This technique utilises a widely accepted Most Probable Number (MPN) methodology and is adapted for areas that may have little, or no accessibility to a laboratory. This could include not only rural areas, but potentially military and off-shore activities and situations where transport and disposal of samples may be an issue.

Steve Markham of Marquis and Lord gave a fascinating presentation regarding data management. His initial slides certainly showed how much data science has improved over the last 10 years and a poll of the audience indicated that those with recent academic experience were much better informed. He presented a variety of data in different formats, clearly demonstrating how the visual appearance can improve understanding, for data such as hot water temperature and thermostatic mixing valves. The same data can be displayed in different ways which would benefit engineers in one format and infection control personnel in another. UK government is also beginning to use these newer programmes and they can be relatively quick to learn and implement.

Ian Leahy of Palintest discussed bathing waters and the effects of rainfall, birds, animals and people. A group of researchers originally from Plymouth University, have provided new developments which allow testing of bathing waters at the beach and analysis of data within 30 minutes.

Dr. Kat Fish, an applied environmental microbiologist from Sheffield University, discussed the research being undertaken by the Pennine Water Group. She described scaled models of pipework and the effects of flushing on adhered biofilms. The team have some very sophisticated techniques to detect both the community and structure of biofilm and she showed data to support the mobilisation of organisms in shower-hoses after times of stagnation.

James Sorensen, a hydrogeologist from the British Geological Survey discussed the use of fluorescence spectroscopy to instantly detect faecal contamination in drinking water. He noted that *E. coli* secrete tryptophan when in the viable but non-culturable (VBNC) state and so this could be used as a potential measure. There is a potential that these newer techniques could be used instead of turbidity measurements as they are better correlated with *E. coli* and total viable counts.

Latest Research

Astrobiology.
2017 Dec;17(12):1183-1191. doi: 10.1089/ast.2016.1620. Epub 2017 Nov 8.

Pure and oxidized copper materials as potential antimicrobial surfaces for spaceflight activities.

Hahn C, Hans M, Hein C, Mancinelli RL, Mücklich F, Wirth R, Rettberg P, Hellweg CE, Moeller R.

Microbial biofilms can lead to persistent infections and degrade a variety of materials and are notorious for their persistence and resistance to eradication. Such microbial biofilms present a danger to crew health and spacecraft integrity and thus the use of antimicrobial surfaces may provide an alternative strategy for inhibiting microbial growth and biofilm formation, compared to conventional cleaning procedures and the use of disinfectants. The results indicated that antimicrobial surfaces in spaceflight facilities could improve crew health and mitigate material damage. Furthermore, the results indicated that cuprous oxide layers were superior to pure copper surfaces and that cell density is a significant factor.

J Hosp Infect.
2018 Jan;98(1):60-63. doi: 10.1016/j.jhin.2017.08.021. Epub 2017 Sep 7.

Rate of *Legionella pneumophila* colonization in hospital hot water network after time flow taps installation.

Totaro M, Valentini P, Costa AL, Giorgi S, Casini B, Baggiani A.

Legionellae may be resistant to disinfectants in the pipework of hospitals, which is a problem particularly in areas where there is low flow or stagnation of water. The authors evaluated *Legionella* colonization of a water network, within an Italian hospital, after the installation of time flow taps (TFTs) in proximity to dead legs. The water volume flushed was 64 L/day from May 2016 and 192 L/day from December 2016. Before the installation of TFTs *L. pneumophila* sg 2-14 was detected from all outlets and remained positive until November 2016. From December 2016, *Legionella* persisted in one outlet only. The authors concluded that TFTs with chemical disinfection may reduce *Legionella* colonization associated with dead legs.

Latest Research (continued)

Int J Environ.
Health Res. 2018 Jan 29:1-9. doi: 10.1080/09603123.2018.1429580. [Epub ahead of print]

Adhesion of *Legionella pneumophila* on glass and plumbing materials commonly used in domestic water systems.

Assaidi A, Ellouali M, Latrache H, Mabrouki M, Timinouni M, Zahir H, Tankiouine S, Barguigua A, Mliji EM.

The authors investigated adhesion of *Legionella pneumophila* serogroup 1 and serogroups 2-15 on glass, galvanized steel, stainless steel, copper, polyvinyl chloride (PVC), cross-linked polyethylene (PEX-c) and polypropylene random copolymer (PPR). The two *L. pneumophila* serogroups and plumbing materials showed a hydrophobic character, while the glass surface was hydrophilic. All strains were adhered to all materials with the exception of copper. Results showed that adhesion of both *L. pneumophila* sg 1 and sg 2-15 were highest on galvanized steel, followed by PVC, PEX-c, PPR, stainless steel and lowest intensity on glass. The extent of adhesion correlates with surface roughness and acid-base interactions, while hydrophobicity seems to have no effect in adhesion intensity.

Antimicrob Resist Infect Control.
2018 Jan 22;7:10. doi: 10.1186/s13756-018-0300-x. eCollection 2018.

Antimicrobial effect of copper alloys on *Acinetobacter* species isolated from infections and hospital environment.

Rózanska A, Chmielarczyk A, Romaniszyn D, Majka G, Bulanda M.

Acinetobacter baumannii may be a problem for many hospitals, especially intensive care units. Surfaces made from materials with antimicrobial properties, especially copper alloys, may provide a supplementary method of increasing biological safety in the hospital environment. The results of this study confirmed effective activity (bacteriocidal or bacteriostatic) of the copper alloys selected, in contrast to stainless steel. The reduction in bacterial suspension density is significantly different depending on the strain and copper alloy composition.

Latest tap decontamination option helps keep patients safe from waterborne Healthcare Aquired Infections (HAIs)

In 2010, a definitive article from Germany suggested that as many as 40% of healthcare-acquired Pseudomonas aeruginosa infections originate from water systems.[1] Fast forward to 2013, and for the first time in the UK, the Department of Health publicly acknowledged, in its ground-breaking HTM 04-01: Addendum document,[2] that P. aeruginosa bacteria can occur at water system outlets — such as taps — and within the last two metres before the point of discharge.

The HTM 04-01 addendum was published as a direct response to lessons learned from the tragic 2011-2012 death of three Northern Irish babies from *P. aeruginosa* infections traced back to contaminated taps. The guidance, which was updated in 2016, is now established as best practice. It stresses that controls of the water system are necessary both before and after the outlet, and includes advice on regular removal, cleaning and de-scaling or replacement of water outlets, hoses and thermostatic mixing valves (TMVs) where there may be direct or indirect contact with patients.

Image courtesy of Medisafe

Type of Medisafe Pico benchtop thermal washer-disinfector used in the QEHB research.

P. aeruginosa is an infection control scourge that by-passes healthy people but can cause life-threatening infections in anyone with a compromised immune system, such as cancer patients, and in post-operative wounds, burns and diabetic ulcers. It occurs naturally in the environment in moist conditions and forms 'biofilms' on inanimate surfaces.

It is most likely to proliferate in conditions such as stagnant water, on non-metallic materials, such as plastic hoses and intensive care tubing, and in limescale deposits and trapped debris, particularly in tap fixtures. Most tap fittings in intensive care and healthcare settings will contain TMVs delivering 'mixed' water at a safe temperature to minimise scalding risks. However, TMVs often contain numerous surfaces, plastic components and internal water chambers that may cause reservoirs of stagnant water — all conducive to bacterial growth.

Tap manufacturers have come up with increasingly innovative designs to retain the benefits of TMVs while reducing susceptibility for contamination. Some of the latest models of taps can now easily be isolated, de-mounted and disassembled, to allow decontamination before reassembly. Consideration should also be given to taps incorporating less plastic.

And now this decontamination process has been made faster and easier. Research from the Hospital Infection Research Laboratory (HIRL) at the Queen Elizabeth Hospital in Birmingham (QEHB) demonstrates that certain dismantled tap components can withstand high temperatures in a compliant thermal washer-disinfector already in use for other equipment to remove artificial microbial contamination.

Decontamination research

The tap unit investigated was the Markwik21+ tap assembly, which contains minimal polymers alongside a high proportion of anti-microbial brass components and smooth machined internal surfaces, to make it harder for biofilm to form, and a low 70ml static water volume.

The spout, mixing valve and pipework were flushed/immersed in a suspension of test bacteria and placed in a plastic bag. This kept the surfaces moist for seven days to allow a sufficient growth to develop to simulate in-use conditions.
The components were then processed in a thermal washer-disinfector compliant with EN 15883 Part 1.[3] This washer/disinfector is programmed to disinfect at >80°C for ten minutes. The tap assembly was loaded in a standard manner. The components were sampled before and after disinfection to establish the pre- and post-disinfection bacterial counts.

The wash fluid was cultured to determine the number of viable bacteria. Triplicate tests were carried out on two taps.

Results

The results demonstrated that the Markwik21+ tap, from Armitage Shanks could be decontaminated effectively in a compliant washer-disinfector at 80°C for ten minutes. IEN standards (European standards) for disinfection require a ≥5 $\log_{10}$ reduction in test bacteria: a >6 $\log_{10}$ reduction was achieved. The overall mean reduction factors (RF) for the three tests on two taps were: spout, >6.15; strainer assembly, >6.38; pipework, >6.76; and mixing valve, >7.24.

References

1. Exner, M. 'Tap Water', *European Hospital*, 8 July, 2010: http://www.european-hospital.com/en/article/335-Tap_water.html
2. www.gov.uk/government/uploads/system/uploads/attachment_data/file/140105/Health_Technical_Memorandum_04-01_Addendum.pdf
3. EN 15883: 2006, Washer disinfectors: Part 1 General requirements, terms and definitions and tests.

Numbers, material and methods

- Test bacteria *P. aeruginosa* NCTC 6749 disinfection test strain *P. aeruginosa* PS-1054 isolate from QEHB known to produce biofilm
- Concentration of bacteria in suspension: 108/ml
- Thermal washer-disinfector: Medisafe Pico
- Times and temperatures achieved during washer-disinfector cycle measured with digital thermometer and thermocouple lead attached to a tap component
- Tap assembly loaded in standard manner, i.e. no shadowing
- Spout, strainer assembly and mixing valve sampled by placing in sterile bag containing Ringers solution and processed in an ultrasonic bath for 1 minute
- Culture method: Pre-disinfection samples serially diluted and post disinfection samples filtered and filter placed on the surface of the culture plate
- Pipework was too large to sample in same way so a washing/flushing method used
- Pre- and post-flush samples plated onto tryptone soya agar plates and incubated for 18-24 hours at 37°C
- Number of colony-forming units (CFU) were counted
- Plates incubated for another 24 hours to check for further growth
- Counts per 100ml sampling fluid ascertained and converted into decimal logarithms and $\log_{10}$ reductions subsequently counted.

Looking Deeper
Water Hygiene Safety Forum

Looking Deeper is running a biannual round table discussion group with an expert panel focussing on relevant topics around water delivery, sanitary-ware and fittings in relation to infection control and safety.

We are keen to have broad conversations with all areas involved in healthcare water safety including engineers, microbiologists, infection control staff and nursing staff.

If you are interested in joining the panel, or contributing on an ad hoc basis, please contact Elise at elise@elisemaynardassociates.com including a CV and a summary of why you would like to be considered for the panel.

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