Looking deeper

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Inside this issue

Antibiotic-resistant pathogens emerging from drains

Looking Deeper Editor, **Susan Pearson**

More and more evidence is emerging that the organic debris finding its way into the traps, drains and U-bends of clinical wash hand basins (WHBs), which provides excellent nutrient sources for microorganisms and facilitates build up of biofilm, is proving to be the source of an accumulation of antibiotic resistant healthcare-associated pathogens. Much of this debris has been linked to inappropriate usage of WHBs; speaking at the IHEEM conference last autumn, Dr Ginny Moore, of Public Health England's Biosafety, Air and Water Microbiology Group, noted the frequent things that find their way down healthcare sink and WHB drains, such as tea, fruit, gum, paper and even antibiotics.

Concern over the emergence of antibiotic-resistant pathogens and how they are disseminated from healthcare sink and WHB drains is much in evidence in this issue of Looking Deeper, highlighted in particular in our report from the recent Healthcare Infection Society (HIS) conference (pp 8-10), where an entire session was devoted to healthcare risks from sinks, WHBs and drains alone. Two speakers discussed problems associated with the persistent reservoirs of carbapenemase producing enterobacteria (CPE) *Pseudomonas aeruginosa*, while discussions on interventions that could be engineered to decrease or eliminate transmission from hospital sink and WHB drains to patients focused in particular on the design of clinical WHBs.

Frequent things that find their way down healthcare sink and WHB drains include tea, fruit, gum and paper

These issues are echoed again in the papers outlined in our 'Latest Research' section (p13), which are only a tiny selection of the research out there on this subject. These studies include an analysis of how users' behaviour in relation to outlets can play a part in facilitating the establishment of these organisms in WHB waste systems and how to prevent transmission.

A subject that has consistently cropped up in previous issues of Looking Deeper is the need for wider awareness and education on the mechanics of waterborne infections – the biology of the organisms themselves, how they interact with water and the mechanics of transmission.

Following our commitment to promote understanding of these issues, we will be producing extra supplements that provide straightforward baseline information on specific topics such as *Pseudomonas, Legionella* and aseptic techniques.

The first of our new 'Back to Basics' series will be available alongside the summer issue of Looking Deeper.

Contents

Editorial Contributions

Elaine is the Trust Lead Healthcare Scientist/NIHR Clinical Lecturer, Infection Prevention and Control at the NHS Great Ormond Street Hospital Trust for Children. She is also an honorary lecturer in the Department of Civil, Environmental and Geomatic Engineering at University College, London and Chair and founder of the Environment Network, a forum for those interested in the role of the environment within infection control.

Dr Elaine Cloutman-Green

Ros is a public health physician and epidemiologist with a special interest in water and sanitation. Her experience includes surveillance of water related disease and investigation of water incidents and outbreaks at the national and local level, advising water companies and research. She is an honorary senior lecturer at the London School of Hygiene and Tropical Medicine, an honorary fellow of the Royal Society of Public Health (RSPH) and honorary Editor of the RSPH's 'Perspectives in Public Health'.

Dr Rosalind Stanwell-Smith

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 water-borne infection and water management since 2010. She has been a frequent contributor to IHEEM's Health Estate Journal and WMSoc's Waterline.

Susan Pearson

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 and a Fellow of WMSoc, IHEEM, RSPH and IBMS. She chairs and presents at numerous international conferences.

Elise Maynard

In the news...

Detailing risk from domestic water aerosols

What are the risks of becoming ill after inhaling bacteria-containing aerosols at home? New research from Drexel and Arizona State Universities in the US has laid out a framework for understanding the risk from inhaling *Legionella* and other bacteria in water spray from domestic water sources. It is also one of the first studies to closely examine how the latest water-efficient fixtures can affect risks.

The research looked at risks of exposure from water containing a range of bacterial concentrations and took into account available data on aerosol particle volume, size and spray for a variety of showers, taps and toilets.

Shower risks were found to be the highest, likely due to the amount of time a person would be exposed to the water spray, while risks from water-efficient fixtures tended to be slightly less if bacterial concentrations are comparable to those at conventional water fixtures.

Risk was also found to be greater from exposure to multiple sources or when adjusted for populations less able to fight off infection.

Most existing indoor water quality guidelines are not based on risk assessment research. Many focus on creating a 'cut-off' value, but most are based on what people are doing in practice rather than on technical reasoning. This research simulates an appropriate concentration limit based on a risk level that is consistent with other water quality policies.

Driven snow – not so pure?

While building a snowman is a lovely innocent childhood occupation, it may not be quite as hazard-free as you might think – because snow, it turns out, can be a reservoir of unwelcome bacteria. As many as 15 different bacterial species have been found in samples collected from public amenity sites, domestic gardens, public open spaces and melting snow from public footpaths.

A new study published recently in the 'Journal of Water and Health', identified four Gram-negative genera – *Enterobacter, Pantoea, Pseudomonas* (although *P. aeruginosa* was not detected) and *Xanthomonas* – and six Gram-positive genera – *Actinomyces, Bacillus, Brevibacillus, Micrococcus, Staphylococcus* and *Streptococcus* from 37 sites. *Bacillus licheniformis* was the most commonly isolated organism from snow and it was isolated from every snow type. Sadly, it seems that snow may contain bacteria that are capable of causing human infections.

Another piece of research, from Chinese researchers, has also found microbes in snow – *Conyzicola nivalis* bacteria have been isolated in glacial snow from the Zadang Glacier on the Tibetan Plateau.

Ancient Druids' 'soil cure' a key to antibiotic resistance

Newly discovered *Streptomyces myrophorea* Credit: G. Quinn, Swansea University

Hidden amongst the myths and fables from Ireland is one with a surprising relevance to microbiology and medicine: the tale of a soil that ancient healers once used wrapped in cotton cloth to treat ailments ranging from toothache, throat and neck infections.

After becoming aware of the healing traditions of the Boho Highlands of Fermanagh, Northern Ireland, scientists at Swansea University Medical School studied soil from the area – and found that it contains a previously unknown strain of *Streptomyces* bacteria that is able to halt the growth of MRSA and three other major healthcare-acquired superbugs. Interestingly, the alkaline grasslands of Boho were home to Druids around 1500 years ago.

The new strain of bacteria, named *S. myrophorea*, is effective against four of the top six pathogens that are resistant to antibiotics. Alongside MRSA, these are: vancomycin-resistant *Enterococcus faecium* (VRE), *Klebsiella pneumoniae* and carbapenem-resistant *Acinetobacter baumanii*. In addition, it was equally effective against both gram-positive and gram-negative bacteria.

The team is now carrying out further investigations to find out which components of the new *Streptomyces* species inhibit the superbugs' growth. The study was published in 'Frontiers in Microbiology'.

Dates for diaries...

Environment Network meeting
13/05/2019 Birmingham, UK
admin@theenvironmentnetwork.co.uk

WMSoc AGM and Conference
11/06/2019 Birmingham, UK

Armitage Shanks/Pall Medical Water Hygiene Masterclass
11/06/2019 St Albans, UK
www.idealspec.co.uk/events/water-hygiene-masterclass-2019

European Healthcare Design 2019
17-19/06/2019 London, UK
europeanhealthcaredesign2019.salus.global

17th International Conference on *Pseudomonas*
22 -26/07/2019 Putrajaya, Malaysia
pseudomonasconference.com

5th International Conference on Prevention & Infection Control (ICPIC)
10-13/09/2019 Geneva, Switzerland
conference.icpic.com

Healthcare Estates Conference
9-10/10/2019 Manchester, UK
healthcare-estates.com/mm-agenda/

Share your thoughts with us in the next issue

To keep the conversation on water safety flowing we would really value your reactions to this fourth issue of Looking Deeper — we would appreciate hearing from you about what you liked, what you feel could be improved, 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**

Pathogen-free and risk-free: going beyond "visually clean"

Susan Pearson talks to Dr. Elaine Cloutman-Green about forward-looking approaches to cleaning and guidance.

Dr. Elaine Cloutman-Green is the Trust Lead Healthcare Scientist/ NIHR Clinical Lecturer, Infection Prevention and Control at the NHS Great Ormond Street Hospital for Children (GOSH).

Dr. Cloutman-Green explains why the "visually clean" infection control standard no longer fits a modern healthcare system and discusses some of the strategies, including taking into account how patients interact with their environment, which should deliver a more risk-free environment for patients.

How does taking patient/user behaviour into account help to deliver strategies that take cleaning beyond the concept of "visually clean"?

Credit: Royal Society of Public Health*

Controlling risk from healthcare acquired infections has historically been focused on the way healthcare professionals behave and the way they interact with their environment.

This belief – that the environment is not important in terms of transmission of infection – dates from work in the United States in the late 1980s (e.g. by D.G. Maki[1]), leading the UK Department of Health (DH) to adopt the concept of "visually clean" as the standard to be achieved.

But microorganisms are invisible, which means that a risk-free environment and the control of risks from pathogens can never be just about cleaning. We urgently need to acknowledge that the "visually clean" approach no longer fits an evolving NHS – a major component of the healthcare environment is being left out of the equation, namely patients, their families and visitors. Instead, we need to start putting more emphasis on how users themselves interact with their environment.

For example, adults in single rooms tend to use their bathrooms rather than their separate clinical wash hand basin (WHB). Conversely, in a paediatric setting the clinical WHB will be used a lot, while the bathroom is less used; parents changing nappies are likely to wash their hands at the clinical WHB.

Usage depends not just on the patient demographic but also on the interventions, and their frequency, being carried out for the patients connected with a particular WHB.

We know that up to 60% of basins are covered in faecal flora in some settings[2] because even after cleaning there may be long term biofilm contamination. So we need to focus on what those WHBs are actually being used for – are they being used for purposes other than hand hygiene? For example, is a WHB being used for cleaning teeth in an area where people may be carrying out hand hygiene after dirty procedures?

Also, traditionally only healthcare professionals have been considered to be the individuals carrying out delicate procedures such as changing dressings or giving drugs – but that's not where we are now. We have patients living with chronic conditions and we have patients, especially with children, where family are their primary carers.

We now work to support patients and carers to be self-sufficient outside the hospital environment – so the premise that we should only train healthcare professionals [in safe environmental hygiene] is no longer valid. We need education for families, visitors and the patients themselves – which is a huge challenge. Getting across tricky concepts, such as the idea of working with something invisible, not just something that's "visually clean" is a big cognitive load for people to take on alongside the stress of dealing with ill health.

At GOSH, for patients who are with us for a long time, such as bone marrow transplant patients, families will be taught about how the environment works, for example, how to wash their hands – and we monitor this behavioural teaching alongside environmental monitoring.

What can be done to take 'cleaning' further?

We need to define what we mean by 'clean'. "Visually clean" is never going to mean that your environment is risk-free from pathogens because surfaces can become contaminated at any point. So at GOSH we ask cleaners to use substances that have long-acting anti-microbial properties but that leave a residue on surfaces – although this requires specific education of cleaners as the residue can mean that surfaces don't look as 'clean', which is their normal standard.

Alongside deep cleaning, our cleaning standards also include microbiological checks of surfaces for the DNA/RNA of significant viruses and bacterial culture.

Because it is never possible to screen a whole room we use a system of sentinel surveillance points that are based on understanding the ecology of problematic organisms. This is an evidence-based risk assessment approach: we work out how many samples we need to take in a room to capture the point where that room will fail. For example, *Klebsiella* bacteria, although not always waterborne, survive very well on surfaces such as sinks and WHBs and can form a significant amount of biofilm. We find that if sinks and WHBs are free of *Klebsiella* then we don't usually find it anywhere else. With *Pseudomonas aeruginosa*, if we do detect it, patient and water isolates rarely match. When it does match its presence is frequently believed to have resulted from back-contamination from patients.

Guidance and risk assessments

We need more discussion about creating guidance that supports Trusts to create risk assessments based on their clinical knowledge and expertise. For example, ICU patients at GOSH undergo clinical surveillance for *P. aeruginosa* and where any cases are suspected as hospital-acquired, sinks and WHBs will be tested and samples sent for genetic typing to determine if there's an issue with the water or whether back-contamination is the issue, as is generally the case.

This is the type of information that Trusts possess about their specific organisation, patients and risk factors that would be a useful basis for creating tailored risk assessments, but may not be covered in the guidance. While large hospitals will have access to a water safety group (WSG), bringing together expertise from both the clinical side and the engineering side, other organisations, such as care homes, may not have access to an experienced WSG. Providing a strong structure or template for organisations that do not have specialist knowledge is crucial, but Trusts such as GOSH and other big teaching hospitals that have access to a lot of specialist knowledge and surveillance will benefit from being able to input that information into their risk assessments.

Klebsiella bacteria: survive well on wash hand basin surfaces

Conclusion

It will be increasingly important in future for new guidance to be less generally prescriptive, to have a degree of flexibility written in to take into account specialist knowledge where it exists. Guidelines could be revised to describe the types of actions that need to be taken but could also outline a second route that allow Trusts to reach the same outcome via a different route based on their specific clinical environment, risk-assessed by their WSG against that standard.

We also need to see more infection-control staff on WSGs and more communication and understanding between engineers, clinicians and infection control personnel so that each understands the others' problems and focus.

References

1. Maki, D.G. *et al* "Relation of the Inanimate Hospital Environment to Endemic Nosocomial Infection", *N Engl J Med,* **307**(25): 1562-6, 1982.

2. Cloutman-Green, E. *et al* "The important role of sink location in handwashing compliance and microbial sink contamination", *Am J Infect Control*, **42**(5): 554-5, May, 2014.

*Hygiene protocol for cleaning taps and sinks (RSPH video) https://www.youtube.com/watch?v=Wc-RgwIJpdY

Healthcare Infection Society 11th International Conference HIS 2018

26-28 November 2018 – Arena and Convention Centre Liverpool

Image courtesy of the Healthcare Infection Society

Dr. Paz Aranega Bou

Dr. Mike Weinbren

The packed programme included a wide variety of sessions related to multi-drug resistant (MDR) bacteria, as well as environmental sources of infection, such as water and drains.

One of the first plenary sessions focused on the 'hospital and the human microbiome.' Professor Nicholas Loman (Institute for Microbiology and Infection, University of Birmingham) explained how whole genome sequencing (WGS) allows precise lineage tracing and noted that water outlets are an important microbiome in hospitals.

He described how transmission from water to patients in augmented care units has been demonstrated in four trusts over a 16 week period by utilising WGS. 550 isolates were acquired from both patients and the environment, revealing that clones are persistent over time and that individual outlets harbour unique populations. Transmission rates ranged from zero to two thirds positivity and the type of tap or plumbing may be a source of contamination.

Armitage Shanks and Pall Medical supported a Royal Society of Public Health (RSPH) symposium, 'Managing Hospital Water Hygiene', chaired by Dr Susanne Lee (Specialist consultant, Leegionella).

Dr Mike Weinbren (King's Mill Hospital, Sherwood Forest Hospitals) discussed biofilm and timelines related to contamination of water from the era of John Snow and the London cholera epidemic, through to the present day and stressed the importance of using wash hand-basins (WHB) only for hand-washing. He discussed the problems around sample taking and cleaning before moving onto outbreaks of MDR bacteria. There is a need to ensure equipment is protected from splashing, he said, sluices should therefore be positioned more ergonomically. The discussion moved on to consider whether the source of contamination could be the drain and waste pipe? The 2003 SARS outbreak was discovered to originate from vertical spread via the sewage stack.

There is now clear evidence to show wipes are creating blockage within hospitals and that disposal of antibiotics into the hospital water system is taking place. Macerators are prone to blockage and the basin trap can harbour carbon sources leading to biofilm growth. Dr Weinbren advised that it requires experience to detect these hazards and training is needed for clinical staff.

Dr Mark Garvey (University Hospitals Birmingham) described a new build scenario that was specified prior to the 2016 HTM 04-01 revision. Flushing of the water system had not been taking place and they are

still dealing with problems – *Pseudomonas aeruginosa* with evidence of transmission from taps to patient. Remediation measures were undertaken, but *P. aeruginosa* returned after six months, so point-of-use (POU) water filters were installed. The centre was enrolled as part of a wider WGS study (as described above).

Dr Garvey described the measures used to try to engineer out the problem: after filters they tried holistic interventions regarding waste water disposal, cleaning outlets and installation of a new tap design that can be easily disinfected, showing demonstrable service improvement (see pp 10-12). He advised that the cleaning of taps is critical and that POU filters should be used as a short term measure that needs to be managed appropriately.

Solutions proposed included new tap and WHB designs and he also noted that terminal room disinfection does not clean sink drains.

Risks from sinks and drains

Day two began with a session of short quick-fire free papers focused on healthcare risks from sinks and drains, chaired by Dr Tim Boswell (Nottingham University Hospital).

Dr Chloe Hutchins (Quadram Institute) presented a retrograde contamination study demonstrating that flushing taps twice daily gave short term effects on biofilm. The highest contamination was in the first flush and she therefore concluded that the first sample of water should not be used and that regular flushing does have a role as a control measure.

Claire Thomas (Imperial College) reviewed a carbapenemase producing enterobacteria (CPE) *Pseudomonas aeruginosa* in a haematology unit in 2013. The mains water supply was from a bore-hole. A second case initiated an outbreak investigation but no clear source was identified.

POU water filters and environmental *P. aeruginosa* water tests were used to mitigate the issue. In 2017 another two cases were identified, and although the typing was slightly different, it proved to be the same CPE. Extensive environmental sampling was performed plus significant remediation and training of cleaners. She concluded that CPE are persistent in the environment and reside in drains, which are difficult to remediate.

Dr Philip Carling (University School of Medicine, Boston, US) reviewed a number of papers that described long duration outbreaks. Mitigation measures included bleach, acetic acid and other chemicals. Physical measures utilised were sink replacement and a drain heating device. This shifted the outbreak organism from *Pseudomonas* to *Serratia*. Rates of acquisition were lower but not eliminated.

Dr Paz Aranega Bou (Public Health England [PHE]) also commented on CPE being found in sinks. PHE have developed a model sink and drain for research purposes. They wanted to discover whether CPE can re-enter the clinical environment.

They tested two types of sinks: with fast versus slow drainage. Slow drainage results in significantly higher splash dispersal for drains positioned under taps compared to those basins with rear drains.

In practice they found that hospital waste traps contain nutrients such as fruit, gum and paper. In conclusion there is evidence that there should be appropriate disposal of liquid waste. Drain position and good drainage is also important.

Dr Juliette Severin (Erasmus MC, Rotterdam, Netherlands) described a VIM-gene positive *P. aeruginosa* where the sink drains were the main reservoir. Chlorine, steam and removal of sinks was not effective in removing the colonisation and drain covers were utilised (the design of the sink has a drain below the tap). Hotspots were found in ICU (intensive care unit) single rooms, medication rooms and dirty utility. The contamination was sited in the U-bend and drain. Statistically there was a short-term, improvement, but this decreased in the long-term.

Porton Down test rig - sinks with fast or slow drainage. Image courtesy of PHE, Porton Down

Splashing distances

Samuel Yui (UCLH) described a study to test a novel new WHB design. He included three basin designs, all with a back outlet and one of which was designed with a fin. The study involved use of a fluorescent dye, and droplets caused by splashing were counted and sized.

The fin design had the fewest splashes of all three with less than 1 mm droplets more predominant. All designs produced a spread greater than one metre. Further work is now planned to simulate hand washing. In conclusion, the anti-splash fin design reduced droplet formation by 96% compared to basin B and 79% compared to basin C.

In further sessions on Day three, Professor Catherine Noakes (Leeds University) explained that droplets are generally surrounded by fluid, which affects dynamics. Engineers want to break the chain of transmission – she described modelling approaches that her team has developed with links to the Bradford Teaching Hospitals Trust. They have found that open windows can actually decrease the risk of infection.

A four year project linking airborne transmission to surfaces is currently being undertaken.

Dr Susanne Lee, in another quick-fire paper round, described routine sampling from thermostatic mixing valves (TMVs) in one Trust. Low numbers of *Legionella* were found, mostly *L. anisa.*

Remediation or replacement of TMVs proved a successful intervention. Dr Lee noted that compliance with temperature at sentinel points does not necessarily mean a system is safe and that TMVs must remain in place wherever there is a scald risk.

Samuel Yui compares the reach of splashing from three different wash basins.

Installation of new taps significantly reduces *Pseudomonas* on an ICU

A new investigation of the clinical impact of introducing new tap outlets on an ICU at Queen Elizabeth Hospital Birmingham (QEHB) reports an immediate and substantial reduction in the acquisition of *Pseudomonas aeruginosa* infections.

P. aeruginosa, an opportunistic pathogen that favours moist environments and has the ability to attach to inanimate surfaces, such as those inside pipes, taps and wash hand basins (WHBs), is a serious bacterial healthcare acquired infection (HAI) in critically ill and immuno-compromised patients. In the UK, *P. aeruginosa* is responsible for 3% of all reported monospecies bacteraemias and around 50% of infections acquired on intensive care units (ICUs).

Water outlets and associated plumbing are now accepted as significant reservoirs of infection in healthcare facilities, although other routes of infection can include cross-infection, for example via healthcare workers' hands and contaminated medical equipment. In 2016, an update of the Department of Health's guidance 2013 HTM 04-01 put forward a risk management approach to water safety as the key to controlling *P. aeruginosa* infections in healthcare settings. HTM 04-01 details recommendations for sampling water and instigating risk reduction and preventive measures when outlets are found positive for the organism.

At QEHB, the infection control focus has been on practical holistic control measures, which have resulted in reduction of waterborne transmission of *P. aeruginosa*. However, despite remedial work

on existing tap outlets, some colonisation returned leading the team to consider finding tap outlets that could withstand high level disinfection.
A previous investigation into decontamination of taps that can be disassembled demonstrated that certain fittings can be decontaminated in a thermostatic washer disinfector.[1*] A further study at QEHB established how outlet decontamination combined with installation of point-of-use (POU) filters can reduce waterborne transmission of *P. aeruginosa* on an ICU.[2]

Now, a new study from the same team describes the impact of installation of new tap outlets on the number of outlets colonised with *P. aeruginosa* and the resulting clinical significance.[3]

QEHB is a NHS tertiary referral centre with one of the largest co-located ICUs in the world with 100 beds and 231 water outlets, of which 130 are clinical outlets. Previous water sampling on the ICU has indicated 30% of outlets as positive for *P. aeruginosa*, with ground-breaking whole genome sequencing data suggesting at least a 30% transmission from water to patient.[4]

Methods

For the latest investigation, eight new taps were fitted in July 2016 on clinical WHBs in ICU A on an eight-bedded bay, which has a dedicated sluice to dispose of patient waste. The new taps, Markwik 21+ (Armitage Shanks) were chosen based on recommendations from other centres. These taps can be detached from the water supply, disassembled and effectively disinfected as above.*

Water samples were taken from all water outlets on the ICU every six months as originally recommended in HTM 04-01, although this recommendation has since been updated (in 2016) to a risk management approach. Water samples were also taken from the eight test outlets and from eight randomly selected control (clinical WHBs) outlets on one unit of the ICU.

Table 1

Total number of QEHB ICU water outlets positive for *P. aeruginosa* in 2017.	
Area A	(20) 29%
Area B	(15) 30%
Area C	(9) 18%
Area D	(19) 31%
Total	**(63) 27%**

Numbers in the brackets refer to number of positive outlets.

Monthly infection and control procedures were audited during the period of this report, including monitoring the correct disposal of patient waste water and tap cleaning.

At the end of the 33-week test sampling period, two test taps on the ICU were removed and disassembled into their component parts (spout, thermostatic mixing valve and pipework [bar]), which were sampled for pre-counts, disinfected in a washer-disinfector and then sampled for post-disinfection counts.*

Various statistical models were used to determine the results (see Numbers, materials and methods overleaf).

Results

Water sampling from the ICU demonstrated that 27% of outlets were positive for *P. aeruginosa* in 2017 (see Table 1).

- **TVCs**

Weekly sampling commenced immediately after installation of the test taps. The mean TVC isolated from 264 control samples was 15,402 CFUs, while the mean TVC from the same number of test samples was 10,360 CFUs. A negative binomial regression model was used to confirm that the TVCs isolated from the test taps were significantly lower than for the control taps (p=0.000232).

- ***P. aeruginosa***

While substantial levels of *P. aeruginosa* were recovered from control taps, there were only two isolated instances of contamination of test taps: 2 CFU recovered from one tap and 1 CFU from another.

- **Tap decontamination**

Removal of the two test taps after eight months revealed bacterial contamination of all the tap components except for the spout of one of the taps. However, thermal disinfection reduced all contamination to zero.

- **Water testing frequency**

The use of Bayesian analysis indicated that monthly sampling is more reliable than six-month sampling regimes over any one six month period.

- **Statistical analysis of interventions**

Use of the Poisson regression method used to analyse the overall clinical isolates from the ICU suggested that two previous interventions, fitting POU filters to selected taps and alteration in the disposal of waste water alongside improved cleaning protocols, led to a marked reduction in *P. aeruginosa* acquisition. However, the regression model used to analyse the ICU alone produced marked evidence that the new taps were associated with a noticeable decrease in the incidence of *P. aeruginosa* acquisition on the ICU.

Conclusions

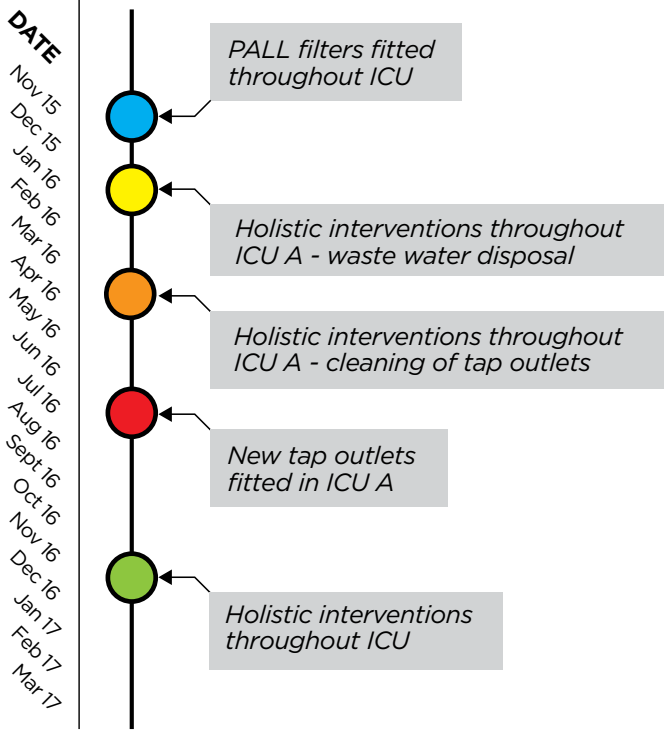
The researchers concluded that fitting new taps on the ICU was the only important intervention, resulting in an immediate and sustained 72% decrease in the acquisition of *P. aeruginosa*.

However, they noted that it would be useful for larger studies to confirm these findings that replacing taps can be a more cost-effective alternative to fitting filters. The team also noted that although the taps were clear of *P. aeruginosa*, the high number of TVCs detected was not surprising, as water is known to harbour a range of microorganisms.

Numbers, materials and methods

- Water samples were taken at the end of the night shift prior to any tap flushing and when water use on the ICU was at its lowest.
- *Samples were enumerated via membrane filtration, culture on tryptone soya agar with results expressed as TVC (total viable counts)/100ml, as outlined in the research mentioned above.
- *P. aeruginosa* isolates on culture plates were identified by standard microbiological investigations, while isolates suspected as linked to a transmission event were sent for analysis at the PHE Antimicrobial Resistance and Healthcare Associated Infections (AMRHAI) reference laboratory.
- Negative binomial regression models in the MASS package in R version were used to compare results for TVCs and *P. aeruginosa* counts (expressed as CFUs [colony forming units]). Bayesian analysis was used to determine the probability of a tap being contaminated with *P. aeruginosa*. Comparison of patient acquisition rates of *P. aeruginosa* over 100,000 bed days in the ICU overall against ICU A used segmented Poisson regression models in R.[5]

Timeline of interventions during study period.



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2. Garvey, M.I. *et al* "Engineering waterborne *Pseudomonas aeruginosa* out of a critical care unit", *Int J of Hyg and Env Health* 220(6): 1014-1019, 2017.
3. Garvey, M.I. *et al* "Tap out: reducing waterborne *Pseudomonas aeruginosa* transmission in an intensive care unit", *J Hosp Infect*, 2018 Jul 31. pii: S0195-6701(18)30404-3. doi: 10.1016/j.jhin.2018.07.039. [Epub ahead of print]
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5. R version 3.3.1 (2016-06-21) – Bug in your hair. The R foundation for statistical computing.

Latest Research

Infect Control Hosp Epidemiol.
2018 Nov:39(11):1307-1315. doi: 10.1017/ice.2018.235. Epub 2018 Oct 4.

Sink traps as the source of transmission of OXA-48-producing *Serratia marcescens* in an intensive care unit.

Regev-Yochay G *et al*

This study describes successful containment of a prolonged OXA-48-producing *S. marcescens* outbreak after recognising sink traps as the source of transmission. The Sheba Medical Center intensive care unit (ICU), contains 16 single-bed, semi-closed rooms. Active CPE surveillance includes twice-weekly rectal screening of all patients. A case was defined as a patient detected with OXA-48 CPE >72 hours after admission. From January 2016 to May 2017, 32 OXA-48 CPE cases were detected, of which 81% were *S. marcescens*. A single clone was the cause of all but the first two cases. The common factor in all cases was the use of relatively large amounts of tap water. The outbreak clone was detected in two sink outlets and 16 sink traps. In addition to routine strict infection control measures, measures taken to contain the outbreak included (1) various sink decontamination efforts, which eliminated the bacteria from the sink drains only temporarily and (2) educational intervention that engaged the ICU team and lead to high adherence to 'sink-contamination prevention guidelines.' No additional cases were detected for 12 months. Despite persistence of the outbreak clones in the environmental reservoir for one year, the outbreak was rapidly and successfully contained. Addressing sink traps as hidden reservoirs played a major role in the intervention.

Appl Environ Microbiol.
2018 Oct 26. pii: AEM.01997-18. doi: 10.1128/AEM.01997-18. [Epub ahead of print]

Droplet rather than aerosol-mediated dispersion is the primary mechanism of bacterial transmission from contaminated hand washing sink traps.

Kotay S, Donlan RM, Ganim C, Barry K, Christensen BE, Mathers AJ.

An alarming rise in hospital outbreaks implicating hand-washing sinks has led to widespread acknowledgement that sinks are a major reservoir of antibiotic resistant pathogens in patient-care areas. An earlier study using a GFP-expressing *Escherichia coli* (GFP-*E. coli*) as a model organism demonstrated dispersal from drain biofilm in contaminated sinks. This study further characterises the dispersal of microorganisms from contaminated sinks. Replicate hand-washing sinks were inoculated with GFP-*E. coli* and dispersion was measured using qualitative (settle plates) and quantitative (air sampling) methods. Dispersal caused by tap water was captured with settle plates and air sampling methods when bacteria were present on the drain. In contrast, no dispersal was captured without or in between tap events, amending earlier theory that bacteria aerosolise from P-trap and disperse. Numbers of dispersed GFP-*E. coli* diminished substantially within 30 minutes after tap usage, suggesting that the organisms were associated with larger droplet-sized particles that are not suspended in the air for long periods.

J Hosp Infect.
2018 Nov;100(3):e115-e122. doi: 10.1016/j.jhin.2018.04.025. Epub 2018 May 5.

Characterizations of handwashing sink activities in a single hospital medical intensive care unit.

Grabowski M *et al.*

This study aimed to understand behaviours in the intensive care unit (ICU) that may facilitate establishment and nosocomial transmission of multidrug-resistant Gram negatives from a sink-trap reservoir to a patient. Motion-sensitive cameras captured anonymised activity paired with periodic in-person observations during a quality investigation from four ICU sinks (two patient rooms and two patient bathrooms) in a university hospital. Analysis of 4810 sink videos over 60 days in patient rooms and adjoining bathrooms gave a false-positive rate of 38% in which the camera triggered but no sink interaction occurred, while assessment of observed behaviours were: 37.4% medical care, 29.2% additional behaviours, 17.0% hand hygiene, 7.2% patient nutrition, 5.0% environmental care, 4.2% non-medical care. Hand washing was only 4% of total behaviours. Sub-analysis of 2748 of the later videos further categorised 56 activities where a variety of nutrients, which could promote microbial growth, were disposed of in the sink. Conclusion: several non-hand hygiene activities took place regularly in ICU handwashing sinks, which may provide a mechanism for nosocomial transmission and promotion of the growth of (possibly multi-drug resistant) bacteria in the drain. Redesigning hospital workflow and sink usage may become necessary.

Note: "Sinks" in these abstracts could also be referred to as "basins".

Public health impacts of public toilet closures

Each year, there are around 300 closures of public toilets in the UK which, combined with a rapidly ageing population, is now leading to serious public health problems.

A discussion of these health concerns relating to lack of toilet facilities was the focus of a recent well researched and eloquent webinar* presented by Dr Rosalind Stanwell-Smith, a public health physician and epidemiologist and honorary senior lecturer at the London School of Hygiene and Tropical Medicine, who noted that more people globally have access to a mobile phone than a toilet, due to either a lack of sanitation or lack of water.

Dr Stanwell-Smith introduced the audience to a term known as "potty parity", which has inspired legislation in some parts of the US, Canada and China to provide more and/or larger toilets for women – mainly due to the fact that women may be assisting children, or may take more time in a toilet as they have more clothing or sanitary products to manage.

The webinar conveyed some of the key findings of a survey (of 2089 respondents) commissioned by the RSPH.** This revealed that where public toilets are in short supply, people will seek out conveniences in supermarkets, restaurants, pubs and even betting shops!

However, it was also noted that a significant number will urinate in a back-alley or a bush – leading to potential public health issues. Many councils do not have by-laws to prevent this at present and of those who do, only a very few prosecutions have been made in recent years.

The likely public health impacts of fewer public toilets can be numerous – from restricting fluid intake, which can be damaging to kidneys, and infection due to lack of hand-washing facilities. For the disabled, there are additional aspects – when available, disabled facilities are located where there are already public toilets, or may be inappropriate for the needs of their users. Infections have been linked to the homeless: an outbreak of Hepatitis A was reported in California in 2017[1] and on 'Skid Row',[2] in Los Angeles, where there are only nine toilets for an estimated homeless population of 1,800; while in Seattle, there have been reports of *Streptococcus* and *Shigella*, amongst other pathogens, which have been attributed to a rise in homeless people lacking access to sanitation.

Where public toilets do exist, the survey revealed a number of hygiene aspects, such as lack of toilet paper, or they were often unclean or had a bad smell. Other issues that emerged included the cost of entry, safety and concerns regarding the facilities being used for drug use.

Dr Stanwell-Smith addressed funding issues, looking back to historical incentives such as the 1851 Great Exhibition, where George Jennings's water closets initially made a profit, creating a sense that public toilets should be profitable or at least pay their way.

A number of possible funding options were provided on the RSPH survey questionnaire, including advertising to provide funding.

Former Edwardian public convenience in Bristol: closed in 2001

Turning again to history, Dr Stanwell-Smith described how the 1848 Public Health Act recommended that every new house should have a water closet, privy or ash pit with sewage connection – but this was to be at the householders' expense. Some 30 years later only 12% of houses had a water closet. Boards of Health were set up with a recommendation to provide "Public Necessaries" but very few complied and while the Public Health Act of 1936 outlined similar permissive legislation, free provision was for men only. In 1963, a public turnstiles act made it the duty of local authorities to abolish turnstiles in public conveniences. This was repealed in 1981.

Today there remains no legislation, only a recommendation, for the provision of public conveniences. The slow progress is also due to the substantial costs involved, but perhaps a more delicate hurdle is a reluctance to discuss issues of public hygiene in relation to street urination. As the problems faced by many of the "voiceless" public toilet users, such as bowel diseases and bladder problems, are becoming more prevalent, the issue needs more open discussion.

References

1. https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/Immunization/Hepatitis-A-Outbreak.aspx
2. https://losangeles.cbslocal.com/2017/10/18/portable-restrooms-hepatitis-a-outbreak/

* The RSPH webinar 'Provision of Public Toilets for Public Health' (sponsored by Armitage Shanks and Pall Medical).

** At the time of going to press, the full data from the RSPH survey are not yet available for reproduction in 'Looking Deeper'. Please visit www.**RSPH.org.uk** and/or email **tgreen@rsph.org.uk** if you would like to be alerted when the policy paper has been published.

For further information please also see: **www.publicinconviences.org**

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