Looking deeper

THE JOURNAL OF THE WATER SAFETY FORUM

Issue 6 | **November 2019**

Inside this issue

All about design

Looking Deeper Editor, **Susan Pearson**

"The world is facing a global healthcare workforce crisis and a future of too much work with too few workers — but design principles can, if well implemented, help alleviate the growing demographic and health challenges."

This was one of the key messages from the opening address by Mark Britnell, global chairman and senior partner of healthcare, government and infrastructure at KPMG International, at the European Healthcare Design 2019 Congress in London earlier this year.

With his presentation referencing Michelangelo, he discussed health models that had used systems design to significantly improve patient outcomes. For example, Europe's first Ambulatory Care and Diagnostics Centre, which opened at the Central Middlesex Hospital in 1998, arose from the ambition to separate emergency patient flow from elective flow and map patient flows — and to use these as the foundation for architectural design.

However, Britnell also acknowledged that good design needs to be used well: "We succeeded in the architectural design.....but we failed, perhaps, in changing completely the clinical behaviours of the medical and surgical staff who used it. So it was a very, very bold attempt to try to use the physical design to support and also lead clinical process re-engineering."

"The greatest danger for most of us is not that our aim is too high and we miss it, but that it is too low and we reach it."
Michelangelo

However, all these architectural concerns are now shot through with the thread of rising anti-microbial resistance and its increasing implications for infection control. So in this issue of Looking Deeper we've chosen to put a spotlight on some of the ways good design can play a part in optimising healthcare.

In our interview with Suzanne MacCormick we hear how the involvement of a professional healthcare planner early in the procurement process ensures that clinically-led design will deliver best practice compliant solutions.

We also feature new research that highlights the role of design in reducing splashing — limiting the dangers from potentially contaminated water droplets reaching vulnerable patients or nearby equipment — and we also look at how innovative devices such as novel 'plasma pockets' could help reduce infection.

Moving on from design, we spend time behind the scenes with a water safety group to find out how colleagues from different disciplines collaborate to ensure safe water in healthcare facilities.

Last, but not least, this issue carries the second in our exclusive 'Back to Basics' series — with our supplement on the facts behind Legionnaires' disease, its causes and how to prevent it.

Contents

Would you like to receive a regular copy of this journal?

To receive a copy or online version, please email:

editorial@lookingdeeper.co.uk

Editorial Contributions

Suzanne is the associate director of healthcare advisory services at WSP. She joined WSP in 2018 after over 20 years running her own healthcare consultancy. She has spent much of her career championing the delivery of clinical excellence and she uses her expertise as a clinical planner to underpin the delivery of strategy, business case and estates development, to ensure robust solutions that meet the brief and exceed expectation. She has taken several organisations through capital project development from inception to delivery and has shown them how estates can be an enabler to deliver their clinical aspirations.

Suzanne MacCormick

Noemi is the founder and chair of the Masters in Industrial Design, with a focus on medical and social design, at the Technion, the Israel Institute of Technology. She has previously held the chair of industrial design at the Faculty of Architecture and Town Planning in Haifa and served as the director of the Hyperbaric Research Unit of the Israeli Naval Hyperbaric Institute (INHI), leading applied and basic research on performance in extreme environments. She is also currently a visiting professor at the University of Venice IUAV, Italy, teaching on design for emergencies and disaster.

Professor Noemi Bitterman

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

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 30 years and on waterborne infection and water management since 2010. She has been a frequent contributor to IHEEM's Health Estate Journal, WMSoc's Waterline and the Clinical Services Journal.

Susan Pearson

In the news...

Canine detectives sniff out *Pseudomonas*

The tense moment when the sniffer dogs are brought in doesn't just happen in the movies — it also happens in clinical diagnostics — because dogs can detect diseases such as cancer, as well as drugs and money. Now, their abilities go a step further – a new scientific study by Imperial College, London, and the Cystic Fibrosis Trust has demonstrated that Bio Detection Dogs have a very high level of accuracy when asked to identify the *Pseudomonas aeruginosa* bacteria associated with the most serious lung infections in people with cystic fibrosis (CF).

If *P. aeruginosa* is not detected and treated early in people with CF it can be hard to clear and can cause significant lung damage. It is particularly problematic in children with CF, but is hard to detect, with some methods of obtaining samples very invasive and uncomfortable. Yet early detection can lead to better long-term lung health.

However, *P. aeuginosa* has a very distinct smell. Published in the 'European Respiratory Journal', the research reveals how the dogs, trained by the charity Medical Detection Dogs, are able to differentiate between ultra-low concentrations of *P. aeruginosa* and other CF bacterial pathogens by sniffing bacteria grown in a nutrient liquid.

Professor Jane Davies, from Imperial College London, said: "This is a really exciting development. Advanced technology to detect infections, for example in breath, has proved difficult so far. The successful training of the dogs on cultured samples will now be used as the foundation for testing patient samples directly."

Single-patient rooms may cut hospital infection rates

Moving to single-patient rooms could significantly reduce rates of hospital-acquired infection (HAI), according to a study in the 'JAMA: Internal Medicine' journal published by the American Medical Association. The report was based on two rooms at a McGill University Health Centre (MUHC) site, in Quebec, Canada, in 2015, where a MUHC Research Institute team identified that rates of both colonisation and blood infections due to vancomycin-resistant Enterococcus (VRE), a common multi-drug resistant (MDR) organism, fell immediately and dramatically after patients were relocated.

The RI-MUHC team conducted a time-series analysis that looked at changes in the rates of several infections over a period spanning 65 months, following a move from the old Royal Victoria Hospital, containing many three to four-person wards, to the new 350-bed Glen site facility, which exclusively features private rooms.

Rates of infection at the Glen decreased by over 70% for VRE, and were clearly in excess of changes elsewhere in Quebec.

Although the study could not prove causation, the changes were so rapid that they seemed likely to be a result of a move — alongside rigorous cleaning, excellent staff hand hygiene and aggressive intervention for outbreaks.

This study provides evidence to support the design of hospitals with single-patient rooms.

Prevention is key – conclusion of water hygiene masterclass

The increased prevalence of multi-drug resistant (MDR) bacteria, many of them waterborne, and emphasis on prevention being safer than 'cure' was the focus of an expert masterclass on water hygiene organised jointly by Armitage Shanks and Pall Medical in St Albans earlier this year.

The speakers included Dr Elaine Cloutman-Green, Lead Healthcare Scientist for Infection Prevention and Control at Great Ormond Street Hospital. She stressed that current risk assessments are not robust enough in preventing infection and highlighted key routes of transmission of bacteria, which include those from basins and taps, from nurses, visitors, patients in bed, showering and from hospital equipment.

Elaine discussed design of en-suite bathrooms and the disposal of patient fluids and other objects into clinical wash hand basins, plus the dangers from unseen risks such as bacteria in water droplets from a basin or contaminated aerosols from toilets, and how these can be mitigated by innovative design.

Elaine advocated a multi-disciplinary approach to water hygiene risk assessments as there needs to be varying expertise present to truly understand the engineering and clinical risks. She strongly recommended that water safety groups (WSGs) be consulted whenever premises are being redesigned or refurbished and risk assessments completed at key stages for all projects.

Professor Martin Exner of the Institute of Hospital Hygiene and Public Health, University Hospital, Bonn, gave the German perspective on evolving microorganism ecology and risks around waterborne HAIs. He noted the last metre of water to a tap spout or shower head as a key infection reservoir for bacterial growth, as are older-style taps with complex components.

In particular, he described waste-water systems as the "gastro-intestinal tract" of any hospital and the most important reservoir of MDR and antibiotic resistance external to the patients themselves.

Martin put forward the RAG (Red, Amber, Green) rating as a useful risk assessment tool and also described how controls for legionellosis should be designed to deliver contamination levels As Low As Reasonably Practicable (ALARP).

The meeting was chaired by leading independent public health microbiology consultant Dr. Susanne Lee.

For information on water hygiene masterclasses in 2020, visit: **idealspec.co.uk/events**

Dates for diaries...

Federation of Infection Societies (FIS) Conference 2019
11-14/11/2019 Edinburgh, UK
microbiologysociety.org/event/

Designing Out 3
20/11/2019 London, UK
wmsoc.org.uk/conferences.php

Antimicrobial resistance in the 21st century: a global threat
28-29/11/ 2019 Panama City, Panama
escmid.org/fileadmin/src/media/PDFs/1Dates_Events/event_flyers/

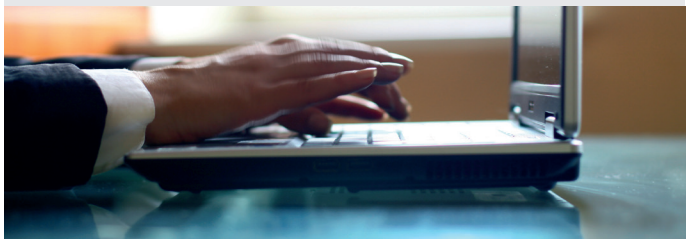
What is the future of water in public health?
12/12/2019 Sheffield, UK
rsph.org.uk/events.html

HIS/PHE Foundation course in infection prevention and control
21-24/01/2020 London, UK
his.org.uk/training-events/

Health Infection Society 40th Anniversary celebration
10-11/06/2020 London, UK
his.org.uk/training-events/40th-anniversary/

Share your thoughts with us in the next issue

We would really value your reactions to this latest issue of Looking Deeper. We'd like to hear from you about what you liked, what you feel could be improved on and what topics you want to see discussed. You can contact us at **editorial@lookingdeeper.co.uk**



Planning for clinical excellence

Susan Pearson talks to clinical planner Suzanne McCormick about the impact of well-planned design in the prevention of hospital-acquired infections (HAIs).

Suzanne MacCormick is an expert clinical planner and associate director of healthcare advisory services at WSP. She has taken several organisations through capital project development from inception to delivery, demonstrating how estates can meet briefs to exceed expectations in delivering clinical excellence.

Issue 3 of Looking Deeper emphasised the importance of good design in improving hospital water. Here, Suzanne outlines how the inclusion of robust clinical planning at an early stage in the design and procurement of new healthcare facilities and buildings contributes a major role in optimising water safety to protect patients from waterborne infections.

Why should a clinical planner be involved in the procurement/design process?

The role of a clinical planner is to ensure that the design of a new facility or building, or refurbishment, is fully compliant with guidance and best practice, and wrapped around excellence in clinical delivery.

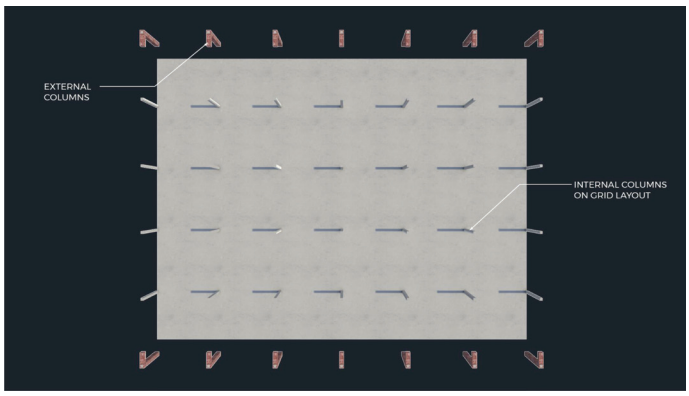
The clinical planner will ideally be engaged at the inception stage, either directly by the NHS Trust or by a team bidding for a project. They will work with the clinical teams to develop the clinical model on which the business case would be based before moving on to the tender and procurement stage. The planner could also be brought in at a later stage to carry out a 'sanity' check on plans and designs already drawn up, carrying out core checks to ensure that the design 'flows' and that subsequent problems are unlikely to arise. It is not unusual for a planner brought in at this later stage to find that the designs and plans require amendments to ensure that best practice on clinical delivery is followed.

Once the clinical model has been developed, the clinical planner will work with the clinical and infection control teams to put together detailed service descriptions that underpin both the operational delivery and the procurement brief. This ensures that core objectives are clearly stated, can be met, and will deliver best practice solutions through clinically-led design. These are then tested to ensure current constraints will be resolved, the requirements of the clinical model met and future aspirations delivered.

Clinical models should include future considerations, especially since rapidly developing technology now means that the way healthcare is delivered is likely to change radically. For example, in out-patients, as personal data from smart devices such as fitbits could now be uploaded, the patient will become the point of care, reducing the numbers of out-patient appointments needed. So a building planned today needs to be flexible enough to meet today's needs whilst including areas that can be easily re-purposed to accommodate the latest technology.

The out-patient department of today could in future be re-designated for intermediate care or assisted living accommodation; there would be considerations for water safety that would not apply to the previous out-patients' facility — the placement of water supply and outlets would need to be taken into account to facilitate any future change of purpose.

Once a design is drafted, the planner can take the team on a 'virtual tour' round the design using BIM (building information modelling software) or 3D to show a realistic model. The clinical and IPC teams will ultimately be responsible for signing off a design, but the planner will have been able to outline every single element to demonstrate how well it works and highlight any aspect that is not delivering as it should, so that the working reality of the design is clear.



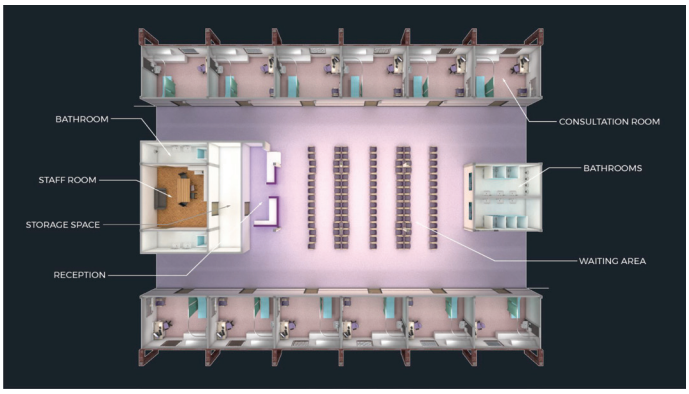
3-D image of grid system, which facilitates subsequent adaptation for alternative usage. Credit: Alioune Mbow & Benjamin O'Connor, WSP

How could design affect water safety?

Best practice demands that wards should have clinical wash hand basins (WHBs) that are not to be touched by patients or visitors. They should be placed so that clinical staff can access them appropriately and they should be involved in discussions about their placement, based on close consideration of how these staff might move around a ward while doing their job. In a four- or six-bedded ward, there should be one clinical WHB for two beds, although there are examples of such wards with a basin next to each bed. A basin for use by visitors should be situated outside the ward entrance, while mobile patients would use the WHB located in the ward bathroom.

However, patients need to be educated about where they can wash their hands, which is a difficult task as nursing staff are often too stretched to have time to do this, or are reluctant to 'nag' patients, or may not fully understand the significance of using different basins.

Future design options might include different colour basins for different usage or different coloured panels behind basins — while an advanced technological solution could provide basins that can only be operated by clinical staff via a 'smart' staff name badge.



3-D image of an out-patients clinic built on a grid system as in previous image. Credit: Alioune Mbow & Benjamin O'Connor, WSP

Are there problems that crop up in the design process?

Conversations between the planner and the clinical teams and the prevention and control of infection (IPC) teams working on a procurement brief always need to be sensitive about listening well to concerns and taking into account the professional experience of professionals who are used to decision-making.

The degree of competence both between and within organisations varies enormously. Some Trusts may have a whole infection prevention and control (IPC), team, while others may only have one senior IPC person whose knowledge of regulations and guidance is assumed and on which the IPC element of procurement rests. It is crucial that these standards are interpreted correctly — yet sometimes this 'translation' can go awry. A good clinical planner will be highly competent in the area of IPC and will be able to advise and act as a conduit between the design team and the clinical team to ensure a compliant, safe design.

Can the costs of a pleasant patient environment take away from the budget that influences safety?

The guidance should ensure that the procurement process includes clauses that guarantee that safety is never compromised. At the start of the procurement process, the cost consultants should always look at the highest cost elements in a procurement brief in relation to the elements that must be protected.

However, aesthetic considerations do not always have to cost more. For example, simple strategies such as utilising attractive furniture and pleasant matching colours can make a huge difference; use of colours that make people feel good, or are calming, such as lilac, are a "really easy win" in terms of creating an appealing patient environment. Conversely, certain colours usually considered "cheerful" can have the opposite effect, for example, yellow can make patients more irritable, can make babies cry more and induces migraines.

The introduction of light wells that pour daylight or simulated daylight into core areas is another strategy that creates a more pleasant healing environment.

Conclusion

Clinical planning is an important part of healthcare design that needs more recognition and would benefit from a recognised qualification. In addition, architects involved in healthcare design can range widely in their understanding of some of the issues discussed above, and the introduction of some specialist training would be useful.

If a clinical planner is not involved, the design/procurement process should always have checks; "a building should never get to the stage where it's designed in such a way that there are risks. All of those risks should be precluded through smart design."

Design options might include different coloured panels behind basins to signpost different usages

Smart basin design cuts harmful splashing

A new study demonstrates that novel wash hand basin design can reduce splashing when compared with more conventional basins.

Splashing from wash hand basins (WHBs) is now widely recognised as a potential risk in healthcare situations as water droplets have been shown to travel up to two metres, possibly reaching vulnerable patients or care residents, or landing on nearby surfaces and equipment. As we've previously covered in some depth in Looking Deeper, waterborne healthcare-acquired infections (HAIs), such as *Pseudomonas aeruginosa* and *Legionella pneumophila*, may grow on WHB surfaces and in WHB drains if any waste has been discarded in these basins; where there are high levels of bacteria, small droplets in splashed water could be highly contaminated and dangerous.[1]

However, the design of WHBs can play a part in how much splashing occurs and how far water droplets might travel. For example, taps arranged directly above a drain outlet can cause greater splashing back than water that hits a basin surface,[2] while tap outlet fittings without flow straighteners, which are increasingly used to reduce biofilm formation inside taps,[3] may increase the risk of splashing as the water hits the basin.

Here we look at results from research investigating the ability of a novel splash-reducing basin to reduce droplet formation under simulated hand washing conditions.[4]

Methods

Basins

The WHB under investigation was compared with two alternative WHBs commonly used in healthcare. All three had ceramic glazes and drains located at the rear of the WHB.

- Basin A: hydrophilic glaze, which reduces the opportunity for bacteria to stick to a basin, and moulded ceramic fin designed to reduce splashing by creating shallower angles at which water hits the basin. The uppermost rims at the edges and back of the basin were thinned and rounded compared to conventional basins to allow greater surface area within the basin bowl. Reduced flat surfaces at top of basin to reduce stagnant water formation
- Basin B: similar shape to Basin A but with smaller surface area in basin bowl and more flat surfaces at top rims
- Basin C: rounder design with smallest surface area in the basin bowl and greatest surface area at top rims.

Test system

The study took place in a 2 x 2 metre test chamber lined with polythene sheeting on the floor and walls to catch water droplets. WHBs and taps were placed to allow a distance of 2 metres to the front and to one side of each WHB.

Water droplet (splash) testing

Tap water was coloured with a fluorescent dye to allow visualisation with ultraviolet light and the surrounding floor was covered with absorbent paper to capture splashed water droplets. The WHBs were tested with and without a nurse washing her hands. In the no hand washing test, the tap was run for 30 seconds with uninterrupted water flow. With hand washing, a nurse wearing protective overalls, gloves and a visor washed their hands following the World Health Organisation (WHO) seven-step hand washing guidelines for healthcare. A fall-out period of one minute after each test allowed water droplets to settle on the floor.

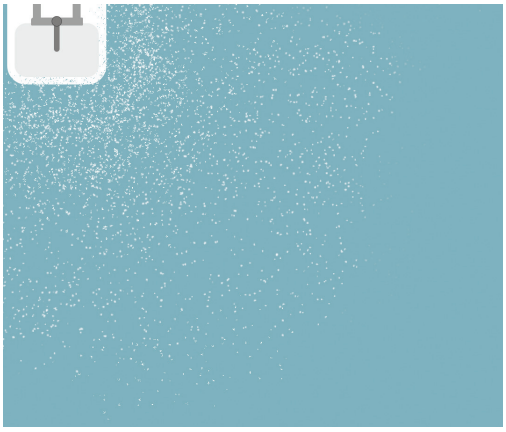
Each WHB was tested three times with and without hand washing and was cleaned between each cycle to remove any residual fluorescence.

The fluorescent water droplets settling on the floor were photographed immediately after each test before being counted, categorised by size and the distances travelled measured from the centre front of each test basin.

Results

Floor droplets after flushing

Droplets were evenly distributed on the floor to the front and sides of all three WHBs when taps were run, or "flushed", into the basin with no interruption, and small droplets (<1 mm) were predominant with all three WHBs (73-86% of droplets — see Table I). The number of small droplets decreased over distance for all the WHBs,



Basin C: Splashing pattern from flushing only

whilst droplets of >5 mm were found to spread further. Basin B produced the highest number of droplets of all sizes, with high numbers of large droplets (>5 mm) and the furthest droplet spread, up to 202 cm from the front of the basin.

Basin C produced significantly fewer droplets than Basin B with the furthest droplet found at 172 cm from the front of the basin.

Basin A reduced the total number of droplets on the floor by 95% when compared with Basin B; however, the difference from Basin C was not significant. The furthest distance a droplet travelled from Basin A was the least of all basins (129 cm).

Floor droplets after handwashing

Splashes reached the nurse's overalls from all three WHBs, but could not be quantified due to their high numbers. Two droplets were found on the nurse's visor in two of three tests with Basin C. The presence of the nurse blocked splashes from reaching the floor directly in front of all the WHBs.

The basins again produced mostly small droplets. Although fewer droplets were found on the floor with Basins B and C with hand washing when compared to flushing only, no significant difference was found with Basin A. More large droplets (>5 mm) were observed from Basin A with hand washing than without.

Basin B produced the most observed droplets. Fewer droplets were observed with Basin A when compared with Basins B (mean 81% fewer) and C (mean 45% fewer).

Basin A: Splashing pattern from flushing only

Conclusions and recommendations

- Droplets travelled over 100 cm from all the WHBs and up to 202 cm with Basin B
- Basin A demonstrated a reduction in the total number of droplets observed with no hand washing when compared with Basin B. Numbers of droplets of all sizes were fewer than with Basins B and C and few large droplets were produced
- The furthest distance that droplets were observed was shortest with Basin A
- Fewer droplets were observed on the floor after hand washing with Basin A than with Basins B and C. This is a repeat of the results.

Overall, when no hand washing was involved, the conventional WHB produced >1000 droplets, which were found to spread further than 2 metres. The novel basin (A) significantly reduced the number of droplets formed during hand washing and reduced the distance spread.

Table 1: Average number of droplets on floor surfaces following hand washing and flushes with each basin

	Flush (30 seconds without hand washing) Distance travelled from basin				With hand washing Distance travelled from basin			
Droplet size	0-50cm	50-100cm	> 100cm	**Total**	0-50cm	50-100cm	> 100cm	**Total**
				Basin A				
< 1mm	145	49	15	**209**	310	48	0	**358**
1-5mm	23	17	13	**53**	29	26	0	**54**
> 5mm	0	0	1	**1**	30	21	1	**53**
Total	**168**	**67**	**29**	**263**	**369**	**95**	**1**	**465**
				Basin B				
< 1mm	3446	1101	197	**4744**	1649	387	7	**2043**
1-5mm	121	250	192	**563**	100	102	7	**210**
> 5mm	31	198	330	**559**	95	121	38	**254**
Total	**3598**	**1549**	**718**	**5865**	**1845**	**610**	**52**	**2507**
				Basin C				
< 1mm	852	122	7	**980**	561	79	2	**642**
1-5mm	85	69	5	**160**	52	19	0	**71**
> 5mm	28	47	12	**87**	89	35	2	**126**
Total	**965**	**238**	**24**	**1227**	**702**	**134**	**4**	**839**

The distance travelled was measured from the front centre of each basin. Standard deviations not shown.

Where fewer droplets were observed with Basins B and C after hand washing, this may be because high numbers of splashes land on users during hand washing.

With all the basins, some aerosols formed may have remained suspended in air or some droplets may have been too small to visualise by the methods used. Droplets could also have been formed directly from the outlet — so a proportion of detected droplets may not be influenced by basin design.

The use of partitions or placement of basins further away may reduce the risk of contamination from splashes up to 2 metres from beds and equipment.

Numbers, materials and methods

- Taps: Markwik21+ (Ideal Standard, UK) mixer tap with single-bore outlet fitting and thermostatic mixer valve set to the midpoint, mounted to regulation 20cm above top surface of each test basin
- Water circulated at room temperature, pumped at flow rate of ~ 8 L/min
- Water dyed with fluorescein (10 ppm) (Cole-Parmer, UK)
- Ultraviolet light wavelength used for visualisation: 365nm
- Droplet sizes counted: <1 mm, 1-5 mm and >5 mm diameter
- Counting and sizing automated using Photoshop CCPro, Adobe Systems (CA, USA) and manually verified
- Data analysis: means compared by one-way analysis of variance (ANOVA) performed using RStudio software (Boston, MA, USA) and differences considered statistically significant when $P<0.05$
- Mean hand washing time: 28 seconds (range: 25-30 seconds, σ:1.8).

References

1. Muzslay, M. *et al* "ESBL-producing Gram-negative organisms in the healthcare environment as a source of genetic material for resistance in human infections", *J Hosp Infect* **95**:59-64, 2016.
2. Hota, S. *et al* "Outbreak of multidrug-resistant Pseudomonas aeruginosa colonization and infection secondary to imperfect intensive care unit room design", *Infect Cont Hosp Ep* **30**:25-33, 2009.
3. Cristina, M.L. *et al* "The impact of aerators on water contamination by emerging gram-negative opportunists in at-risk hospital departments" *Infect Cont Hosp Ep* **35**(2):122-9, 2014.
4. Yui, S. *et al* "Evaluation of droplet production by a new design of clinical handwash basin for the healthcare environment", *J Hosp Infection*, **103** (Issue 1): 110-114, 2019.

Design solutions for mu

Innovative technological solutions and new design concepts in the prevention of healthcare-acquired infections was the focus of a well-attended workshop at the recent European Healthcare Design 2019 conference.

Healthcare-associated infections (HAIs) are now the most frequent adverse events in healthcare delivery worldwide and are becoming ever more dangerous as multi-drug resistant (MDR) bacteria proliferate and treatment options shrink. With deaths from MDR HAIs in Europe at 25,000 a year, and growing, the healthcare costs and productivity losses for the EU alone are now estimated to be in excess of £1.3 billion a year.

Wash hand basin design

Looking at how design can impact HAI reduction, independent microbiology consultant Elise Maynard put forward a case study from a healthcare site showing how well-designed wash hand basins (WHBs) and taps can reduce *P. aeruginosa* contamination.

Designed around 20 years ago, prior to publication of current guidance, the facility has ten in-patient rooms, a chemotherapy area for out-patients and a day centre. Water safety is looked after by a water safety group (WSG), as advocated by the WHO (see page 12) and HTM 04-01 "Safe water in healthcare premises". The group comprises the landlord of the building, an independent advisor, facilities managers (FM) and maintenance contractors, plus various tenants, including different commissioning groups, hospital trusts and healthcare workers.

The healthcare site is monitored for Legionnaires' disease, as part of the water safety plan (WSP), but was not being checked for *Pseudomonas aeruginosa*. The WSG felt that the patients were sufficiently high risk to warrant a testing schedule and a plan was put in place to review areas where users would be most at risk from *P. aeruginosa* — i.e. the patient rooms and chemotherapy room.

Of around 100 samples, 90% were found to be negative. This low 10% positivity indicated that the overall water system was clean, but the critical points, were tracked down to assisted baths and three clinical WHBs in patient rooms. It was noticed that the contaminated taps were positioned directly over

lti-drug resistant healthcare-acquired infections

the WHB drain and these were replaced in the correct orientation with a newer hygienic clinical tap, which is easier to clean and maintain.

Specialist cleaning was required for the assisted baths. The cleaners had notified the WSG that one or two WHBs were not draining when being cleaned. Mitigation involved replacing U-bends and putting up notices for patients and visitors not to dispose of any waste in the WHBs.

This is where smart design comes into play: by fitting a sink designed with a back drain to minimise splashing and fitting an off-set tap that incorporates a thermostatic mixing valve and can easily be removed and taken apart for cleaning (see Figure 1).

Figure 1. Replace A with smart design B.

Novel design solutions

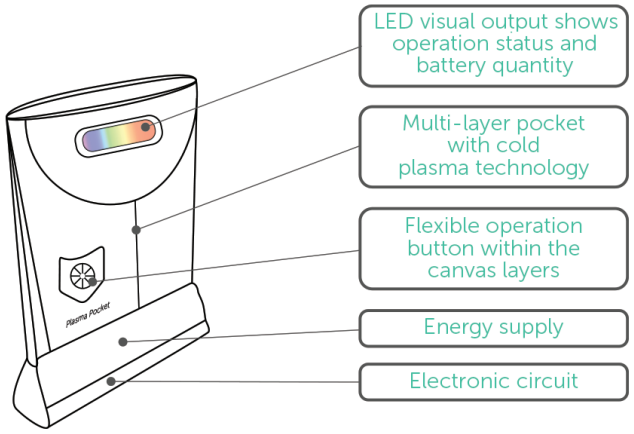
In a second presentation Professor Noemi Bitterman presented novel approaches to design solutions for reducing infection in healthcare facilities.

Professor Bitterman, founder and chair of the Masters in Industrial Design, (with a focus on medical and social design) at Technion, the Israel Institute of Technology, described several innovative designs that emerged from a task set for a group of students of industrial design, engineering and architecture. They were asked to think 'outside of the box' by drawing on diverse concepts, such as existing technology used in other contexts, existing patents and even nature, to influence novel design for infection control. For example:

A hand hygiene solution based on innovative plasma based devices: Human factors can play a part in low compliance: it takes time and training to wash hands properly and repeating 40-50 times a shift and frequent use of alcohol gels can lead to dry and peeling skin. The aim was to design a device that would increase compliance, reduce skin damage, decrease time taken and become 'natural' rather than 'intentional' to use.

The students came up with the idea of a 'plasma pocket', a small portable cleaning device utilising 'cold plasma', a partially ionised gas with a proportion of charged particles close to 1%, which is used in various equipment to kill bacteria, and could be used at room temperature without damaging the skin. The 'pocket' is introduced into clothing, with a button to a battery that would provide a nine hour supply, long enough for a shift. By simply slipping hands into a pocket, its use would be intuitive rather than 'intentional' (see Figure 2).

Figure 2. Innovative Plasma Pocket design for intuitive hand cleaning.



Smart rails: A large variety of pathogens are found on hand rails and bed rails in hospitals. The students' ideas focused on delivery of hand disinfectant solution through pores in the rails themselves, with a sensor working out when the rail is being held. A door handle utilising this type of technology is already available. A second group put forward the idea of a 'smart' rail incorporating a small 'robot' that moves inside the rail to exude a solvent that contains particles of silver, which is antimicrobial.

The workshop was organised by Armitage Shanks.

Inside the Water Safety Group

Water safety groups lie at the heart of the infection control strategies keeping healthcare patients safe from waterborne diseases. Susan Pearson attended a water safety group meeting to find out how they work in practice.

A water safety group (WSG) is a multi-disciplinary team whose collective remit is to create, deliver and maintain a water safety plan. Members of the team should ideally represent every speciality that might be found in a healthcare facility – from facilities personnel to clinicians and nursing staff. A water safety plan (WSP) is a comprehensive hazard management approach towards each stage of delivery of water from main supply to end user, a concept first highlighted by the World Health Organisation (WHO) at several expert review meetings between 2000 and 2001. The WHO went on to formalise the WSP approach in its 2004 'Guidelines for Drinking Water Quality', while the collaborative approach of WSGs to deliver WSPs was outlined in its 2011 'Water Safety for Buildings' guidance.

In the UK, the first water safety guidance in healthcare to be built around WSGs was introduced with the 2013 edition of the Approved Code of Practice (ACOP) (L8) for the prevention of Legionnaires' disease and HTM 04-01, the first guidance on water safety in relation to other waterborne pathogens, such as *Pseudomonas aeruginosa.*

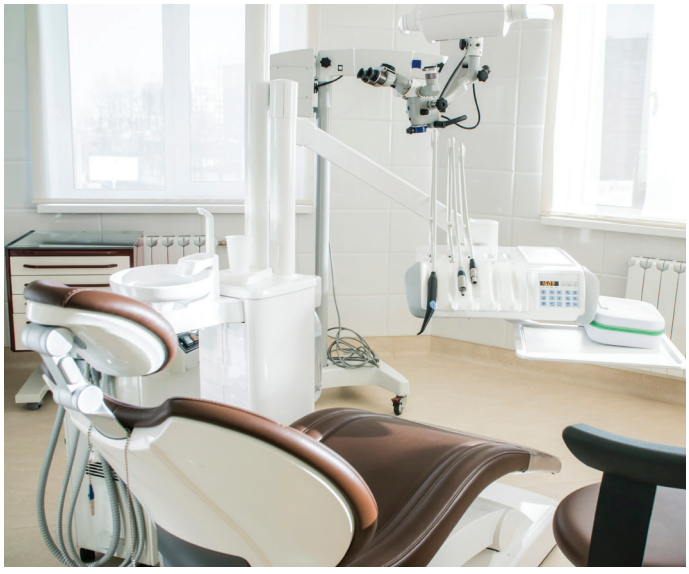
This article provides a flavour of the types of issues a WSG group might discuss, based on a WSG quarterly meeting at a large NHS Foundation Trust Hospital.* The meeting was attended by the (interim) Head of Estates and Chair of the WSG; the Trust Authorised Engineer (AE) for water; the Senior Officer for Estates and Trust Authorised Person (AP) for water; a member of the Health and Safety team; an independent microbiology consultant; the Senior Nurse for infection prevention and control (IPC); a Consultant medical microbiologist; and the Deputy Head of Hotel Services (cleaning etc). Minutes were taken by a member of the admin team.

While relaxed and friendly, with the cooperative motivation of the group very evident, the meeting was carefully structured with a formal agenda, including a detailed follow-up on previous action points and specific reports from the AP, such as water sampling results for *Legionella* and *P. aeruginosa.*

Some of the specific issues discussed by the group included:

Satellite sites

A topic that was discussed at some length concerned water safety in various 'community', or 'satellite', sites located beyond the main Trust site, but still falling under its remit. These are a common feature of many NHS Trusts as they provide services that may be attended by Trust patients or serviced by Trust personnel and are therefore covered by the 'parent' Trust's WSP. They include some units housed in buildings that are not owned by the Trust. In these cases, the Trust's WSP applies only to those areas or equipment required for units under the Trust's administration, for example dental, maternity and dialysis facilities, but does not apply to the entire building.



When the building is under different ownership, such as a landlord, it will be the landlord that is responsible for the overall provision and management of the drinking water supply, the showers and so on. For example, the dental unit would expect the landlord to provide safe water for its showers and hand washing facilities. However, where the Trust owns the dental equipment, then its WSP will cover the *Legionella* management of equipment such as dental chairs.

The landlord should have a WSG managing properties that house these NHS services, but these are often overlooked.

This WSG group reported issues with communication at some satellite sites. The water AP felt that landlords had not always provided information to the WSG to confirm that all their water systems were being managed 'robustly'. He also reported concerns from a site containing a maternity unit where the Trust WSP covers the birthing pools, but where the site landlord is not evidencing management of the building as a whole. More positively, the AP described a much closer working relationship with one group of sites that has its own WSG, on which he now sits. This gives him access to this group's action plans and *Legionella* tracker documents, which had not previously been shared with the main Trust.

The group highlighted the need for regular feedback from community WSGs, and for more emphasis on establishing connections with those responsible for water safety at remote sites in order to understand any risks. They also discussed obtaining legal advice to establish the Trust's responsibility in the event of a Trust patient or staff member contracting an infection associated with water systems at one of these sites.

Assisted baths

The microbiology consultant stressed that infrequent use of assisted baths often results in high counts of *Pseudomonas aeruginosa* and they should therefore not be used in augmented care areas. For example, in an elderly care unit, patients with skin disorders such as open leg ulcers would be particularly at risk.

The group established that there was an assisted bath located in the dermatology unit, where it would be in constant use, and another in the cardiac unit, where it would be less used. The importance of routine testing was emphasised and a discussion initiated about removing these baths altogether. However, if the baths are removed, the team noted that this would need to be done in such a way as to prevent 'dead legs'.**

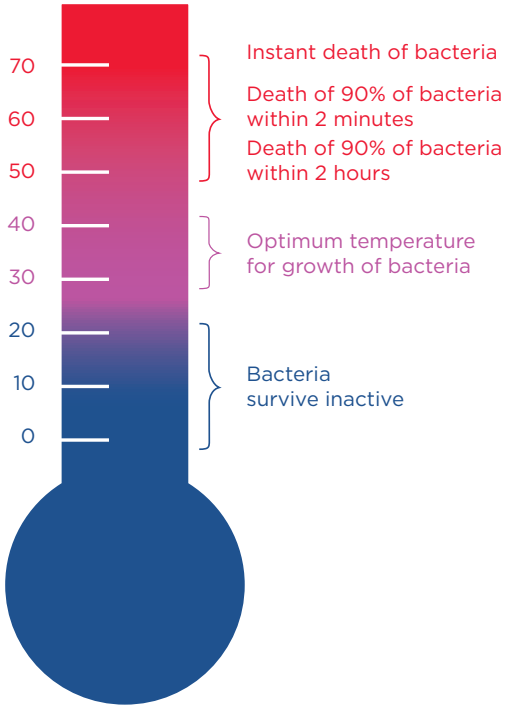
Pseudomonas aeruginosa

It was agreed that the clinical staff in those units would be approached about removing them. It was concluded that if the baths were to remain, further sampling would be needed, alongside a review of the water risk assessment (RA). However, if the sampling were to come back as positive, there would be compelling evidence for the baths' removal.

Water storage systems

Annual inspections of water storage systems carried out in April highlighted water temperature issues in a number of cisterns. These were generally due to lack of turnover in tanks that are overly large for the areas they serve. All these systems were discussed, but of most concern was the tank serving the accident and emergency department (A&E). The water levels in this cistern have already been lowered as much as possible, but it remains hugely oversized. The inlet supply temperature was logged as 35.3°C, with the water stored at 29.3°C because the soft water main increases in temperature as it travels through the duct to reach the tank. Water should be stored below 20°C to prevent *Legionella* proliferation, as these bacteria multiply rapidly between 20°C and 45°C.

The likely cause of the problem was identified as a lack of lagging in the pipe ducts leading to the tank, which contain asbestos and are therefore inaccessible.



Possible remediation would be to remove the tanks to divert water from the mains directly to plate heat exchange heaters so that only hot (pasteurised water over 70°C) water is fed into the system.

Alternative solutions included: employing specialist contractors who might be able to access the ducts to lag pipe work and engineering solutions, such as installing a smaller tank inside the main tank.

In the meantime, the tank will be sampled monthly until an engineering solution is found.

Use of POU filters

A question arose over the need to continue testing in areas with outlets that had previously been contaminated with *Legionella* and are now fitted with point-of-use (POU) filters. Remediation has been carried out in these areas and although *Legionella* testing has now been providing clear samples, there is a concern about removing filters in augmented care areas.

The group looked at the costs of continuing to take monthly samples with each sample taking 10-15 minutes of an operative's time.

It was agreed that sampling would continue, but be reduced in frequency, with the aspiration being to get a series of three clear samples before removing the filters and carrying out a full RA on each wash hand basin. As showers are a greater risk, it was agreed that filter shower heads would be kept in place.

The microbiology consultant also pointed out that risks to patients where the room has lobby areas are minimal, as they are used for staff hand washing only. In the meantime, there are issues around sampling in patient rooms as nursing staff are worried about patients being disturbed. However, patient showers can be tested as bathroom doors can be closed during sampling.

The issue will be re-visited by the WSG in the next quarter when more data will be available. In the interim, the Director of Nursing will be contacted by the WSG to establish the IPC team's risk appetite for removing POU filters in augmented care areas.

Capital projects

Unfortunately there was no representation from the Projects team at this meeting, but on previous occasions they had noted a number of milestones that will need the WSG's input, for example, for risk assessments and flushing regimes.

*The NHS Foundation Trust discussed in this article cannot be named for legal reasons. **A 'dead leg' is a plumbing 'dead end' where an out-of-use pipe, basin or shower has been blocked leaving an area of stagnant or slow-flowing water.

Worries with the (hospital) waterworks: problems, practices and pragmatic solutions

Healthcare Infection Society (HIS) Spring Meeting, May 2019, Royal College of Physicians, London.

The HIS education committee and meeting convenors, Dr David Harvey of the Wirral University Teaching Hospitals NHS Trust and Dr Mike Weinbren of Sherwood Forest NHS Foundation Trust put together a packed and excellent programme, with a long list of eminent speakers. A number of the submitted abstracts were presented as both oral communications and posters, some of which are detailed below.

The oral presentations covered a variety of subjects related to contamination and control of water, from engineering through to the relative value of clinical screening. The main focus was on transmission of multi-drug resistant (MDR) bacteria in high-risk areas such as augmented care and intensive care units (ICUs).

Dr Joost Hopman of Radboud University Medical Centre delivered the keynote lecture, controversially discussing the "Waterless ICU". In practice, this means keeping the patient safely away from water sources such as taps and drains, which can become contaminated though improper use, and having dedicated hand-wash stations just outside patient ward or rooms.

Dr Mike Weinbren discussed critical control points for water management in augmented care areas, where there are a variety of new problems related to MDR. It would appear that antibiotics are being absorbed into biofilms. Mike compared the HTM 04-01 guidance with HSG 274; the latter has a lot of industry support but there is a need for competency-based training on the critical control points.[1,2]

Legionella pneumophila serogroup 1 can be found pan-hospital, as are carbapenemase-producing Enterobacteriaceae (CPE), but opportunistic pathogens are typically niche within water distribution systems (WDS). He stressed: the water safety group (WSG) should provide an expert opinion and define areas of responsibility; the *Legionella* risk assessment and assessor needs to be competent; the WSG needs to review in detail; and risk assessments also need to be done at key stages especially at the design stage.

With regard to controls – temperature and flushing are key, but other measures such as point of use (POU) filtration have certain advantages. The wash hand basin (WHB)'s sole purpose should be for decontamination of hands and although some modern WHBs have better designs, training is still essential. Contractors and installers should be audited and relevant materials such as You-tube videos should be provided for cleaning staff. Germany, for example has a "safe sinks" sign. Mike also advised considering removal of WHBs in drug preparation areas and considering microbiological sampling as a critical control point. He raised the question of whether we should be developing regional experts to assist WSGs.

Dr Anand Kamalanathan (Wirral University Teaching Hospital NHS Trust) followed on by presenting his experience of WHB and *P. aeruginosa* across seven years in his neonatal intensive care unit (NICU). He noted that publication of the HTM 04-01 Addendum in 2012 was a wake-up call. His unit reviewed historical data and found zero clinical isolates in NICU, but unfortunately this situation was not to last. They created a cleaning procedure involving regular cleaning with regular staff, replaced all WHBs and changed patient screening, as well as reviewing other potential sources. Their incidence baseline is now extremely low.

Dr Elizabeth Darley, (North Bristol NHS Trust) described an unusual colonisation and infection episode on an NICU, which resulted in sterile water being used for neonatal skincare plus single use breast pumps. In addition, the unit cleaned all contaminated taps and outlets and installed POU filters, with restricted access. Neonatal screening showed intermittent colonisation but strain types did not match positive outlets or other babies in the same room. There was a resource implication for screening that was not giving helpful

information, so it was stopped in 2015 with no additional infections noted since. Water sampling, however, continues on a rolling programme.

Dr Ken Agwuh (Doncaster and Bassetlaw Teaching Hospitals NHS Foundation Trust) looked at practical aspects of sampling water in the hospital setting. In-house *P. aeruginosa* testing was outsourced, but all outlets came back positive, yet in-house sampling and testing came back negative. An in-house team was set up for sampling with controlled collection.

Elaine Moloney (Dublin Dental University Hospital) discussed U-bends, which are out of sight and out of mind. The effectiveness of a novel system for decontamination has been studied, demonstrating good success. One of the unexpected outcomes was that the *P. aeruginosa* strains involved appear to adapt to the wastewater pipework.

Elise Maynard (Independent Consultant) discussed the complexities of performing water hygiene risk assessments and the importance of well-trained and competent multi-disciplinary teams.

Guidance will be developed by the British Standards Institute to assist in the future.

Take aways from the day:

- Rethink the built enviroment
- Do not misuse wash hand basins
- Pathogens can be dispersed via a variety of routes
- Innovative new WHB designs can help
- Engineering solutions may help
- Established biofilm is highly tolerant to remedial disinfection
- The WSG and WSP can be highly effective in water management

References

1. www.gov.uk/government/uploads/system/uploads/attachment_data/file/140105/Health_Technical_Memorandum_04-01_Addendum.pdf
2. HSG 274 Part 2: www.hse.gov.uk/pUbns/priced/hsg274part2.pdf