Looking deeper

THE JOURNAL OF THE WATER SAFETY FORUM

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Inside this issue

Advanced healthcare solutions from Armitage Shanks

The natural world – threats and inspirations

Looking Deeper Editor, **Susan Pearson**

The dust has well and truly settled on November 2021's COP26 international conference on climate change since the intense UK media spotlight on the issues has receded as the news cycle moves on.

But committed international focus and action must continue in order to halt the acceleration of global warming.

Rising temperatures, erratic weather and flooding may generally still be perceived as a long way from the doors of UK healthcare facilities and care homes, but since climate change is not going away the potential effects for water safety in healthcare need to be considered on an on-going basis.

Our main feature on pages 6-9 looks into this, exploring what problems could be encountered and suggestions for solutions that might resolve these. The article sets out how rising temperatures may lead to higher water temperatures, in turn potentially increasing risks from waterborne pathogens such as *Legionella* and *Pseudomonas*.

Alongside climate change, antimicrobial resistance (AMR) poses a major threat to human health worldwide; a recent report published in the Lancet[1] estimated that 1.27 million deaths in 2019 were directly attributable to bacterial AMR. The leading culprits included the water-associated bugs *Klebsiella pneumoniae, Acinetobacter baumannii* and *Pseudomonas aeruginosa.*

"In addressing climate change by reducing emissions, we are preventing the worsening of health conditions around the world..."

Christina Figueres, Former Executive Secretary, UN Framework Convention on Climate Change

Our article also considers the effect of erratic rainfall and disrupted water supplies as a driver of (AMR). Polluted water sources such as lakes, rivers and streams can become reservoirs of AMR pathogens – with 'unhealthy' water supplies making prevention of hospital-acquired infections harder to keep on top of.

Rising AMR will inevitably be one of the factors informing how risks from the healthcare built environment might be minimised. Looking at planning in hospitals of the future, we investigate the role of high tech innovation in reducing transmission of healthcare-associated pathogens via bactericidal or 'self-cleaning' 'smart' surfaces. The natural world – insect wings and metallic ions – may prove inspiring solutions (pp12-14).

In the meantime, hospital cleanliness remains the crucial factor in preventing hospital-acquired infections. The new National Standards of Healthcare Cleanliness 2021, launched at the end of last year, provide a significant update on previous instructions and guidelines, which we outline on pp10-12.

1. "Global burden of bacterial antimicrobial resistance in 2019: a systemic analysis" *Lancet* **399** (10325): 629-655, February 12, 2022.

Contents

Editorial Contributions

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

Elise is an independent consultant to the water and medical devices industries and a former Chair of the Water Management Society (WMSoc). She is a state-registered microbiologist, a BSI committee member and was on the steering group for Department of Health HTM 04-01: Safe water in healthcare premises. Elise is a Fellow of WMSoc, IBMS, IHEEM and also of the Royal Society of Public Health (RSPH), where she is an active member of the water special interest group. She chairs and presents at numerous international conferences.

Elise Maynard

Darren is a Professor in Health and Environment in the Centre for Research in Biosciences and the Institute for Bio-Sensing Technology at the University of the West of England, Bristol. He also contributes to a number of environmental programmes and modules at undergraduate and postgraduate levels within the Department of Applied Sciences. Darren has over 17 years of experience in developing applied technology platforms at the life science/environmental/physical science interface for addressing real-world problems, with current research on interdisciplinary themes addressing the Grand Challenges associated with Health, Agri-Food, Water and Environment.

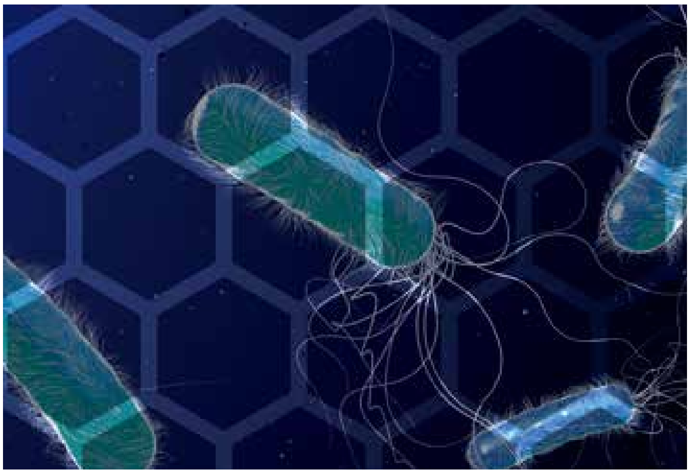
Professor Darren Reynolds

Gordon Nichols is an independent Consultant epidemiologist who has worked for over 50 years within NHS, PHLS, HPA, ECDC, WHO, PHE and UKHSA settings, undertaking diagnosis, surveillance and research, and responding to outbreaks of diarrhoeal diseases, food and waterborne infections and outbreaks, climate change and disease, and cruise ship hygiene amongst other Public Health duties. Gordon was awarded his PHD through Surrey University and has had honorary appointments with Exeter University, UEA, and the University of Thessaly in Greece.

Dr Gordon Nichols

In the news...

Pseudomonas captured in 'honey-trap'



Pseudomonas could be banished from potable water in a literal 'honey-trap' — a novel device incorporating honey, which could be scaled up as a biodegradable, easy-to-use and cost effective sustainable solution for water disinfection.

Utilisation of the process in which bacterial cells have a tendency to be attracted towards specific chemicals — known as chemotaxis — lies at the heart of a *Pseudomonas*-attracting strip dipped in water that can attract and 'trap' the bacterial cells, *in situ*.

The strip integrates a combination of serine, a *Pseudomonas*-specific chemo-attractant, and honey, known as a natural anti-microbial agent found to be an effective inhibitor of *Pseudomonas* biofilms and wound infections.

Researchers from the Amity Institute of Biotechnology at the Amity University in Rajasthan, India, found that dipping the serine side of the strip attracted bacteria so that the porous nature of the strip then facilitated the capture and subsequent diffusion of the bacterial cells towards the honey-impregnated end of the strip.

The strip was dipped in culture from the serine end and after various incubation periods, the difference in bacterial load was confirmed via electrical conductivity culture and absorption spectroscopy. The percentage efficiency of the device is reported as 96% with a log reduction equivalent to 1.6 within a time frame of two hours.

Pandemic behavioural changes cut antibiotic-resistant infections

A fall in antibiotic-resistant bloodstream infections in England in 2020 for the first time since 2016 is likely to have been due to Covid-19 pandemic protections such as less social mixing and enhanced hygiene, and fewer people in hospital, according to the UK Health Security Agency (UKHSA). However, these numbers still remain higher overall than six years ago. UKHSA reported a reduction in bloodstream infections overall, and from *Escherichia coli* and *Streptococcus pneumoniae* bloodstream infections in particular.

Susan Hopkins, chief medical adviser at UKHSA, said: "Antimicrobial resistance (AMR) has been described as a hidden pandemic, and it's important that we do not come out of Covid-19 and enter into another crisis...Serious antibiotic resistant infections will rise once again if we don't act responsibly — and that can be as simple as regular and thorough handwashing."

UKHSA reported that one in five people with a bloodstream infection in 2020 had an antibiotic-resistant infection. This indicates that resistant infections could rise following the post-pandemic years and will require ongoing action.

New Code of Practice on risk assessment for *Pseudomonas aeruginosa*

The British Standards Institution (BSI) has released a brand new standard, BS 8580-2:2022, for the first time putting forward a formal Code of Practice (COP) for risk assessments for *Pseudomonas aeruginosa* and other waterborne pathogens. The new standard complements 2019's BS 8580-1 'Water quality - Risk assessments for Legionella control - Code of Practice.'

BS 8580-2:2022 is applicable to all types of healthcare provision and also other settings, such as educational, leisure and some commercial and industrial facilities. It comprises several sections that cover how to risk assess within each of the different types of setting, as well as a number of very useful informative annexes. One of these details the types of pathogens commonly encountered and their environmental and clinical niches. The others give clear examples of pre-survey preparation, risk assessing in healthcare and one situation for leisure.

The BSI has also produced a 2022 revision of the 2008 BS 7592 'Sampling for Legionella bacteria in water systems. Code of Practice'. This revision expands the original COP to include more information regarding preparation for sampling, training and task risk assessments. It includes more detail on the reasons for sampling and the creation of sampling plans. Additional sections include sampling for gross contamination and commissioning/recommissioning, while new annexes cover sampling for incident or outbreaks and when to use respiratory protective equipment (RPE).

Dates for diaries...

Microbiology Society: Annual Conference 2022
4-7/04/2022 Belfast, UK
microbiologysociety.org/event/annual-conference/annual-conference-2022.html

18th International Conference on Pseudomonas
18-23/04/2022 Atlanta, Georgia, USA
pseudomonasconference.com/

32nd ESCMID Annual Congress
23-26/04/2022 Lisbon, Portugal
escmid.org/dates_events/eccmid/

WMSoc: Compliance is not the goal of risk managment
28/04/2022 On-line water webinar
wmsoc.org.uk/public/index.php/events/927

Health Infection Society (HIS):
40th Anniversary Celebration
19/05/2022 London, UK
his.org.uk/training-events/40th-anniversary/

WMSoc: Which Direction Now? A 360° view of water management
21/06/2022 Fazeley, UK
wmsoc.org.uk/events

IHEEM: Healthcare Estates Conference, Exhibition and Awards 2022
4-5/10/2022 Manchester, UK
healthcare-estates.com or office@iheem.org.uk

Authorising Engineers Conference 'Making The Standard'
6th July 2022 Epsom Racecourse, UK
heem.org.uk/events/authorising-engineers-conference-2022/

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**

Water, water, everywhere?

As climate change leads to contradictory problems –from both rising sea levels and droughts – what will be the impact on healthcare water? And what are the solutions?

Last November's COP26 meeting in Glasgow put climate change into the spotlight as never before, generating weeks of press coverage on an unprecedented scale in the UK. This interest was not just down to our status as hosts: hopes and expectations were running high for countries to make their strongest commitments yet to fulfil the goals laid out at COP21 in Paris five years ago. This 'Paris Agreement' set targets for limiting the increase in global temperatures to well below 2°C above pre-industrial levels, ideally pursuing efforts towards an increase of no greater than 1.5°C.

But was this achieved? By the end of the summit, the 'Glasgow Climate Pact' that emerged "was welcomed by many for its commitment to doubling adaptation finance and requesting countries to present more ambitious climate pledges next year."[1] However, although much was accomplished, it seems unlikely that there was enough widespread agreement reached between countries to make the 1.5°C target achievable.[2]

Was water much discussed? WaterAid CEO Tim Wainwright thinks not, saying there was "not nearly enough" attention given despite the need for urgent action. "The way that climate change affects human beings is almost entirely through water, either too much or too little," he said. "So why aren't we talking about water all the time?"

So, following the outcomes of this latest COP, what might the implications look like for water safety in healthcare?

Warming water and infectious diseases

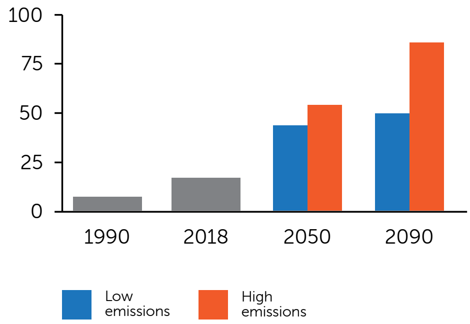
Dr Gordon Nichols, a Consultant Epidemiologist who has worked in public health settings for over 50 years, including for, the World Health Organisation (WHO), has described how climate change is likely to pose challenges to healthcare water in the UK in two ways: rising temperatures may lead to higher water temperatures, potentially leading to greater risks from infectious diseases; while unpredictable weather patterns that could make water supplies erratic will harden the focus already in place on more sustainable water use. In Europe, readings taken between 2000 and 2006 estimated that 15% of the EU land area was already affected by drought.[3]

Speaking at a webinar for the Royal Society for Public Health (RSPH) last summer, Dr Nichols described how despite 25 previous COP international meetings, readings of atmospheric CO_2 at the Mauna Loa Observatory on Hawaii have still steadily increased, from below 320 ppm in 1960 to over 400 in 2020. This has the potential for change all around the world. Once 'tipping points' have been reached "we will not be able to move backwards," he said: Greenland ice sheets could melt and/or there could be a huge release of methane from permafrosts or other sources.

UKCP18: UK climate change projections

- Rainfall will increase in the winter and decrease in the summer
- Sea levels will rise
  - Greater sea-level rise in the south than the north
  - London will have a sea-level rise of between 0.3 and 1.1 meters by 2100
- There will be more extreme weather in the winter
- More intense storms
- Summer rainfall will decrease
- Chance of summer heatwaves increased 50% by 2050

Chance of exceeding Summer 2018 temperature



Credit: Dr Gordon Nichols

In the UK, we will eventually see relatively high sea level rises, more extreme weather in the winter and more intense storms. Summer rainfall will decrease, but where it does fall may be heavier, while chances of summer heat waves could increase by 50% by 2050.

Looking at how weather can affect water-related disease outbreaks, Dr Nichols described how studies that compared outbreaks against rainfall between 1910 and 1999 indicated that 28% of drinking water-related outbreaks were preceded by lower than average rainfall in the three weeks prior to the outbreak. Conversely, 15% of outbreaks were preceded by heavy rainfall in the week before the outbreak. According to Dr Nichols, these results identified the importance of weather, which, he stressed, means that in future water companies will need to factor weather into their risk assessments.[4]

The potential for warmer water in water systems could lead to a rise in incidence of healthcare-significant waterborne pathogens such as *Legionella, Mycobacteria* and *Pseudomonas* spp.

Water supply challenges

Talking about the significance of erratic rainfall, Darren Reynolds, Professor of Health and Environment at the University of the West of England (UWE) in Bristol notes: “Historically [we know] civilisations thrive when they have access to good quality reliable sources of water....[but currently we] sometimes have too much, sometimes not enough. Where it falls really impacts our resilience. Moving forward...we may well get periods of very dry weather, followed by periods of very wet weather, which is equally bad [because] we have ‘catchments’ or reservoirs — no matter how much it rains you only ever have the same ‘container’ to store the rainfall. The really big issue [is] how we...manage our water supply.”

"Water sources are coming under increasing pressure in terms of quality."
Professor Darren Reynolds

While it’s hard to imagine that water supplies could be a problem in the UK, WRAS’s (Water Regulations Approval Scheme) Managing Director Julie Spinks notes that only 0.3% is available for human use. At the Water Management Society’s ‘Water; a precious resource’ webinar in September 2021 she warned participants of the Environment Agency’s prediction of a serious decline in availability of water — but also a significant increase in demand.

Antimicrobial resistance (AMR)

Erratic rainfall leading to cycles of flooding and drought will also put another huge pressure on our water sources. Prof Reynolds highlights the crucial role of water bodies in the carbon cycle — the bacterial communities they contain process and respire carbon. Pollution — including antibiotics that are excreted into sewage and then find their way into ground water — that leaches into our rivers is causing an actual change in their ecological function. And in the UK, “there isn’t one river in England and Wales that meets either good chemical or ecological status.”

Prof Reynolds highlights the resulting connection between polluted rivers and the rise of antimicrobial resistance (AMR). Polluted rivers are a poorly recognised driver of AMR, he says, eventually leading to antimicrobial resistant organisms finding their way into buildings’ water systems, in turn leading to biofilm growth.

He emphasises: “We don't really have as much water available to us as we think — [and those] water sources are coming under increasing pressure in terms of quality and that in turn is absolutely going to affect healthcare settings.”

“We need to understand that those healthcare settings are connected to the outside world... [and] what happens in the outside world matters a lot. If we're going to keep on top of antimicrobial resistance and if we're going to keep on top of preventing healthcare-acquired infections, [we] need to make sure that the water we are supplying to those places is fit for purpose...”

Solutions for healthcare

While facilities managers are already focused on keeping cold water temperatures below 20°C to fend off bacterial growth, this may become more challenging; at the same time pressures to reduce water usage are likely to require new engineering solutions. Everyone interviewed for this article agreed that innovation will be key, but Prof Reynolds also emphasised: “you do need the financial pull...industry can be a very powerful force for change if you get the conditions right. You will also need encouragement from the government as well to nudge those kinds of things in the right direction.”

Fixtures and fittings

According to one marketing executive of a leading sanitaryware company, solutions are already in development (although currently too commercially sensitive to detail). "COP26 has given us an interesting — and critical — puzzle that we have to take very seriously. I believe we have to find new ways of thinking and working — and they're not all obvious yet... [specifically] the materials we use are going to have to change."

Finding new materials for components will be a key challenge. Brass is widely used in healthcare fittings because of its excellent anti-microbial properties, however, global supplies of copper and zinc, from which brass is composed, are shrinking. Increasing demand is leading to current reserves being exhausted, leading to escalating prices for both metals. Part of the demand for copper in particular is being driven by its crucial role in sustainable technologies such as wind turbines and solar panels — yet conversely new copper mines may have major negative environmental effects.[5]

While brass is 100% recyclable and recycled brass from 'retired' taps is often used in new fittings, new designs are likely to reduce copper usage as other more sustainable anti-microbial materials are developed.

Fixtures manufacturers will also need to develop designs that take into account changes in water temperatures and potentially reduced water supplies.

Some manufacturers are reducing the scale of the problem by minimising the distance of the water supply from the end of a tap's spout, the water's journey through the cartridge and spout. A smaller internal bore size allows water to flush through faster resulting in more 'local' pressure, which effectively keeps those surfaces cleaner.

Warming temperatures

Warming water temperatures are already a major challenge in countries such as Australia where ambient 'cold water' temperatures of up to 27°C have been found in some buildings. In future, hospitals may have to address rising temperatures by installing chillers — however, these in turn could have the disadvantage of increasing carbon consumption and facilities' carbon footprints.

As warmer water temperatures may adversely affect the operation of currently available thermostatic mixing valves, fixtures manufacturers may also have to consider warmer incoming water temperatures in new designs for thermostatic controls in taps.

Water usage

The particular need in healthcare for standard maintenance flushing to prevent water stagnation and consequent development of biofilm, with its potential to harbour pathogenic microorganisms, will mean that facilities will be hard pushed to reduce their water usage. If water usage in hospitals does have to be cut there could be scope for reducing flushing in several ways:

- Utilising blasts of high temperature water, an excellent method of removing biofilm — but will require fixtures and fittings that are resilient against high water temperatures
- Electronic programmes built into fixtures and fittings to run automatic periodic flushing: already available, although conversely seen as water wastage and not considered best practice by organisations such as WRAS, for example. These programmes must not be run as a default — the installer must make a conscious decision to switch on the programme to allow periodic flushing. Yet these products must be flushed often enough to prevent biofilm build-up
- Toilets and urinals that reduce the volume of water needed for flushing. Some designs already exist, for example 'hybrid' urinals that incorporate a sensor to detect the concentration of salts in urine to determine the amount of water needed for flushing. However, while this technology meets sustainability requirements (and reduction of water bills in commercial premises), urinals are not likely to be installed in patient areas due to risks from aerosols
- Better design of plumbing systems in new builds to eliminate scope for pockets of stagnant water
- Alternative methods of chemically treating pipe work, either incorporated into the pipe material itself or added

The 6th annual Lancet Countdown on health and climate change report

Published in January 2022, the report tracks 44 indicators of health impacts directly related to climate change.

Highlighting how climate change and its drivers are creating ideal conditions for infectious disease transmission, the report exposes an unabated rise in the health impacts of climate change and a delayed and inconsistent response of countries globally.

It notes that: "Many current COVID-19 recovery plans are not compatible with the Paris Agreement." It demonstrates that "many countries are under-prepared for the health effects of climate change." As the linked Editorial in *The Lancet* notes, while global greenhouse gas emissions dipped by 6·4% in 2020 they have since rebounded. "The imperative is clear for accelerated action putting the health of people and the planet above all else."[6]

to the water. Fixtures and fittings will again need to be resilient against chemical treatments. UV treatments are also available.

Biocides

As the pressure to reduce water usage increases, biocides are likely to play a greater role in keeping water safe. Prof Reynolds explains how the current tendency to disinfect water systems with chlorine-based products has a (desired) residual effect after moving through lengthy pipe runs, but this can lead to the rise of more chlorine-resistant bacteria. Increased chemical use could require extra infrastructure to keep effluent within safe environmental levels exiting hospital premises.

A solution could be a move to 'on-demand' production of 'green biocides', in particular significantly less toxic alternatives such as hypochlorous acid (HOCl).[7] In a recent study by Reynolds and his colleagues, HOCl was demonstrated to be a particularly effective antimicrobial and anti-biofilm disinfectant in point of use (POU) drinking water applications.[8]

Another long-term strategy that could help prevent or reduce bacterial resistance would be disinfection schedules that cycle different biocides.

Decentralised systems

The WHO's Sustainable Development Goals have greatly improved the provision of safe drinking water worldwide,[9] yet centralised provision of safe water via large treatment plants continue to represent a challenge for many lower income countries — as well as representing a potential vulnerability in all water supplies. Prof Reynolds notes there is now a school of thought leaning towards more decentralised systems — or the ability to operate decentralised systems in tandem with centralised systems. These could utilise technologies that produce safe or greener biocides on demand, thereby saving on use of other types of antimicrobial or disinfectants that are often transported in plastic bottles. Decentralised (on premises) water waste treatment also opens up the possibility of utilising 'friendly' bacteria to neutralise pathogens.

"If you look at the cost to the environment of keeping hospitals clean, it's not great. [We need] an ability to think a little bit more localised and a little more decentralised, [with less reliance] on complex supply chains, which we know are [currently] under a lot of pressure ...[and] maybe aren't as fit for purpose as we were thinking.

"If you think about what we do with water, we pump it around, we collect it, we treat it, we make it dirty, we throw it away and then we collect it again. Rainwater harvesting in this country is not really as big as it could be. Grey water use is not as extensive as it could be. We've got to start thinking about water for what it is, which is quite a precious resource.

"I think that's relevant for healthcare settings because at the end of the day ... we need good quality water and we're trying to prevent healthcare-acquired infections that may emanate or originate from water supply systems."

References

1. carbonbrief.org/cop26-key-outcomes-agreed-at-the-un-climate-talks-in-glasgow

2. carbonbrief.org/analysis-when-might-the-world-exceed-1-5c-and-2c-of-global-warming#:~:text=The%20world%20will%20likely%20exceed,a%20median%20year%20of%202043.

3. Kampragou E. *et al* "Water demand management: implementation principles and indicative case studies," *Water Environ J* **25**: 4, 466-476, 2011.

4. Nichols G.L. *et al* "Rainfall and outbreaks of drinking water related disease and in England and Wales" *Journal of Water and Health* **7(1)**:1-8, 2009.

5. https://theconversation.com/clean-energy-the-worlds-demand-for-copper-could-be-catastrophic-for-communities-and-environments-157872

6. doi.org/10.1016/S0140-6736(21)01787-6

7. Thorn, R.M.S. *et al* "Electrochemically activated solutions: evidence for antimicrobial efficacy and applications in healthcare environments" *Eur J Clin Microbiol Infect Dis* **31**: 641–653, 2012.

8. Clayton E.G., Thorn R.M.S. and Reynolds D.M. "The efficacy of chlorine-based disinfectants against planktonic and biofilm bacteria for decentralised point-of-use drinking water" *npj* Clean Water **4**:48, November 2021.

9. https://www.who.int/health-topics/sustainable-development-goals#tab=tab_1

Further reading

https://www.cnbc.com/2021/06/17/copper-prices-rise-amid-green-sustainable-initiatives.html

https://www.cnbc.com/video/2021/07/30/why-a-looming-copper-shortage-has-big-consequences-for-the-green-economy.html

*The UN's global climate summits, COP, which stands for 'Conference of the Parties'

CLEANING: THE POWER OF THE MANY

A multidisciplinary approach is at the heart of the new National Standards of Healthcare Cleanliness 2021, which become mandatory in April 2022.

The new National Standards of Healthcare Cleanliness 2021 harness "the 'power of partnership'", according to Emma Brookes, Head of Soft FM Strategy and Operations at NHS England and Improvement, for the first time formally mandating a collaborative approach across all relevant departments.

A much needed update on hospital cleaning standards was a top priority for Ms Brookes when she joined NHS England in 2017, leading her to set up a huge multidisciplinary working group. Ms Brookes noted: "Cleaning is everyone's responsibility, not just the cleaner on the ward, [but] everybody from the CEO down to the domestic member of staff — everyone needs to take a hand in how this happens."

Taking four years to complete, the project drew in input from around 50 individuals from across the NHS, including from infection prevention and control, nursing, clinical and microbiological leads, the association of healthcare cleaning professionals (ACHP) and partner organisations such as the Health Estates and Facilities Management Association (HEFMA), Public Health Wales and the Health and Safety Executive (HSE).

The new standards replace the 2007 National specifications for cleanliness in the NHS and the previous Healthcare cleaning manual (2013 revision) to reflect modern methods of cleaning and infection prevention and control and other changes that have taken place since 2007. Alongside enhanced collaboration, they have been designed to introduce more flexibility, be easier to use and provide efficacy, assurance of cleanliness, transparency of results and quality assurance through a three-stage audit process via a suite of documents: the standards themselves, appendices with attached tools on pest control and a new healthcare cleaning manual.[1,2]

Although the new standards have been criticised in some quarters, amendments have been made to make them more relevant for primary care, for example.

The mandatory requirements can be summarised as follows:

Functional risk categories:
These have been increased from four to six, replacing the previous 'very high risk', 'high risk', 'significant' and 'low risk' categories. The two new ratings have been added to provide flexibility across numerous different types of organisations to address a longstanding criticism that the standards have been too focused on acute risk. Increasing the categories will allow organisations to place rooms, areas, departments and buildings in appropriate categories.

An optional blended risk category allows an area to be split so that part of it is categorised as 'high risk', while another section of the area is categorised differently. However, an electronic audit system will be essential for keeping track of this arrangement.

Functional risk (FR)1 replaces the previous 'very high risk' category (98%); FR2 replaces 'high risk' (95%); the new category FR3 equates to 90%; FR4 replaces 'significant risk' at 85%; FR5 is a new category; while FR6, at 75%, replaces 'low risk' and also covers a blended approach.

Not all categories will be suitable for all settings, however, in acute settings it is considered good practice to adopt all six functional risk categories.

Organisations are being asked to document how they have allocated categories to different spaces and are required to regularly review these decisions.

Elements, performance, analytical parameters and cleaning frequencies:

Once an organisation has identified its FR categories it must produce a 'cleaning specification' that includes a list of cleaning elements, performance parameters and cleaning frequencies.

Elements: The list has increased from 49 to 50 and organisations are free to add further elements. Elements that do not exist within an organisation do not have to be scored.

Performance parameters: these are the expected standard of cleaning for each element, as previously.

Cleaning frequencies: these have always been broken down according to FR categories and remain similar to what people have been used to doing.

Cleaning responsibilities: This is about ensuring that not only the staff, but also everyone around them in an organisation, including patients, understands who is responsible for cleaning.

Emma Brookes explained: "This has opened up an opportunity to do things differently ...We know that anything above 'hand height' is 'hard FM' and the responsibility of Estates and Facilities....[Similarly] we have nursing responsibilities, domestic responsibilities and so on [so] let's put the experts in charge of cleaning things. We don't go around putting cannulas into patients so perhaps we shouldn't ask nurses to go round doing the expert part of the cleaning. [Cleaning's still] always going to be a part of their job between patients. It's not about absolving people from responsibility — it's about putting the experts in charge of what people should be doing."

Audit frequency: similar to previously but with some additional frequencies — at two months and three months — to help space out audits and introduce flexibility for different organisations depending on the risk of any given area.

Star ratings: these are intended to demonstrate what is consistently done well. In fact, Emma Brookes notes, cleaning scores tend to stay the same — it takes a major event, such as a change of use for a room, to move from a high score pass mark to a very low one. The chances are that a ward with a four or five star cleaning rating will remain the same, unless a major incident takes place. In some instances this will not be an appropriate time to do a cleaning audit if something unusual has happened, such as flooding.

Ultimately, the star ratings are designed for transparency and will be implemented very gradually. They will also be easier for patients to understand than the previous percentage scores.

Efficacy audit: this is a new requirement, which checks the efficacy of the cleaning process at the point of service delivery, such as the correct use of colour coding, equipment, materials and methodology. Previously, a technical audit was always followed by a managerial audit, which, essentially, repeated the supervisor audit. This doubling up has now been removed on the basis that there should be confidence that supervisors and cleaners are well trained enough to carry out a visual audit.

Commitment to Cleanliness Charter: introduces flexibility. Rather than sticking to a highly specific schedule, need can be responded to at any time while continuing to demonstrate a commitment to cleanliness and a clean and safe environment from everyone in an organisation, from the top down.

The Charter displays who is responsible for any task and the frequency of cleaning that should be expected.

Frequency gap analysis: documents whether cleaning frequencies have increased, decreased or stayed the same.

Documents

1. www.england.nhs.uk/publication/national-standards-of-healthcare-cleanliness-2021/#:~:text=They%20are%20based%20around%3A%20being,assurance%3B%20and%20transparency%20of%20results.

2. www.england.nhs.uk/publication/national-standards-of-healthcare-cleanliness-2021-supporting-documents/

How to clean taps and sinks

The ideal protocol for cleaning taps and sinks is clearly outlined in a video produced by the Environment Network for the Royal Society of Public Health (RSPH) (see below). This is an excellent resource for understanding how to clean healthcare patient areas and care home resident bathrooms to minimise the transmission of waterborne pathogens.

Key points include:

1. Preparation — collect together all equipment, ensuring correct colour coding to differentiate between those used for clean and dirty areas.
2. Wash hands before putting on gloves.
3. Make up the cleaning agent, leaving enough time for cloths to soak up the agent.
4. Make a visual inspection of the sink environment. Check if there are any items that should not be there and the condition of the sink e.g. presence of mould, scale, broken-down sealant.
5. Remove any objects in and around sink.
6. Remove blockages using tweezers.
7. Remove scale and flush the tap for 30 seconds.
8. Dry the sink area before applying the chemical, drying from clean to dirty using paper towels. Don't use same paper towel on the tap and then the sink basin.
9. Clean the tap with a fresh cloth — from clean to dirty: handle, tap body, spout, water outlet.
10. Follow a slightly different protocol for cleaning sinks fitted with a filter.
11. Clean the sink bowl with a fresh cloth — from clean to dirty starting with the external area, finishing with the inside of the sink and finally the plug hole, which is most likely to harbour pathogenic bugs. It's important to avoid picking them up and spreading them around with your cleaning cloth.
12. Change your gloves before cleaning the next area.

INSECT WINGS AND SPOTLESS SURFACES:

SMART ANSWERS FOR THE HOSPITAL OF THE FUTURE

What might the hospital of the future look like? Will it be run by robots, artificial intelligence and hi-tech innovation? What will be the key priorities for infection control?

There have been great strides in understanding, prevention and mitigation of contamination and transmission in healthcare settings, yet new challenges keep stacking up.

One of the biggest challenges will be, and already is, from antimicrobial resistant (AMR) microorganisms. This resistance, alongside climate change is now considered to be the biggest threat faced by humans this century and a leading cause of death, killing 700,000 people worldwide every year.[1] Without action, by 2050, this figure is likely to reach 10 million, at a global economic cost of $100 trillion.[2]

In the UK, a five-year initiative launched by the Government in 2019 has outlined three main objectives towards tackling antimicrobial resistance. These are:

1. Reducing need for and unintentional exposure to antimicrobials
2. Optimising use of antimicrobials
3. Investing in innovation, supply and access to tackle AMR

Surfaces and transmission

According to Dr Jon Otter, Director of Infection Prevention and Control at Guy's and St Thomas' NHS Foundation, in a 2021 blog for the Healthcare Infection Society (HIS),[3] one of the key elements that will need to be a consideration for infection control in the 'hospital of the future' will be a focus on surfaces.

Surfaces are now widely understood to play a significant role in the transmission of a range of healthcare-associated bacterial pathogens, including water-related pathogens such as vancomycin-resistant *Enterococci* (VRE), *Acinetobacter*, and *Klebsiella*, and also respiratory pathogens, such as Covid-19.

Research going back to 2000 shows that contaminants can spread to all surfaces on a ward within a matter of hours,[4] and this is backed up by more recent studies. For example a 2015 paper demonstrates how an occupant of a hospital room has a more than doubled risk of acquisition of certain microorganisms, such as MRSA, carried by the previous occupant.[5]

Bacteria tend to form biofilm; free-living planktonic cells coalesce together to produce a protective extracellular matrix that binds the 'colony' together and allows it to adhere to smooth surfaces, such as a hospital bed, a water pipe or a medical prosthesis. Antibiotics work well against planktonic bacteria, but are blocked from reaching bacteria in the depths of a biofilm. Improvement of the ability to remove contamination from surfaces could mitigate the increased risk from microbial contamination and improve outcomes.

While Star Wars-style robots and AI are yet to provide answers, several technology-driven innovations are looking promising.

"We need [to find] a smart surface solution that... [is] affordable, widespread and easy to manufacture."
Dr Gerald Larrouy-Maumus

'Smart' solutions

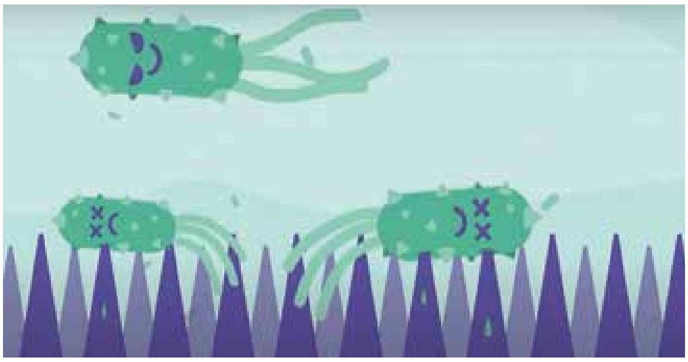
At Imperial College, London, a briefing paper put together by the Institute for Molecular Science and Engineering (IMSE) — a banner bringing together a collaboration of medicine, engineering and medical microbiology disciplines — describes strategies for developing 'smart' surfaces that reduce microbial adhesion, are antimicrobial and disrupt the habitat of microbes.[6]

While no universal solution for 'smart surfaces' has yet been arrived at because much more research is still needed, solutions must be affordable for not only wealthier countries, such as the UK, but also for middle and low income countries.

Three potential strategies were put forward:

i) 'Nanospikes'

Inspired by the natural world, this option seeks to replicate the antimicrobial properties of the wings of a large group of insects, Cicada, which are covered in nanoscale spikes that can puncture bacterial cell walls. Bacteria adhere easily to smooth surfaces, but are uncomfortable on rough or spiky surfaces. A surface covered in 'nanospikes' will puncture the bacteria, therefore leading to lysis of bacteria; lysis is the disintegration of a cell by rupture of its cell wall or membrane.



'Nanospikes' similar to those found on Cicada wings can puncture the outer membrane of bacteria. Credit: Imperial College London

This is a non-specific elegant contact killing mechanism that would be effective for both sensitive and resistant bacteria. However, development would require an affordable material that can be manufactured on a large scale.

ii) Metallic ions

The idea of using antibacterial metallic surfaces such as copper dates back as far as the Egyptians. Copper is essentially 'self-sanitising': solubilised copper ions enter contaminating bacterial cells leading to cell lysis due to cell membrane rupture and leakage of ribosomes.

A randomised trial some years ago showed how changing six touch points in a hospital room, one of them being the bed rails, to copper led to reduced hospital-acquired infections (HAIs) and reduced acquisition of key marker bacteria. Around a 50% reduction in both HAIs and acquisition of antibiotic-resistant bacteria was demonstrated from changing only a relatively small number of touch surfaces in the room.[7]

However, while copper is an excellent option, it is an increasingly limited resource with soaring prices. According to Dr Gerald Larrouy-Maumus of the Natural Sciences Faculty, speaking at the launch of the Imperial Briefing Paper, "we need to think about low and middle income countries [so this is the] reason why we need [to find] a smart surface solution that has same properties as copper but [is] also... affordable, widespread and easy to manufacture."

Copper vessels have been used as 'preservative' containers for thousands of years.

There is also another factor that needs to be considered against widespread use of copper. Research in recent years indicates increasing evidence that some bacteria can survive exposure to 'sub-lethal' concentrations of copper ions in water. Instead of cellular lysis, these bacteria enter a state in which they cannot be cultured but remain viable, known as 'viable but non-culturable' or VBNC. These bacteria are able to resuscitate so that they can be cultured and research is now focused on studying the degree to which they retain their infectivity.[8]

iii) Safe cleaning and self polishing surfaces

The main source of contamination in hospitals with pathogens that are high risk for the most vulnerable patients, such as *Pseudomoas aeruginosa* and *Legionella pneumophila,* is water originating from the hospital plumbing system. Development of a 'bacteria-repellant' 'self-cleaning' surface that prevents attachment of bacteria could incorporate a biocide.

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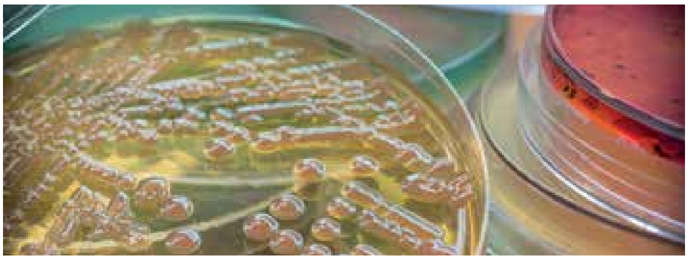
CLOSELY OBSERVED DRAINS

A Water Safety Forum a year ago* focused on the hidden dangers from wastes and drains, highlighting that hospital acquired infections (HAIs) are just as likely to be transmitted from sink and hand wash basin (HWB) waste traps as from water splashed from contaminated taps and basins, which has previously been considered the most likely transmission pathway.



Reports on the role of contaminated waste and drain taps as sources for HAIs continue to rise in the literature. These appear to provide an environment for antimicrobial-resistant microorganisms, with carbapenemase producing Enterobacteriaceae (CPE) high on the list and resistant *Klebsiella pneumoniae* a particular unwanted guest. These bugs appear to spread easily through hospital drainage systems, with appearances by organisms contaminating one drain travelling far too easily to nearby sinks and HWBs.

The cause of the initial contamination is often down to human factors — with basins used inappropriately for disposal of potentially contaminated discarded patient fluids and other substances, such as drinks or foodstuffs, that provide nutrients for bacterial proliferation. This behaviour continues to take place, despite guidance such as HTM 04-01 Part C: 3.3, which emphasises that clinical outlets should be used for hand washing only. Solutions will need to include a strong emphasis on behavioural change concerning usage, with the new healthcare cleaning standard (see pp10-12) helping to address this problem.

The following pages provide a round-up of some of the latest research shedding light in this area:

Microorganisms
2021, Sep, **3**:9(9),1868.

Migration of *Escherichia coli* and *Klebsiella pneumoniae* Carbapenemase (KPC)-Producing *Enterobacter cloacae* through Wastewater Pipework and Establishment in Hospital Sink Waste Traps in a Laboratory Model System

Aranega-Bou, P *et al.*

Experimental rig connecting sinks with hospital waste traps through a common wastewater pipe. Monitoring of Enterobacterales populations were monitored before a wastewater backflow event. Analysis demonstrated that immediately after the wastewater backflow, two KPC-producing *Enterobacter cloacae* were recovered from a waste trap in which carbapenemase-producing Enterobacterales (CPE) had not been detected previously. Following this inter-sink transfer, KPC-producing *E. cloacae* was found to integrate successfully into the microbiome of the recipient sink and was detected in the waste trap water at least five months after the backflow event. Further transfers were observed seven weeks and three months after the backflow.

Infect Control Hosp Epidemiol.
2021 Jun: 42(6):722-730. doi: 10.1017/ice.2020.1287.

Colonisation of carbapenem-resistant *Klebsiella pneumoniae* in a sink-drain model biofilm system.

Burgos-Garay, M *et al.*

A model system simulating a sink-drain P-trap was utilised to investigate colonisation of a biofilm consortia by carbapenem-resistant *Klebsiella pneumonia* (CPKP). The inoculates were originally recovered from two P-traps from separate patient rooms (designated rooms A and B) in a hospital. The study findings demonstrated that the microbial communities in the model were found to be less diverse than the communities in the respective P-traps and suggest that CPKP persistence in P-trap biofilms may be strain specific or may be related to the type of P-trap material or age of the biofilm.

J Hosp Infect.
2021 Sep:115:75-82. doi: 10.1016/j.jhin.2021.05.010. Epub 2021 Jun 8. PMID: 34111433.

Sink drains as reservoirs of VIM-2 metallo-β-lactamase-producing *Pseudomonas aeruginosa* in a Belgian intensive care unit: relation to patients investigated by whole-genome sequencing.

De Geyter, D *et al.*

Findings from this study confirm that sink drains are a possible source of VIM-2 *P. aeruginosa*, probably after being contaminated with clinical waste from patients — and consequently, patients could be exposed to these pathogens dispersed in their environment due to colonised sink drains.

Infection Prevention in Practice
2021, Dec 3 (4): 100179

Drains and the periphery of the water system — what do you do when the guidance is outdated?

Weinbren, M *et al.*

The periphery of the water system (the last 2m of pipework) presents multiple inherent risks including: the necessity to use materials with higher risk of biofilm formation, difficulty in maintaining safe water temperatures, a human interface with drainage systems, outdated guidance and potential resistant bacteria emanating from drainage systems. There is an urgent need for the re-evaluation of the periphery of water and drainage systems. This article examines the requirement and placement of hand wash stations, design of showers, kitchens and the dirty utility with respect to water services and discusses the provision of safe water to high-risk patient groups.

J Hosp Infect.
2021: 112: 16-20

Long-term contamination of sink drains by carbapenemase-producing Enterobacterales in three intensive care units: characteristics and transmission to patients.

Lemarie C. *et al.*

Monthly sampling of sink drains in three intensive care units for carbapenamse-producing Enterobacterales (CPE) was carried out alongside rectal screening for carriage of CPEs of hospitalised patients. CPEs were found in 22% of the sink drain samples, but no acquisition occurred amongst the patients. The authors concluded that systemic sampling of SDs in ICUs to screen for CPE contamination should be discouraged apart from during outbreaks.

In September 2021, a flurry of drains-related posters were presented at the Infection Prevention Society 2021 (IP2021), 13th Annual Conference, in Liverpool, UK:

- **Lets talk about sinks: A quality improvement pilot project to reduce the inappropriate use of handwashing sinks in an acute hospital.** (Poster ID 6)

  Lillystone, M *et al*

  Sinks were found to be used inappropriately 24% of the time, in particular for emptying patient wash water and emptying drinks. A sustained 30% (mean) improvement in solely appropriate hand wash basin usage was reported during the study.

- **What do babies guts and sink waste traps have in common?** (Poster ID 56.)

  Wright, S *et al*

  Report of an outbreak of *Klebsiella pneumoniae* ST-48 where the index case was likely from maternal colonisation followed by on-going transmission via healthcare workers hands and sink waste traps. Persistent colonisation with the outbreak strain was found in sink waste traps. On repeated sampling, the number of positive waste traps reduced. The outbreak was declared over after eight weeks. ESBL screening remains to inform antimicrobial stewardship and prescribing.

- **Can Chemical Disinfection Save Your Sink?** (Poster ID 74)

  Cornbill, C *et al*

  Report from Public Health England regarding disinfection of sinks/sink drainage systems which is notoriously difficult to achieve as biofilms are highly resistant to disinfection. Both liquid and foam format disinfectants were trialled and initially reduced dispersal. However high bacterial counts continued post disinfection within the trap and dispersed from the drain during the operation of the tap. Any effect was short-lived and bacterial levels returned to baseline within 48/72 hours. The foam-based products were comparatively less effective. For long term solutions, the researchers recommended that other mitigating strategies should be investigated.

*Looking Deeper 7: idealspec.co.uk/resources/whitepapers.html