NHS Scotland Assure
Quality in the healthcare environment

NHS National Services Scotland

Research Q&A: hospital sinks and drains as a source of antimicrobial resistant microorganisms: studies to investigate colonisation, dispersal and decontamination.

Dr Ginny Moore

NHS Scotland Assure Research Service

NHS Scotland Assure is adding to the knowledge base available to built environment projects. Building on this existing knowledge will reduce risks, increase quality and promote sharing research with key stakeholders.

Through working with external stakeholders and other NHS Scotland Assure services the research service will ensure information is based not only on best practice but best evidence and will benefit those who need it. The service will seek to ensure that the most up to date and robust research is translated into practice as new and emerging evidence become available.

Throughout 2020 and 2021 the NHS Scotland Assure Research service commissioned a number of research projects which address gaps in current evidence. These research topics relate to previous issues and lessons learned within previous NHS Scotland projects and are in line with the key themes identified by NHS Scotland Assure stakeholders.

Research Q&As

Our research Q&As are designed to talk about these research projects – why the research is needed, what it set out to achieve, what impact it will have on existing guidance and more.

Full research reports are also available by contacting Dr Ginny Moore at **ginny.moore@ukhsa.gov.uk**.

Research Q&A with Dr Ginny Moore

1. What is the research that was carried out?

The research has looked into hospital sinks and drains as a source of antimicrobial resistant microorganisms. It investigated colonisation, dispersal and decontamination of these microorganisms.

2. Why is this research needed?

Enterobacterales are bacteria that usually live in the gut without causing any problems or symptoms. Sometimes these bacteria can get into other parts of the body like the bladder or bloodstream and can cause serious infections, which can be life-threatening. The increasing use of broad-spectrum antimicrobials (antibiotics that target many types of bacteria) has led to a significant increase in multidrug resistance in Enterobacterales and other types of bacteria. Infections caused by multidrug resistant Enterobacterales are difficult to treat and are associated with high mortality.

Of particular concern are Carbapenemase producing Enterobacterales (CPE) which are resistant to all or almost all β-lactam antibiotics (such as amoxicillin or meropenem) and are also frequently resistant to other classes of antimicrobials that can be used for infection treatment. The emergence of CPE is a major public health concern.

Acquisition of CPE primarily occurs among hospitalised patients and patient-associated risk factors, such as length of hospital stay and previous exposure to antimicrobials, have been identified. However, there is increasing evidence linking infections to an environmental source; specifically, hospital sinks, waste traps and/or drains.

The stagnant water within a waste trap facilitates the formation of biofilm comprising many millions of microorganisms – including those that are resistant to antibiotics. Use of the sink and/or tap can dislodge and disperse these bacteria onto surrounding surfaces and pose a risk for onward transmission.

Eradicating biofilms from hospital drains is difficult and there is a lack of guidance on how to proceed if CPE (or other resistant organisms) are recovered from sinks and/or wastewater plumbing.

3. Who were the team behind the research?

The Biosafety, Air and Water Microbiology Group, led by Chief Investigator Dr Ginny Moore based at the UK Health Security Agency (previously Public Health England) in Porton Down.

4. What did the research set out to achieve?

The research sought to assess the efficacy of different chemical disinfectants (and modes of application) when used to treat sinks known to be colonised with antimicrobial resistant Gram-negative organisms.

5. How was the research carried out?

The Biosafety, Air and Water Microbiology Group has designed a unique laboratory model system that incorporates stainless steel (base-draining) sinks, ceramic (rear-draining) handwash basins and waste traps. The waste traps were removed from hospital wards and installed within the system.

This controlled setting has been used to study bacterial colonisation, survival and migration within sink drainage systems and the potential for CPE to detach from drain biofilms and contaminate surrounding surfaces.

For the purposes of this study, four products (selected on the basis of active ingredient, formulation and commercial availability) were used to treat base-draining and rear-draining sinks.

Liquid disinfectants were poured directly into the sink drain. Foaming disinfectants were applied as per manufacturers' instructions.

The type and concentration of Gram-negative bacteria present within the waste trap water and drain hole was monitored weekly (before disinfection) and daily thereafter. Regular monitoring allowed us to assess natural variation within the system and determine the effect of disinfection.

6. What challenges did you encounter?

One challenge we faced was ensuring the efficacy of the disinfectants was not over-estimated. It was essential to neutralise the active ingredient prior to culturing waste trap water or swab samples – otherwise residual disinfectant may continue to have an effect during the culturing process (i.e. over an unrealistic contact time) and prevent the growth of the target organisms.

Effective neutralising solutions differ with active ingredient and so knowledge regarding the constituents of a disinfecting product is essential. If this knowledge is lacking (for example due to undisclosed 'proprietary' product information) then developing and validating appropriate neutralising solutions can be difficult and time consuming.

Working with model systems can be challenging. The model system used in this study was designed to simulate the sinks and associated pipework likely to be found within a hospital environment. We transplanted waste traps taken from in-use hospital sinks into the system to better replicate the hospital 'sink biofilm'.

Although, this could be considered 'real-life', the waste traps did differ in terms of biofilm thickness and composition meaning the efficacy of the different disinfectants could not be directly compared. Instead, efficacy was determined by monitoring the number of Gram-negative organisms recovered from the waste trap and drain before and after treatment.

Finally, whilst fixtures and fittings can be replicated, it is more difficult to simulate clinical practice and the impact of human behaviour has not (yet) been investigated.

7. What were your main findings?

We assessed the efficacy of four different products:

a) a chlorine-based (domestic) foaming product

b) a commonly used chlorine-based solution (10,000ppm; 1% active chlorine)

c) a peracetic acid (PAA)-based foaming disinfectant marketed towards healthcare (0.4% PAA)

d) a PAA liquid formulation

As far as was practicable the concentration of each liquid disinfectant was diluted to that of the active ingredient incorporated within the respective foaming product (as stated in the manufacturers' material safety data sheets).

The concentration of planktonic bacteria within the sink waste trap fell to below detectable levels immediately after treatment with either of the liquid disinfectants (disinfection achieved at least a 4-log reduction in culturable Gram-negative bacteria) and no bacteria were dispersed to surrounding surfaces.

However, neither disinfectant eliminated the colonising biofilm and bacterial levels (and bacterial dispersal) returned to pre-disinfection levels 48 to 72 hours later.

The foam-based products were less effective.

8. How will the research be used?

The research will be used to inform and support guidance on how to proceed if potential pathogens are recovered from sinks.

Ensuring a sink is frequently and appropriately used (for example, that it is not used to discard liquid waste) may help prevent biofilm forming, enhance chemical disinfection and allow for longer-term effect.

However, results from this study would suggest that chemical disinfectants (even if comparatively effective) are a short-term solution and without frequent (daily) application, they should not be relied on to reduce contamination within a sink, prevent bacterial dispersal or reduce the risk of onward transmission.

We also hope that this research informs product development.

It's been suggested that foam-based products allow greater surface coverage and a longer contact time between the surface and active agents and, therefore, may be more effective in reducing bacterial contamination within sinks and drains than liquid disinfectants.

However, in this study the foam-based products were the least effective.

One reason for this may have been the lack of foam flowing up from the waste trap meaning there was little to no disinfection of the drainage outlet. In this study, highest bacterial dispersal appeared to correlate with contamination levels on base-draining strainers or in rear-drainage outlets. None of the chemical disinfectants assessed effectively disinfected these areas of the sink.

9. What are the next steps for study in this field?

Sink design continues to evolve, and recent models have been shown to continually reduce or prevent bacterial dispersal. For longer-term solutions like ward refurbishments or new builds, health boards or Trusts should consider installing these innovative designs.

It is acknowledged, however that installing new sinks may be prohibitively expensive and chemical disinfection may be considered the only option. Since completing this study, a further set of experiments has been carried out and the efficacy of a chlorine-based gel disinfectant has been assessed. Whilst similar studies could be carried out to assess alternative disinfectants, it would perhaps be more beneficial to assess the efficacy of repeat (regular) disinfection protocols.

A comparison of potential engineering and chemical solutions under controlled conditions and/or in a real-life clinical setting would provide useful data for inclusion in a cost-benefit analysis.

10. Will this research have an impact on current guidance?

This research provides evidence to support current guidance documents. For example the UK Health Security Agency document Framework of actions to contain carbapenemase- producing Enterobacterales (Gateway number: GOV-10737) states that *“Poor penetration and/or the inactivation of disinfectants within the biofilm matrix means well-established biofilms are highly resistant to disinfection” and that “Physical removal of biofilm from a sink or shower waste trap by cleaning is unlikely to be fully effective and any biofilm killed or removed will soon be replaced by biofilm recolonising from further down the drainage system”. “Cleaning of waste traps should only be done whenever drainage is impaired”*