

Research finds bacteria resistant to antibiotics in hospital wastewater system

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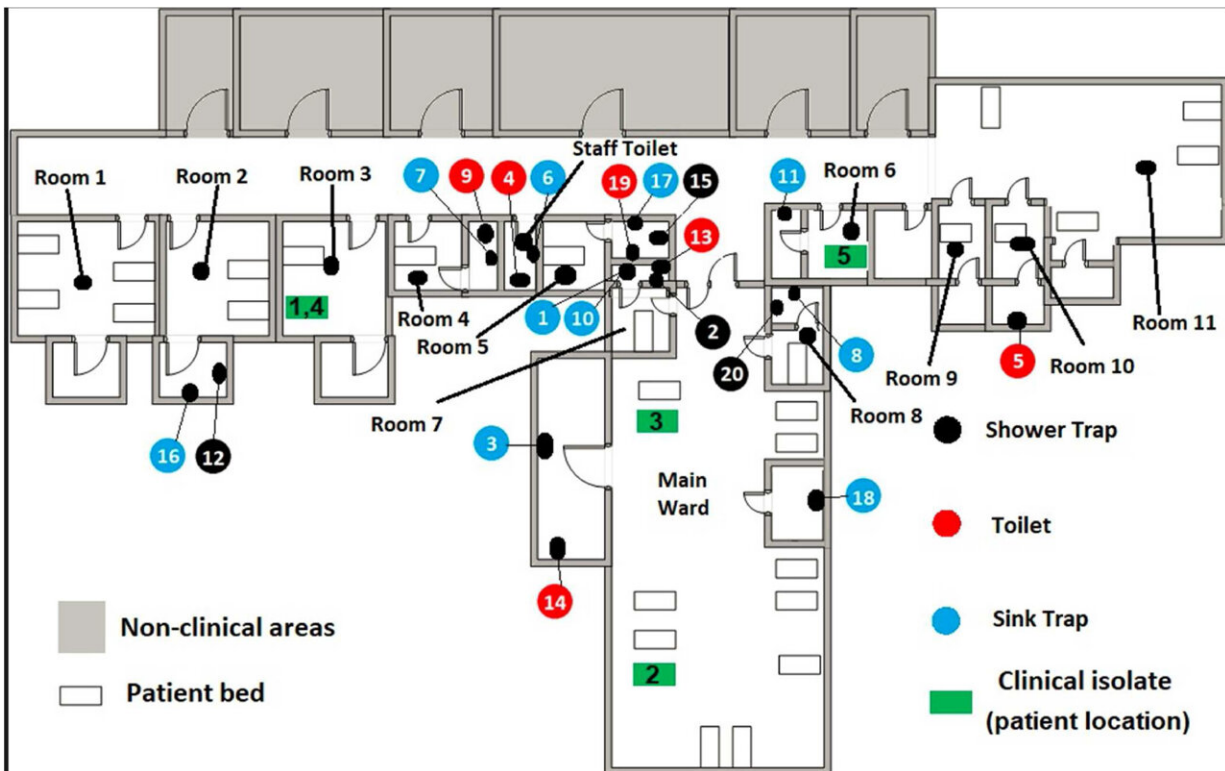


Illustration of the layout of the ward, showing the locations of the wastewater pipe sections used for metagenomic analysis, and the locations of the patients that acquired the clinical isolates investigated (not to scale). The numbers represent the sample numbers for the 20 pipe samples tested. Credit: *Journal of Hospital Infection* (2023). DOI: 10.1016/j.jhin.2023.09.001

A unique new study led by researchers at University of Limerick in

Ireland has found that bacteria that may lead to hospital acquired infection is present in a hospital's wastewater system.

In a partnership with University Hospital Limerick and Queen's University Belfast, the UL School of Medicine has completed an extensive and unique study that saw researchers dive deep into hospital wastewater to find a reservoir of bacteria resistant to antibiotics.

The new research, just published in the *Journal of Hospital Infection*, provides new insight and is the first study of this scale to look at wastewater and to correlate what is found there with outbreaks of infection.

The term antimicrobial resistance (AMR) is well known to the public and to those working in health care. It is a major challenge globally, affecting millions of people each year.

One problem associated with AMR is hospital acquired infection, which occurs when people who are admitted to hospital for treatment become infected by microbes circulating in the hospital wards.

Understanding what these microbes are, where they are, and what drugs they are resistant to helps to put in place systems to prevent and control outbreaks of these infections.

In the unique new study, led by Professor Colum Dunne, Head of University of Limerick's School of Medicine with researchers from University Hospital Limerick and the School of Pharmacy in Queen's University Belfast, largescale genomic and microbiology analysis was completed on UHL's wastewater system.

This work involved processing of the biofilm associated with 20 sinks, showers and toilets from a ward that has been the location of repeated

outbreaks of antibiotic-resistant bacteria.

The unique cross-sectional study was made possible when the ward underwent a refurbishment permitting the researchers an opportunity to examine the [microbial ecology](#) of differing pipework elements in the hospital infrastructure.

As wastewater/plumbing systems across the wards are interconnected, this creates additional challenges for hospital infection control teams.

The analysis, called a metagenome analysis because it is the study of the structure and function of the entirety of DNA sequences from these samples, allowed a complete picture of the bacterial communities present in the sink, shower and toilet pipework. It enabled profiling of all the antimicrobial resistance genes carried by the bacteria present.

By also processing samples from patients who were infected while admitted to the hospital ward, it was possible to confirm that the bacteria that infected them were very likely present in the wastewater system.

Professor Colum Dunne, senior author and study lead who is Head of School and Foundation Chair and Director of Research at the UL School of Medicine, said, "The risks of antimicrobial or drug resistance in hospitals are recognized widely. However, this is the first study to examine hospital wastewater at this scale, and to complete a comprehensive metagenomic profile of the bacteria that exist in the hospital pipework, while also correlating that with infection outbreaks."

"We are hugely appreciative of the openness and cooperation of hospital management and engineering, who are not only open to understanding the microbial communities resident in their water systems, but to also putting in place interventions based on this new knowledge."

"This unique study will lead to infection prevention and control improvements that will, ultimately, benefit patients who are admitted to hospital for treatment. The learnings from this are important internationally."

This work was instigated in the context of growing acknowledgment that the presence of AMR bacteria and antimicrobial resistance genes in the hospital environment and its associated wastewater poses a potential cross-transmission threat to patients, health care staff and the public in the wider community setting.

Dr. Nuala O'Connell, study co-author and Consultant and UL Adjunct Associate Professor in Clinical Microbiology, explained, "This unique work is pivotal in further understanding the role of the hospital environment, in particular the role of sinks, shower drains and toilets as reservoirs of antimicrobial resistant bacteria."

"Such sites pose a risk for health care associated infections and if we can stop these reservoirs from being established by improved infection control practices, we can hopefully stop patients from acquiring difficult-to-treat infections."

"It is also hoped that this work may inform hospital design teams, particularly around the need for sinks and showers in every clinical area as well as ensuring due consideration is given to their location on patient wards to mitigate against potential risks and infections caused by them."

Professor Dunne emphasized the importance of working across disciplines, and highlighted the success seen here by combining Limerick's medical and [clinical microbiology](#) expertise with the advanced molecular capabilities of the QUB team.

Dr. Stephen Kelly, co-author and Lecturer in Pharmaceutical

Microbiomics at QUB's School of Pharmacy agreed.

"I was delighted to be part of this exciting collaboration, involving researchers from various disciplines, North and South. The genomic sequencing we performed enabled powerful analysis of the microbes we detected and their antimicrobial resistance genes in the hospital wastewater system," Dr. Kelly explained.

"Using highly advanced next generation sequencing techniques allowed us to compare the genomes of bacterial isolates from infected patients with the genomes from the pipe sections. This work emphasizes the importance of regular decontamination of patient-facing wastewater apparatus, such as sinks, toilets and showers."

"More broadly, it highlights the benefits of bringing together the expertise of clinicians, microbiologists and bioinformaticians to undertake research which can provide tangible benefits for patients' health."

The importance of the study was summarized by James Powell, who is a Surveillance Scientist at University Hospital Limerick.

"This study highlights for the first time the vast array of microbial life that exists within our hospital system, and just a short distance from staff and patients."

"It makes us aware of the importance of any intervention or barrier that can be placed in between the user environment and this watery underworld: from [infection](#) prevention and control measures to technical innovations that can confine these microbes within the plumbing environment, this study demonstrates the scale of bacterial colonization and resistance genes that can accumulate in these sites. It was an honor and privilege to be invited onto this team and to help with this fantastic

research."

Professor Brendan Gilmore, co-author and Professor of Pharmaceutical Microbiology at QUB, added, "This important study adds significantly to our understanding of the role of bacterial biofilms in [hospital](#) water systems as a reservoir of pathogens and antibiotic resistance which may pose a risk to patients. This should allow more effective intervention to control those risks."

"It is also an excellent example of All-Ireland collaboration between UL and QUB working for the benefit of patients."

More information: Stephen A. Kelly et al, Large-scale characterisation of hospital wastewater system microbiomes and clinical isolates from infected patients: profiling of multidrug-resistant microbial species., *Journal of Hospital Infection* (2023). [DOI: 10.1016/j.jhin.2023.09.001](#)

Provided by University of Limerick

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