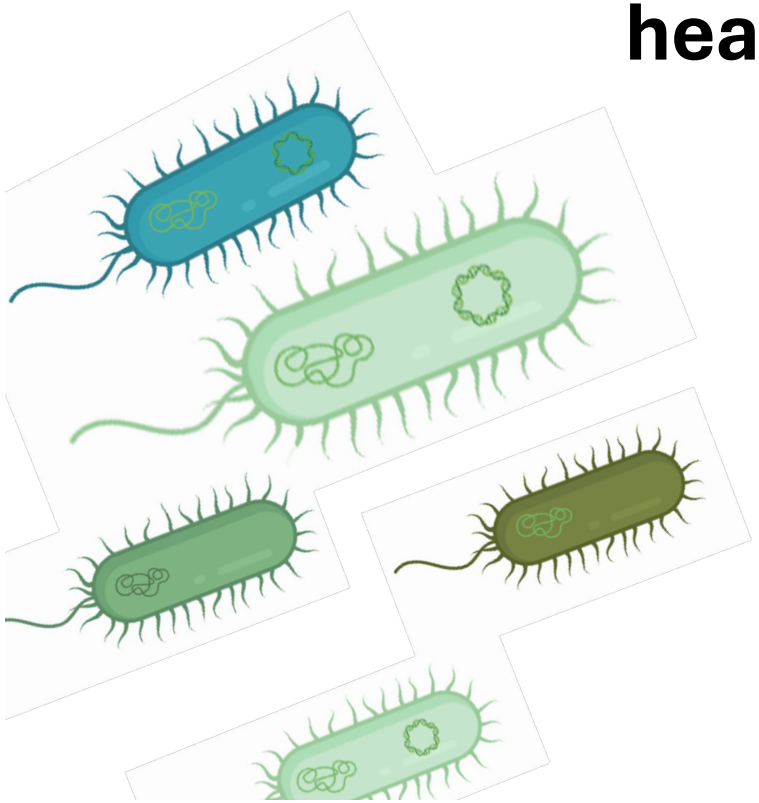
To *aeruginosa* or not to *aeruginosa*: how significant are Pseudomonads in waterborne healthcare infections?



Professor Elaine Cloutman-Green

Great Ormond Street Hospital
University College London

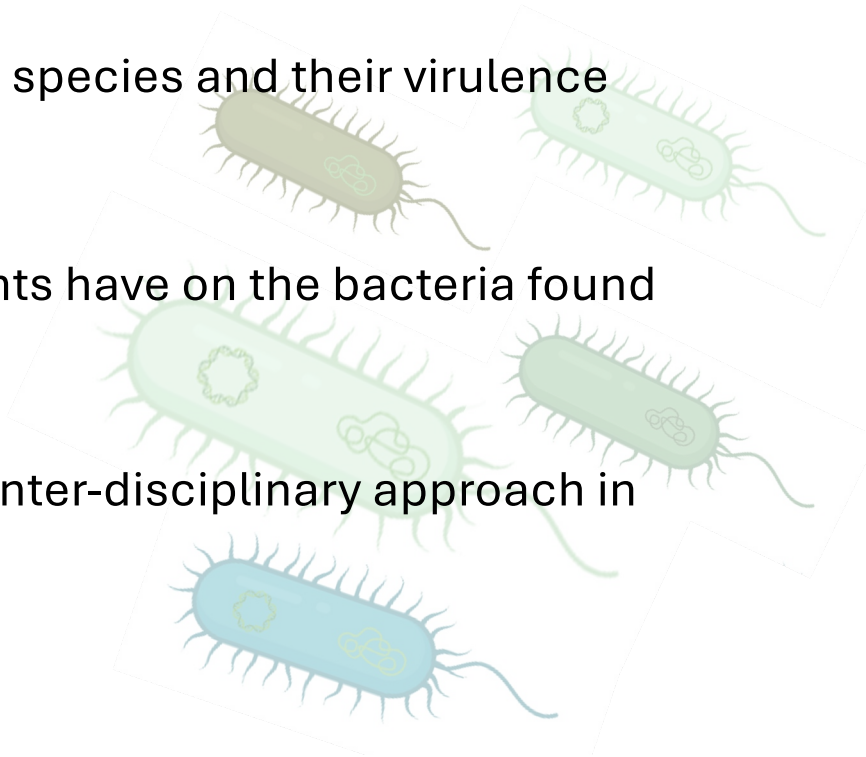
Helen Rickard

University College London

Hosted by Martin Kiernan

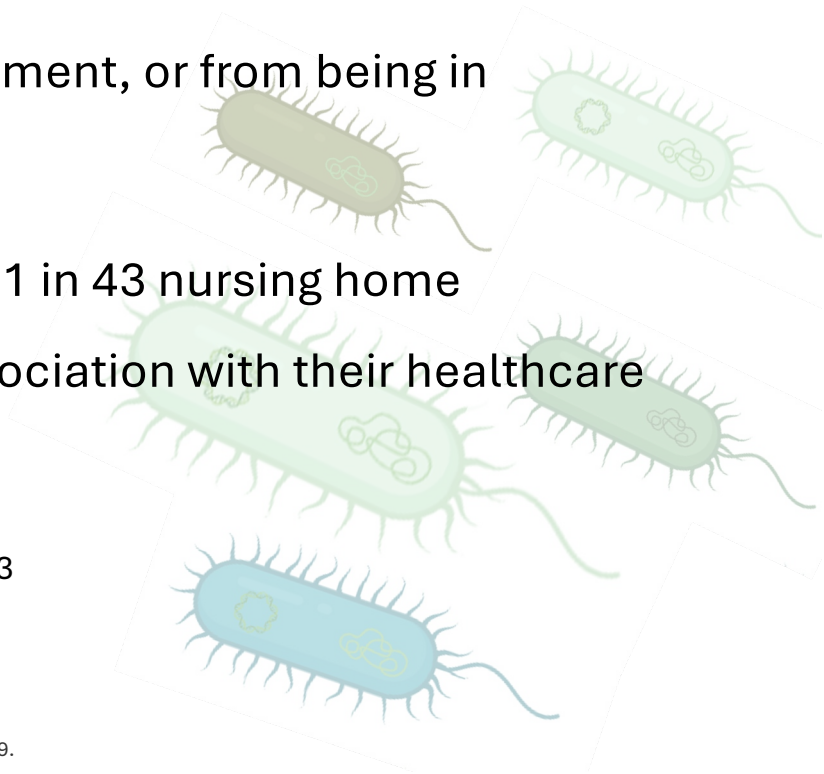
Objectives

- Objective 1: Understand the role of sinks in the transmission of HCAI
- Objective 2: An introduction to *Pseudomonas* species and their virulence factors
- Objective 3: Investigate the impact that patients have on the bacteria found within hospital sinks
- Objective 4: Recognise the importance of an inter-disciplinary approach in infection prevention



An introduction to healthcare associated infections (HCAI)

- “Infections which have developed as a direct result of a healthcare intervention, such as a medical or surgical treatment, or from being in contact with a healthcare setting.”[1]
- Each day, approximately one in 31 patients and 1 in 43 nursing home residents contracts at least one infection in association with their healthcare (USA) [2]
- Financial cost of $7.2-14.9 billion a year in USA [3]

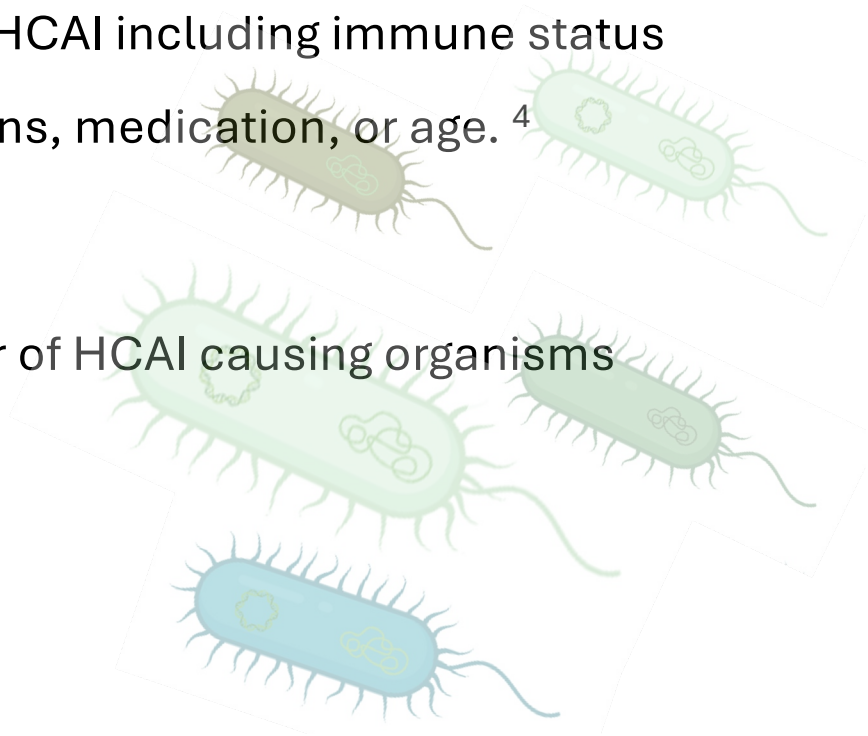


References

1) https://www.england.nhs.uk/patient-safety/healthcare-associated-infections/
2) https://www.cdc.gov/healthcare-associated-infections/php/data/progress-report.html
3) Forrester *et al. 2022.* Cost of Health Care–Associated Infections in the United States. *Journal of Patient Safety* 18(2):p e477-e479.

An introduction to healthcare associated infections (HCAI)

- HCAI are often associated with invasive treatments and devices. Other patient factors can increase susceptibility to HCAI including immune status which may be affected by underlying conditions, medication, or age. [4]
- Endogenous vs exogenous organisms.
- Hospital environment is a significant reservoir of HCAI causing organisms



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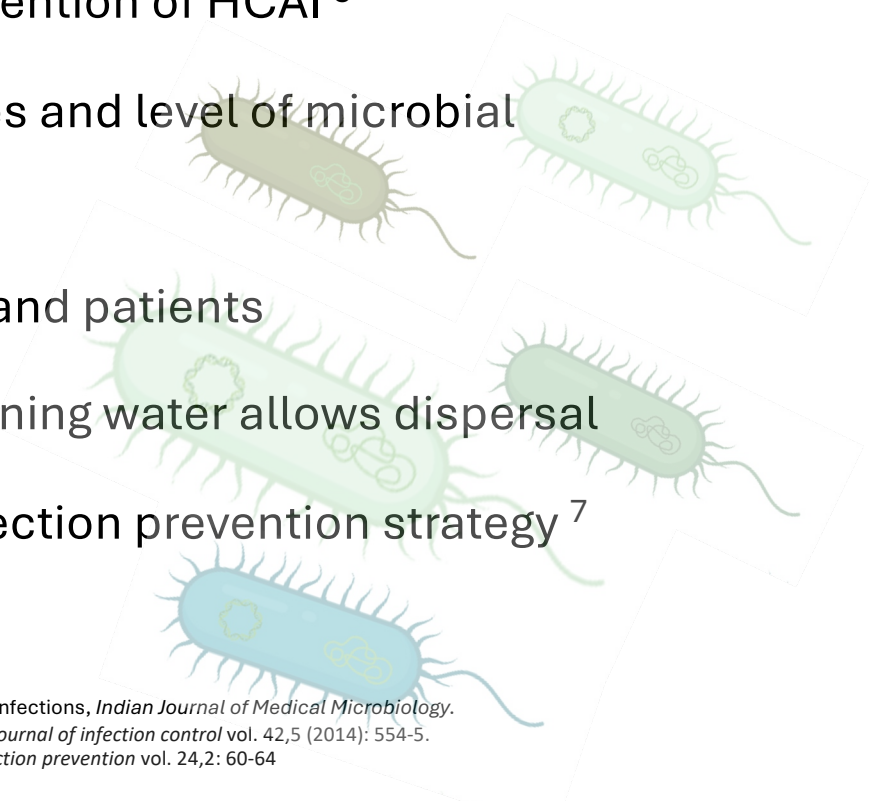
4) Monegro *et al*. Hospital-Acquired Infections. In: StatPearls [Internet]. StatPearls Publishing; 2023

The role of sinks in the transmission of HCAI

- Handwashing is a key intervention in the prevention of HCAI [5]
- Sink location impacts both handwashing rates and level of microbial contamination [6]
- Sinks are at the interface between plumbing and patients
- Hard to clean, allow formation of biofilm, running water allows dispersal
- Sinks have only recently been included in infection prevention strategy [7]



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5) Gupta *et al*. 2023. Hand-hygiene compliance: The importance of WHO's “moment 1” in prevention of healthcare-associated infections, *Indian Journal of Medical Microbiology*.
6) Cloutman-Green, *et al*. The important role of sink location in handwashing compliance and microbial sink contamination. *American journal of infection control* vol. 42,5 (2014): 554-5.
7) Walker *et al*. 2023. Aspects and problems associated with the water services to be considered in intensive care units. *Journal of infection prevention* vol. 24,2: 60-64

Journal of Hospital Infection 86 (2014) 16–23

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Investigation of healthcare-acquired infections associated with *Pseudomonas aeruginosa* biofilms in taps in neonatal units in Northern Ireland

J.T. Walker [a,*], A. Jhutty [a], S. Parks [a], C. Willis [a], V. Copley [a], J.F. Turton [b], P.N. Hoffman [b], A.M. Bennett [a]

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RESEARCH

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Contaminated sinks in intensive care units: an underestimated source of extended-spectrum beta-lactamase-producing Enterobacteriaceae in the patient environment

D. Roux [a], B. Aubier [a], H. Cochard [a], R. Quentin [b], N. van der Mee-Marquet [a,b,*], for the HAI Prevention Group of the Réseau des Hygiénistes du Centre

[a] *Réseau des Hygiénistes du Centre, Hôpital Trousseau, Centre Hospitalier Universitaire, Tours, France*
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e-acquired infections
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Long-term intensive care unit outbreak of carbapenemase-producing organisms associated with contaminated sink drains

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Clinical Microbiology and Infection 27 (2021) 1347.e9–1347.e14

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Original article

A prospective multicentre surveillance study to investigate the risk associated with contaminated sinks in the intensive care unit

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ospital Epidemiology (2018), 39, 997–999
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mmunication

r of *Chryseobacterium indologenes* cases related age water in intensive care units

o MD, MPH, PhD[1], Lina M. Parra MD, MPH[1], Elena Muñez MD, PhD[2], Reyes Iranzo MD[3], ánchez-Romero MD, PhD[4], Jesús Oteo MD, PhD[5] and Angel Asensio MD, PhD[1]

ne Department, Puerta de Hierro Majadahonda University Hospital, Majadahonda, Madrid, Spain, [2]Internal Medicine Department, Infectious a de Hierro Majadahonda University Hospital, Majadahonda, Madrid, Spain, [3]Anesthesiology Department, Puerta de Hierro Majadahonda , Majadahonda, Madrid, Spain, [4]Department of Microbiology, Puerta de Hierro Majadahonda University Hospital, Majadahonda, Madrid, Spain oratory, Department of Bacteriology, Centro Nacional de Microbiología, Instituto de Salud Carlos III, Majadahonda, Madrid, Spain

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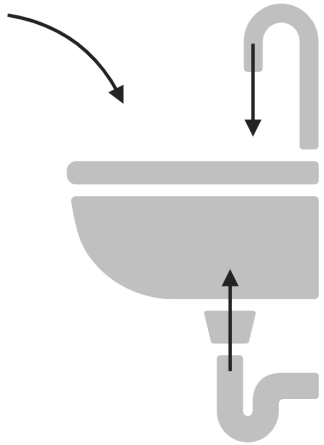
Themes in sink caused HCAI

- Organisms
  - Opportunistic premise plumbing pathogens (OPPPs) [8]
  - Human contaminants
- Patient factors
- Resolution
  - Cleaning and disinfection
  - Physical changes
  - Education and behavior



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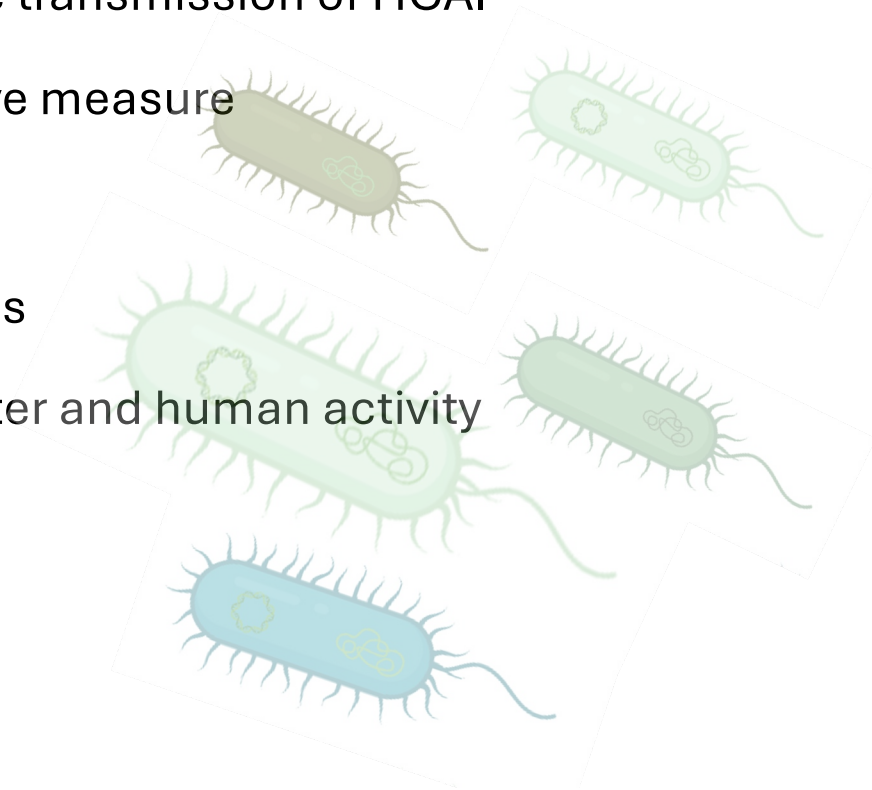
8) Falkinham III. 2015. Common Features of Opportunistic Premise Plumbing Pathogens, *International Journal of Environmental Research and Public Health* 12, no. 5: 4533-4545.

Objective summary

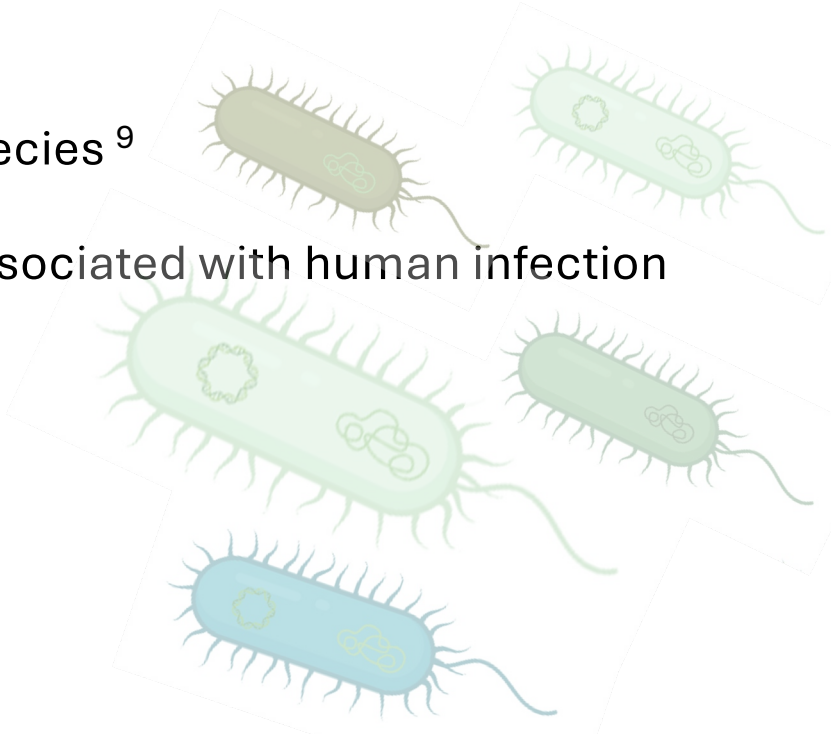
Objective 1: Understand the role of sinks in the transmission of HCAI

- ✓ Hand hygiene essential HCAI preventative measure
- ✓ Sinks allow biofilms to form
- ✓ Running water able to disperse organisms
- ✓ Causative organisms can come from water and human activity



Who/what are *Pseudomonas*?

- Pseudomonads are a group of Gram-negative aerobic bacteria of which *P. aeruginosa* is the most clinically significant
- The genus *Pseudomonas* includes over 140 species [9]
- The *Pseudomonas* species most commonly associated with human infection are *P. aeruginosa*, *P. putida*, and *P. stutzeri* [10]



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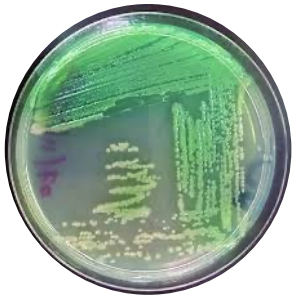
10) Bush *et al*. 2018, Pseudomonas and Related Infections - Infectious Diseases, *Merck Manuals Professional Edition*.

Pseudomonas aeruginosa

- *P. aeruginosa* is a leading cause of HCAI globally [11]
- Able to cause a range of disease types including UTIs, wound infections, pneumonia, and blood stream infections.



- Can be extremely drug resistant
  - ESKAPE pathogen and WHO High Priority Pathogen [12]
  - MDR *P. aeruginosa* caused an estimated 32,600 infections among hospitalized patients and 2,700 estimated deaths in the United States [13]

- Strong biofilm producer – aids environmental survival
- One of most common causes of HCAI transmitted through hospital water [14]

References

11) Elfadadny et al. 2024, Antimicrobial resistance of *Pseudomonas aeruginosa*: navigating clinical impacts, current resistance trends, and innovations in breaking therapies. *Frontiers in microbiology* vol. 15

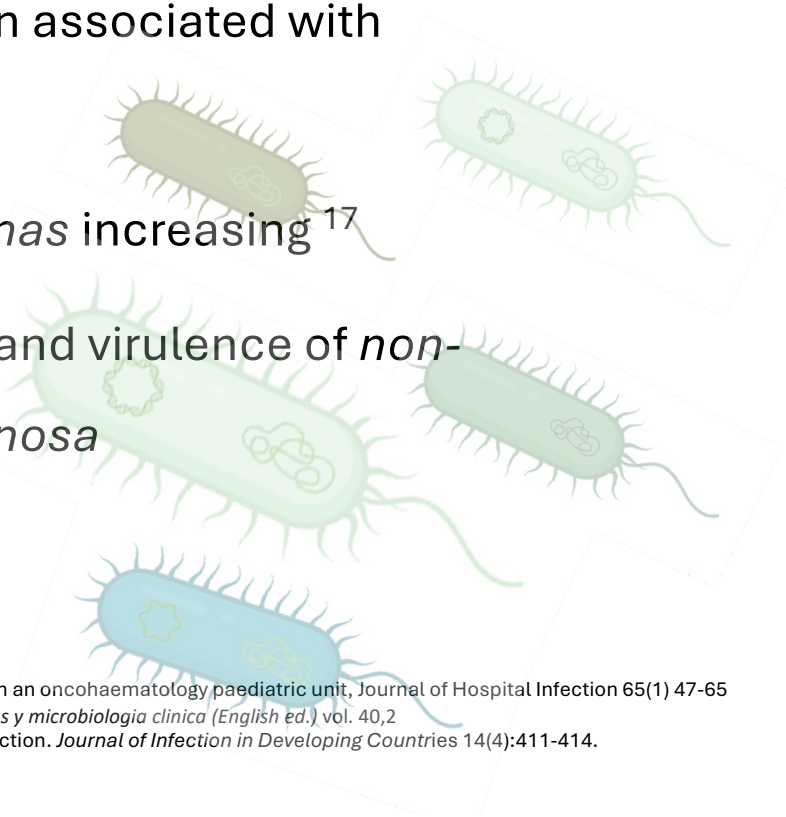
12) https://www.who.int/news/item/17-05-2024-who-updates-list-of-drug-resistant-bacteria-most-threatening-to-human-health

13) https://www.cdc.gov/pseudomonas-aeruginosa/about/index.html

14) Volling *et al*. 2024, Epidemiology of healthcare-associated Pseudomonas aeruginosa in intensive care units: are sink drains to blame?. *The Journal of hospital infection* vol. 148: 77-86.

Non-*aeruginosa Pseudomonas*

- Many strains able to cause human disease – often associated with healthcare settings [15, 16]
- Infections caused by non-*aeruginosa Pseudomonas* increasing [17]
- Less is known about the antibiotic susceptibility and virulence of *non-aeruginosa Pseudomonas* isolates than *P. aeruginosa*



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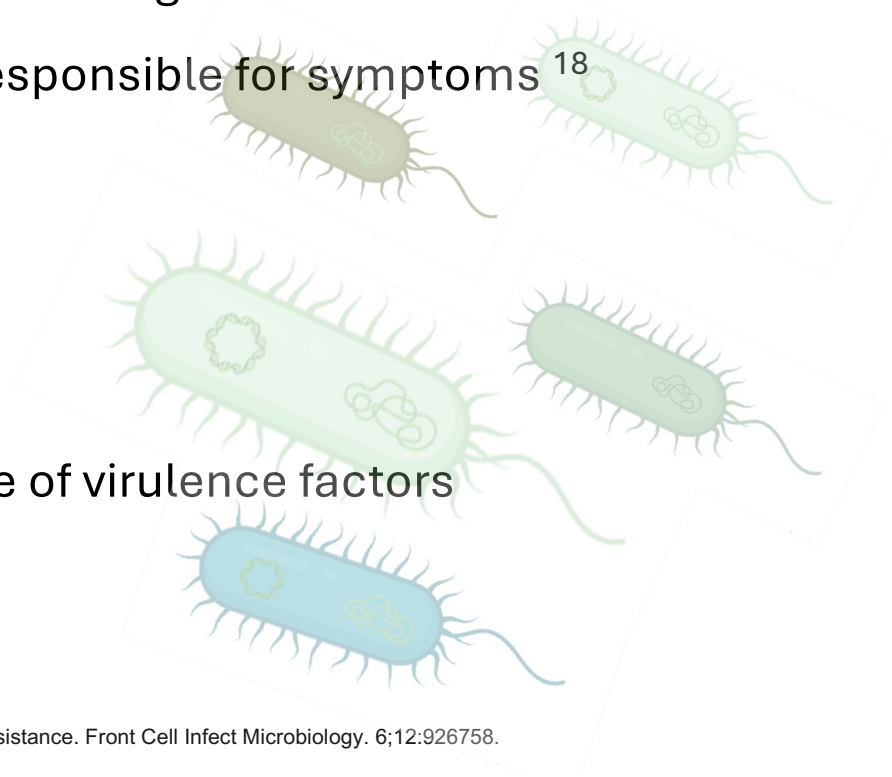
Virulence Traits of Pseudomonas Species

- Virulence factors - the components that allow an organism to infect and persist within a host as well as often being responsible for symptoms [18]
  - Toxins
  - Secretion systems
  - Motility and adhesion determinants
  - Biofilm production
- *P. aeruginosa* known to produce a huge range of virulence factors



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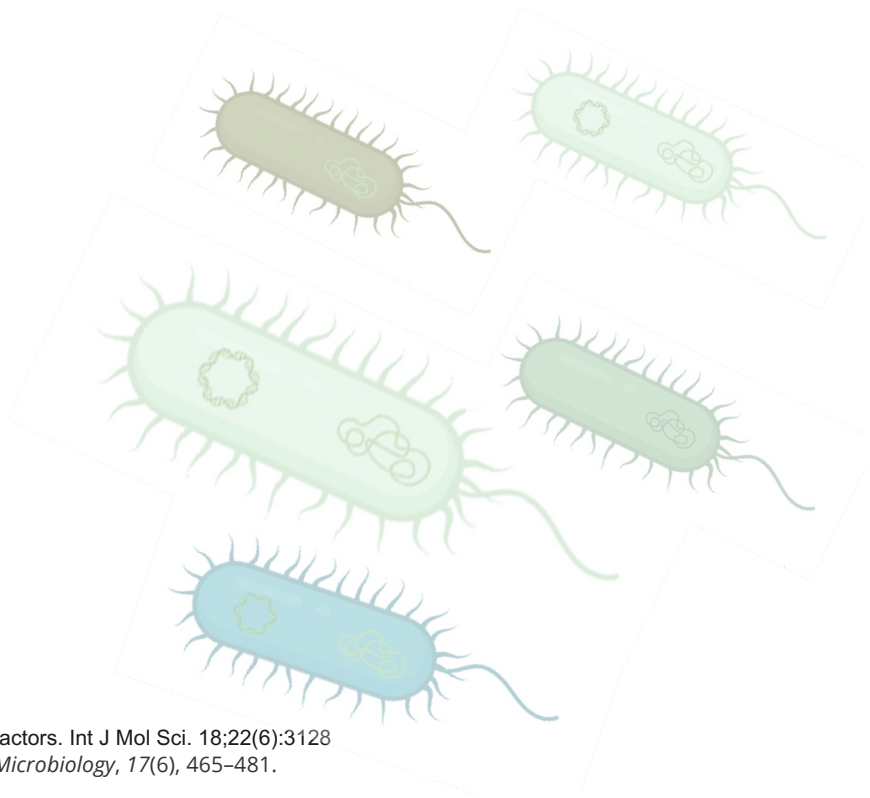
18) Liao *et al*. 2022. Virulence Factors of *Pseudomonas Aeruginosa* and Antivirulence Strategies to Combat Its Drug Resistance. Front Cell Infect Microbiology. 6;12:926758.

Virulence Traits of *Pseudomonas* Species

- Toxins
- Pigment
- Enzymes
- Biofilms
- Motility determinants



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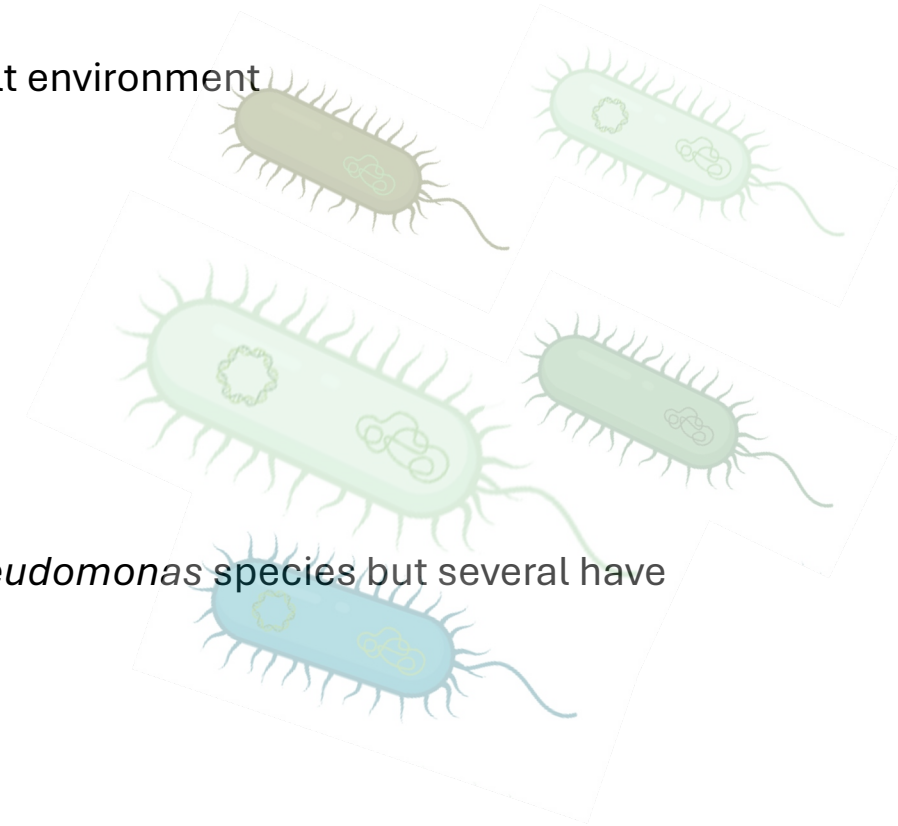
20) Veetilvalappil *et al*. 2022. Pathogenic Arsenal of *Pseudomonas Aeruginosa*: An Update on Virulence Factors. *Future Microbiology*, *17*(6), 465–481.

Objective summary

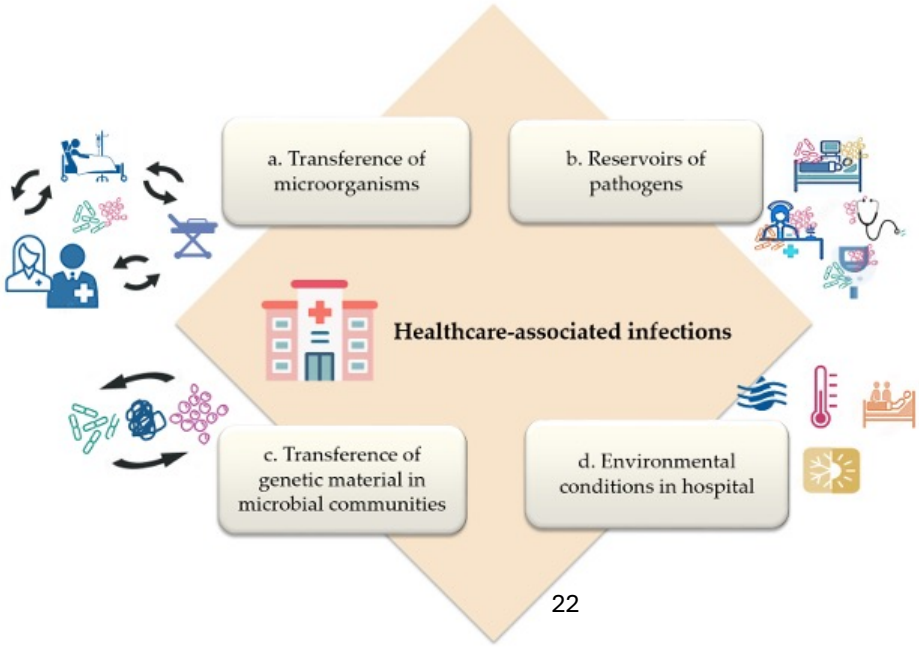
Objective 2: An introduction to *Pseudomonas* species and their virulence factors

- ✓ *Pseudomonas* species are common in the built environment
- ✓ *P. aeruginosa* is a leading cause of HCAI
  - Able to survive in the environment
  - Resist antimicrobials
  - Produce a range of virulence factors
- ✓ Much less is known about non-*aeruginosa Pseudomonas* species but several have also been implicated in HCAI



Movement of microorganisms between patients and environment

- Prior room occupation [21]
- Movement of organisms between humans and environment
    - Important IPC implications



22

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22) Cruz-López *et al*. 2023. How Does Hospital Microbiota Contribute to Healthcare-Associated Infections?" *Microorganisms* vol. 11(1) 192.

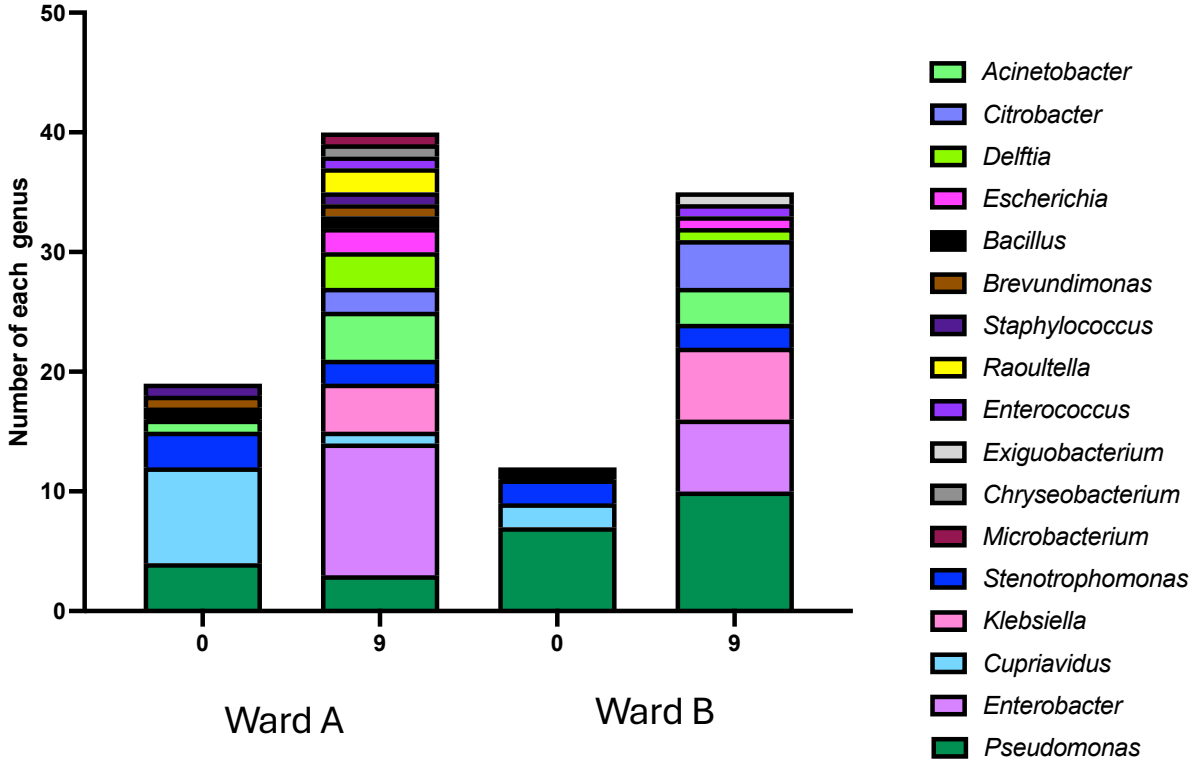
Impact of patients and care on sink microbes

Aim: To determine the effect patients have on the sink microbiome, and to characterise the sink *Pseudomonas* population in terms of drug resistance and presence of virulence factors.

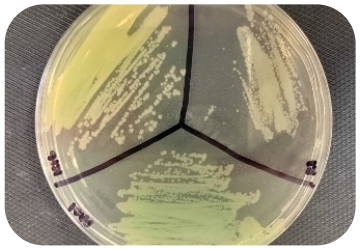
References
23) Rickard et al. 2024. A microbiological survey approach to understanding the virulence factors of Pseudomonas species in healthcare sinks, *Journal of Hospital Infection*, 151 84-91,

Impact of patients and care on sink microbes

- 106 isolates recovered and identified
- Changes after wards open to patients
- Differences between wards after they open to patients

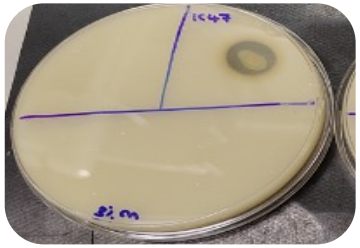


Impact of patients and care on sink microbes

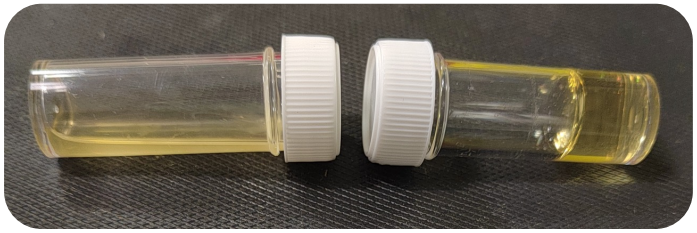


25% produced pigment

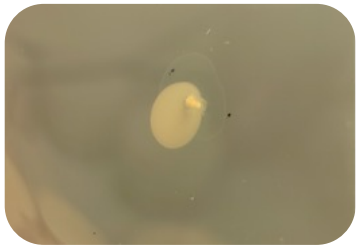
58% were haemolytic



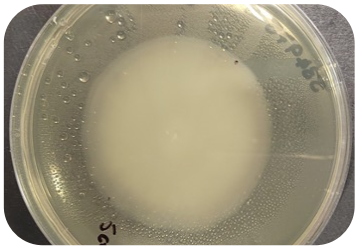
33% produced alkaline proteases



8% produced gelatinase



83% twitched



88% swam

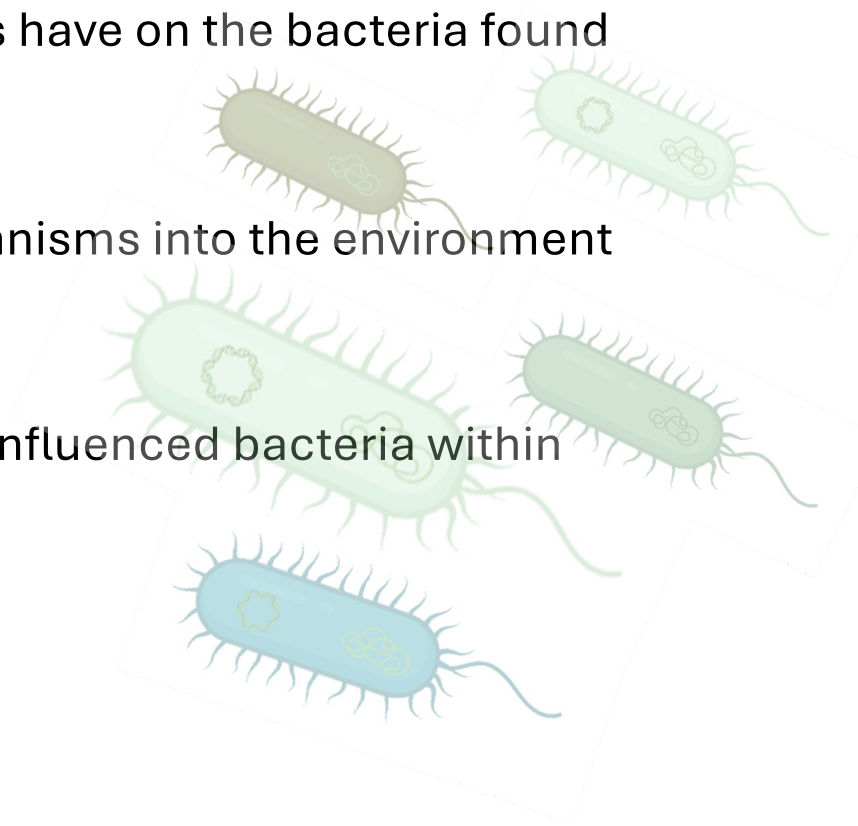
71% produced biofilm

Objective summary

Objective 3: Investigate the impact that patients have on the bacteria found within hospital sinks

✓ Our results suggest that patients deposit organisms into the environment and that these can persist within sinks

✓ Ward occupation and patient demographics influenced bacteria within hospital sinks

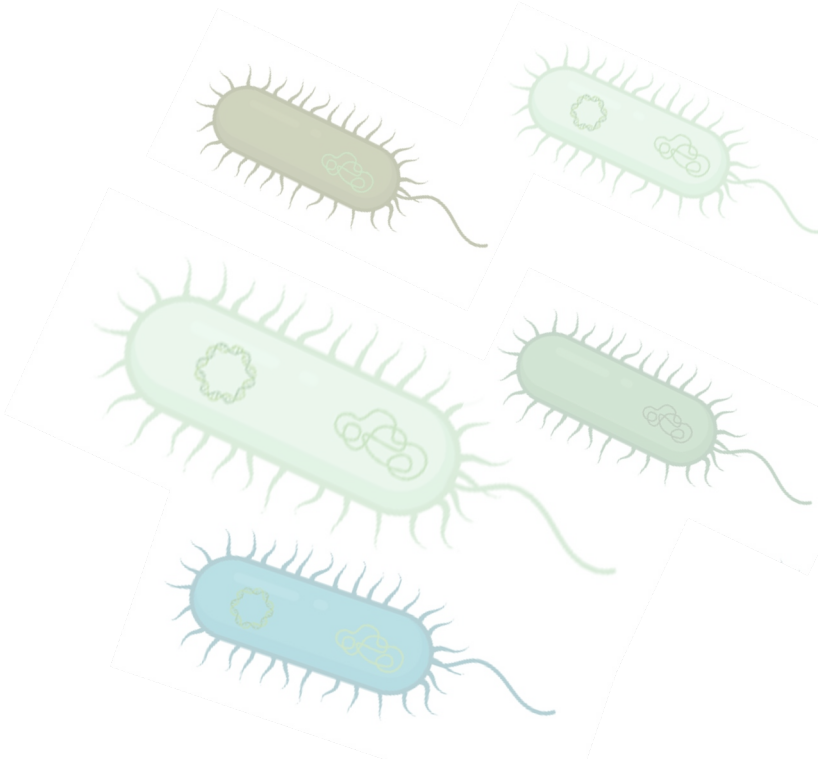


The importance of an interdisciplinary approach in infection prevention and control

- Understanding how people use sinks
- Not all patient populations are at equal risk from sink organisms

The importance of an interdisciplinary approach in infection prevention and control

- Preventing and controlling outbreaks from sinks
  - Microbial surveillance
  - Disinfection
  - Physical changes
  - Sink placement and numbers
  - Use and maintenance
  - Education and intervention

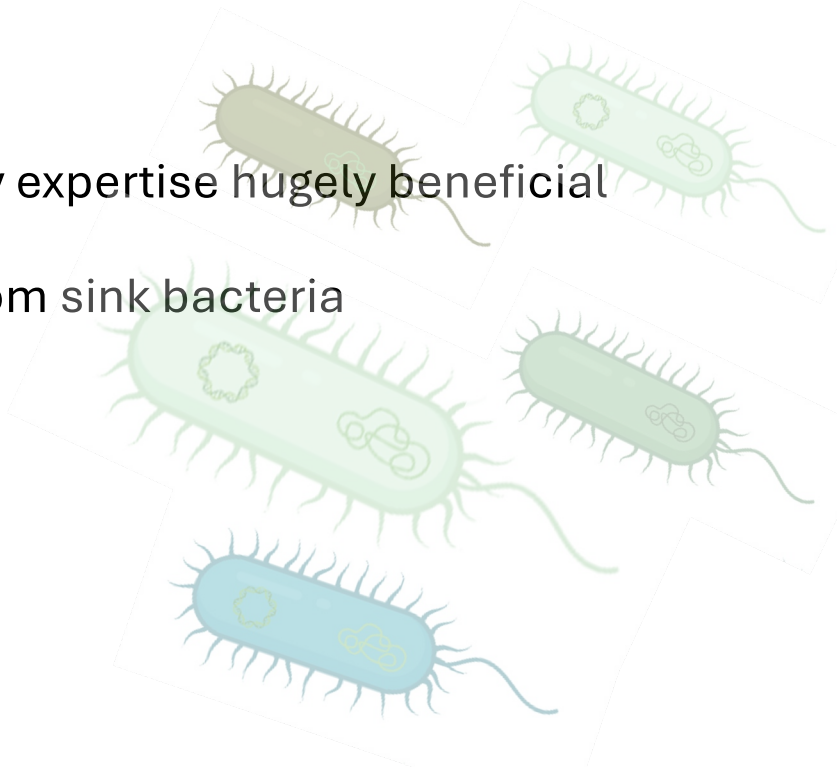


Objective summary

Objective 4: Recognise the importance of an inter-disciplinary approach in infection prevention

✓ Dedicated IPC team with clinical microbiology expertise hugely beneficial

✓ Multiple approaches needed to control risk from sink bacteria



Acknowledgements

- Healthy Infrastructure Research Group members
- Great Ormond Street Hospital staff
- Great Ormond Street Hospital patients and carers

Q&A

2025 Teleclass Education Topics

(most of them at least)

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