The relationship between air and surface microorganisms in hospital wards: a systematic review

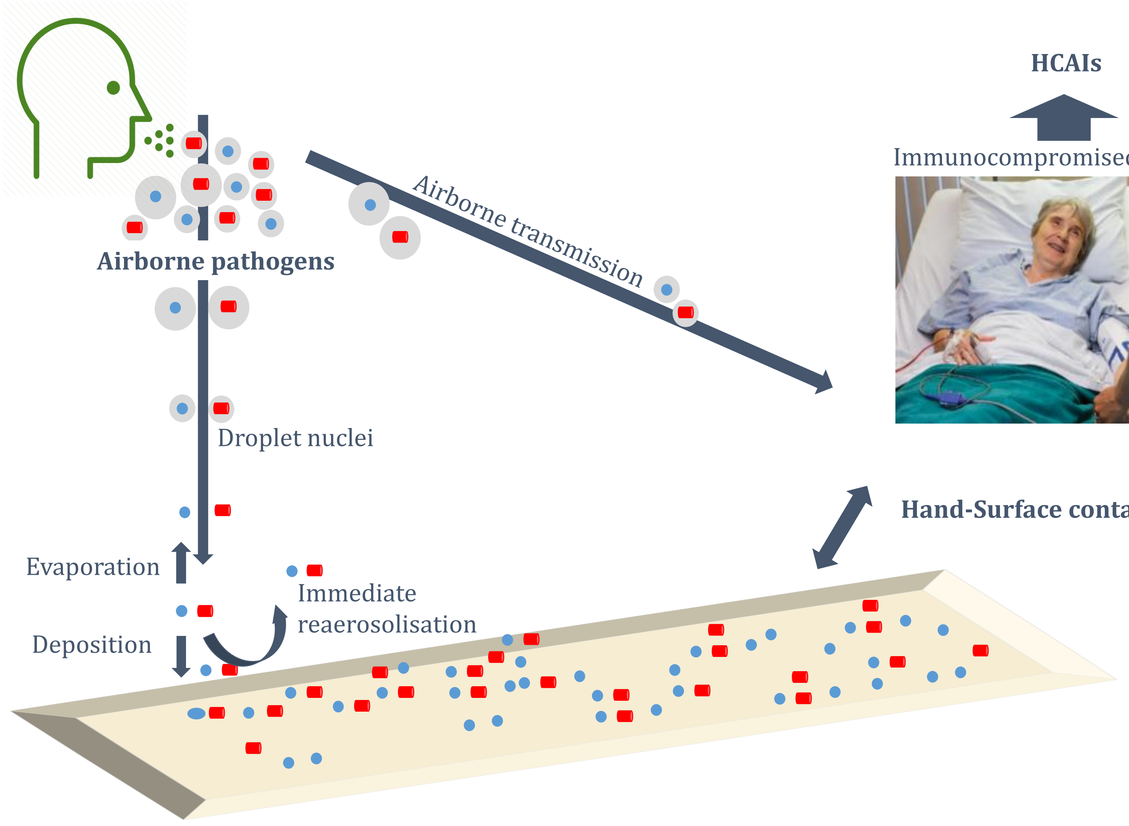
W. Hiwar[1], M-F King[1], L. A. Fletcher[1], S.J. Dancer[2,3] & C.J. Noakes[1]

[1] Water Public Health and Environmental Engineering, School of Civil Engineering, University of Leeds, UK
[2] School of Applied Sciences, Edinburgh Napier University, Edinburgh, UK
[3] Department of Microbiology, Hairmyres Hospital, NHS Lanarkshire Hospital, NHS Lanarkshire, UK

Motivation

- Total UK hospital admissions were about 16 million patients in 2015/2016; 162,000 of them acquired infections, these healthcare-associated infections (HCAIs) cost NHS £1 billion per year. [1, 2, 3].
- The hospital environment is thought to be responsible for up to 20 % of all HCAIs, acting as a reservoir for pathogens [4, 5].
- Exposure to airborne pathogens is a particular challenge, especially in respiratory wards [6]; immunocompromised patients are at crucially raised risk
- The relationship between airborne pathogens, surface contamination and HCAIs remains undisclosed [7].

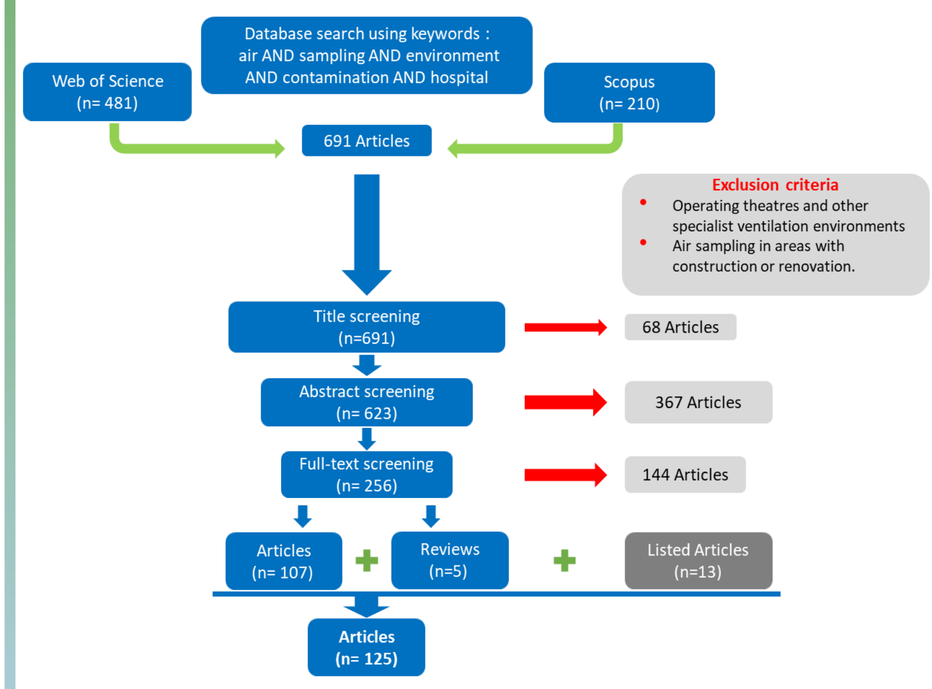
Mechanisms



Aim

To explore the gaps in knowledge on the influence of the environment on airborne pathogens in hospitals.

Methodology

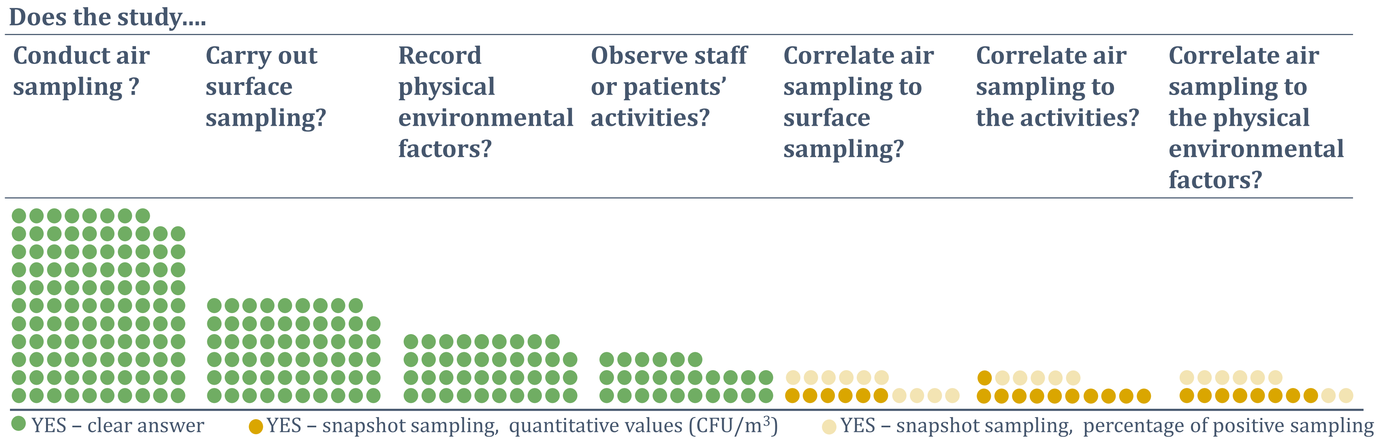


Results

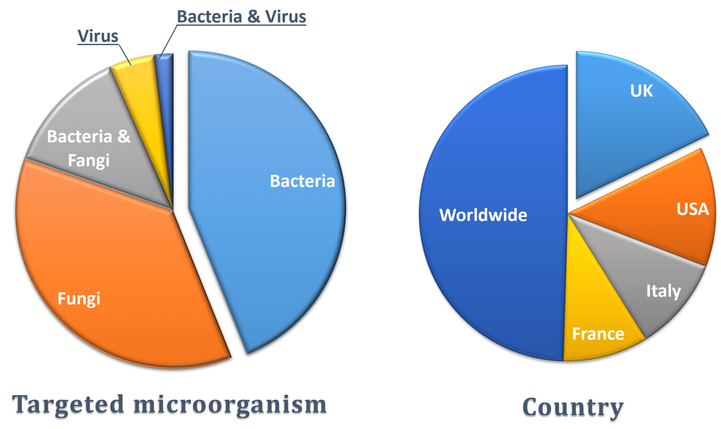
Reviewing previous work reveals the following points:

- Bacteria show the highest percentage of studied organisms in comparison with fungi and viruses.
- The most studied bacteria, fungi and virus were *Staphylococcus aureus*, *Aspergillus fumigatus* and *Torque teno virus* respectively.
- No studies correlated the microorganism load in the air to those on surfaces over short continuous periods of time (e.g. an 8 hour day). Study sampling generally occurs within a time "snapshot" and/or presents data for microorganisms as a percentage of positive results rather than quantitative values.
- The effect of air temperature, relative humidity, type of ventilation system, ventilation rate, size of room, layout of room and human activities on survival rate and spatial deposition rate of airborne pathogens over time is currently very limited.

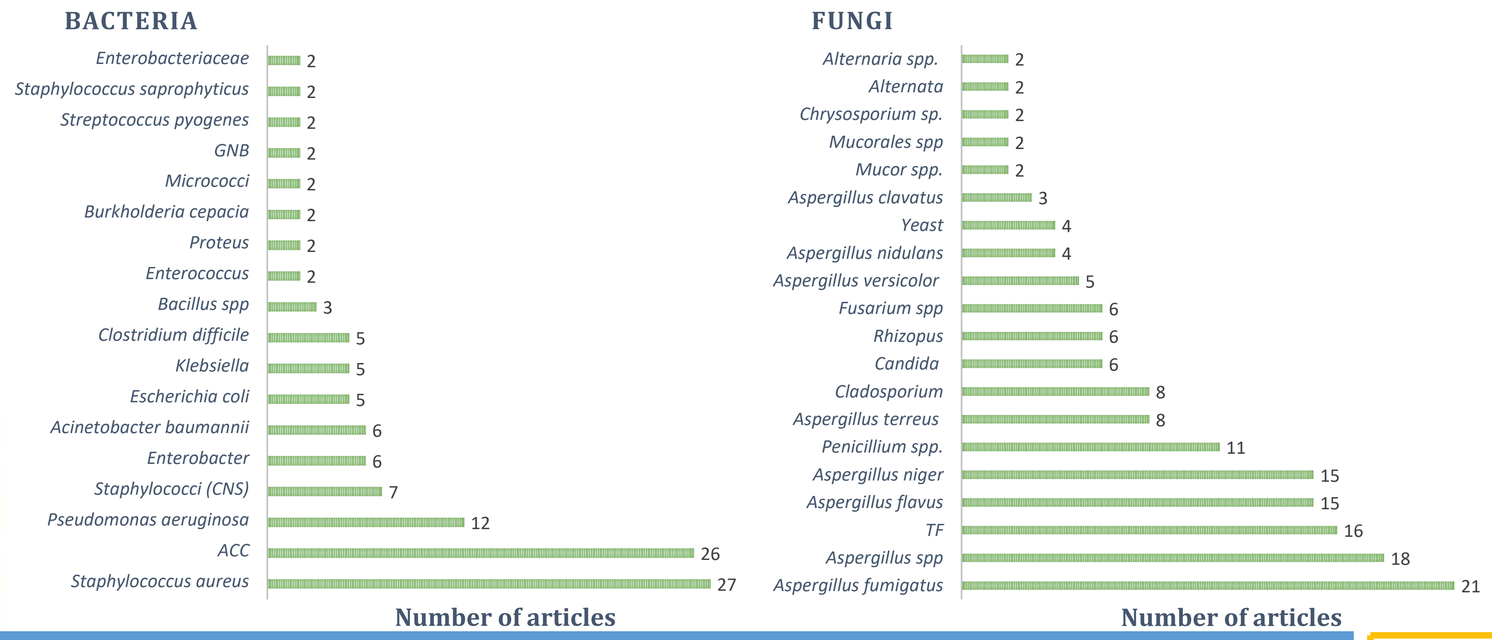
Research questions



Distribution of articles per...



Study target organisms



Conclusions

The field needs to...

- Quantify the relationship between the microorganism load in the air and on surfaces over a range of time lengths.
- Characterise the impact of physical environment and human parameters on this relationship.
- Characterise the environmental factors that influence the survival of microorganisms on surfaces.

- **Such knowledge can be used in mathematical modelling (CFD/risk models) to assess the relationship between airborne microorganisms, ward design and risk in healthcare buildings.**

References

1. NHS statistics, facts and figures - NHS Confederation.
2. Beggs, C. B. The Airborne Transmission of Infection in Hospital Buildings : Fact or Fiction ? Indoor Built Environ. 12, 9–18 (2003).
3. Public Health England. Point prevalence survey of healthcare- associated infections , antimicrobial use and antimicrobial stewardship in England Protocol , Public Health England. 1–29 (2016).
4. Loveday, H. P. *et al.* Epic3: National evidence-based guidelines for preventing healthcare-associated infections in nhs hospitals in england. J. Hosp. Infect. 86, S1–S70 (2014).
5. La Fauci, V. *et al.* Five-year microbiological monitoring of wards and operating theatres in southern Italy. J. Prev. Med. Hyg. 58, 166–172 (2017).
6. Yang, C.-T. *et al.* Construction and Application of an Intelligent Air Quality Monitoring System for Healthcare Environment. J. Med. Syst. 38, 15 (2014).
7. Smith, J. *et al.* Is there an association between airborne and surface microbes in the critical care environment? J. Hosp. Infect. 44, 1–7 (2018).

EPSRC
UNIVERSITY OF LEEDS