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Evaluation of the airborne contamination levels in an Intensive Care Unit over a 24 hour period

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Background

- Airborne transmission of infectious microorganisms poses a critical health threat, particularly in the clinical setting where it is estimated that 10-33% of nosocomial infections are spread via air.
- Current knowledge of the clinical airborne microflora is limited and there is uncertainty surrounding the contribution of airborne microorganisms to the transmission of nosocomial infection.
- Microorganisms originating from the human respiratory tract or skin can become airborne by coughing and sneezing, and periods of increased activity such as bed and dressing changes, staff rounds and visiting hours.
- This study aims to establish an improved understanding of the variability in the dynamics and levels of airborne microbial contamination within an operational intensive care unit (ICU).

Methods

- Environmental monitoring of airborne contamination levels was conducted in Glasgow Royal Infirmary ICU, in both occupied and unoccupied patient isolation rooms.
- A sieve impactor air sampler was used to collect 500L air samples every 15 minutes over a 24 hour period (08:00 – 08:00h).
- Samples were collected on agar plates, and bacterial contamination levels recorded as CFU/m^3 of air.
- An activity log was collated over the sampling period to record activities that might contribute to spikes in contamination levels.

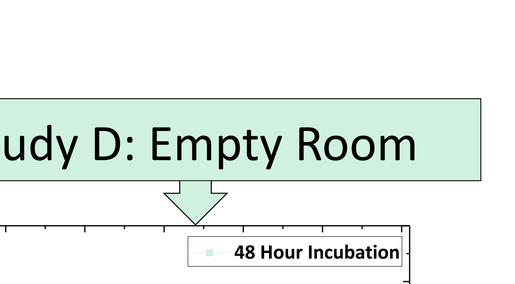


Fig 1. (A) SAS Super 180 Impactor air sampler with fitted TSA plate and separate aspirating head and (B) ICU patient isolation room layout showing position of air sampler.

Results

24 Hour Air Studies

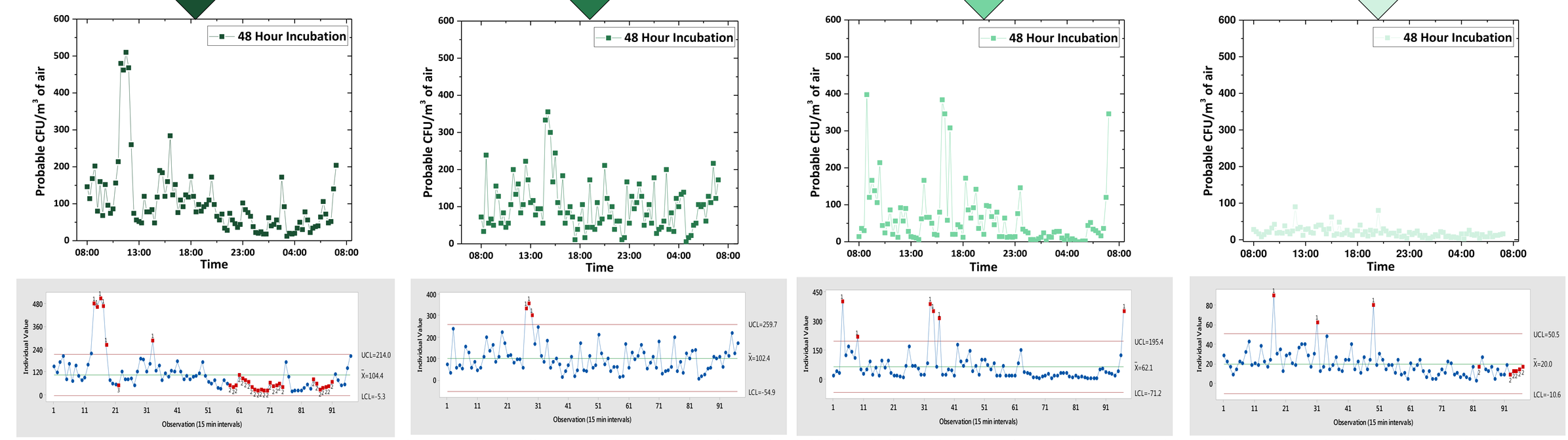


Fig 2. Air contamination levels over a 24 hour period in an ICU isolation room during different patient/ room scenarios. (Top Row) Probable CFU/m^3 of air and (Bottom Row) Statistical process control charts indicating upper and lower control limits and highlighting in red, data points that are termed 'out of control' in relation to the overall dataset. n=97

Average: **104** CFU/m^3
Highest: **510** CFU/m^3
Lowest: **12** CFU/m^3

■ = Patient turn, patient moved from bed to chair, visitation, high room activity

Average: **102** CFU/m^3
Highest: **355** CFU/m^3
Lowest: **5** CFU/m^3

■ = Visitation with personal fan switched on

Average: **62** CFU/m^3
Highest: **398** CFU/m^3
Lowest: **0** CFU/m^3

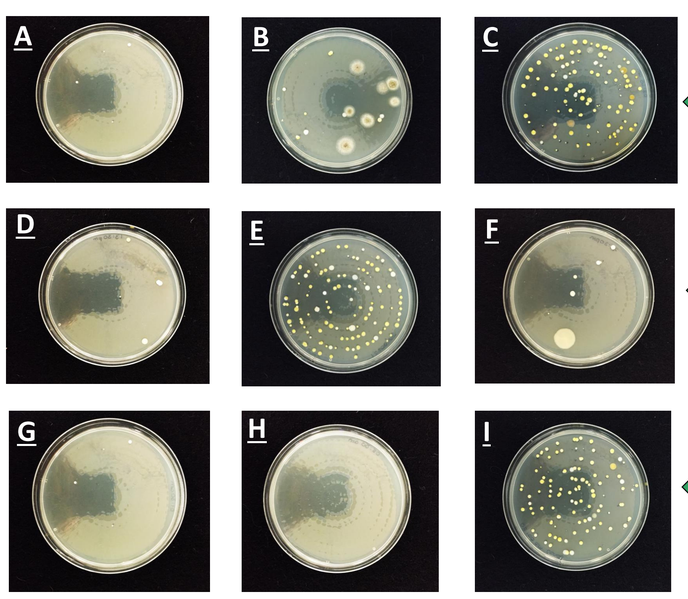
■ = Chest x-ray, high staff numbers present, patient turn, visitation

Average: **20** CFU/m^3
Highest: **90** CFU/m^3
Lowest: **2** CFU/m^3

■ = Floors and surfaces cleaned, bins emptied and staff handover

Microbiology

Visual representation of airborne microorganisms collected onto TSA plates from a patient-occupied ICU Isolation room over 24 hours. Plate images highlight the variation in air contamination levels through out the day.



Morning
A: 08:00 am
B: 08:30 am
C: 08:45 am

Afternoon/Evening
D: 13:30 pm
E: 16:00 pm
F: 22:30 pm

Overnight:
G: 01:30 am
H: 05:00 am
I: 08:00 am

Conclusions

- This study has demonstrated a high degree of variability in levels of airborne contamination over the course of a 24 hour period in a hospital ICU.
- Numerous factors were found to contribute to microbial air contamination levels, including patient status, length of room occupation, time of day and room activity.
- Peaks in airborne contamination showed a direct relation to an increase in room activity.
- Contamination levels were lower overall during the night, and in unoccupied isolation rooms.
- The highest counts were observed in an isolation room occupied for 10 days by a patient with C. *difficile* infection.

Acknowledgements

- The authors of this work wish to thank the staff and patients of Glasgow Royal Infirmary Intensive Care Unit for their patience and help throughout the duration of this study.
- LD is funded by an EPSRC doctoral training grant (Reference: EP/M508159/1).

EPSRC Engineering and Physical Sciences Research Council

ROLEST The Robertson Trust Laboratory for Electronic Sterilisation Technologies