Assessment of the Variability of Airborne Contamination Levels in an Intensive Care Unit over a 24 Hour Period

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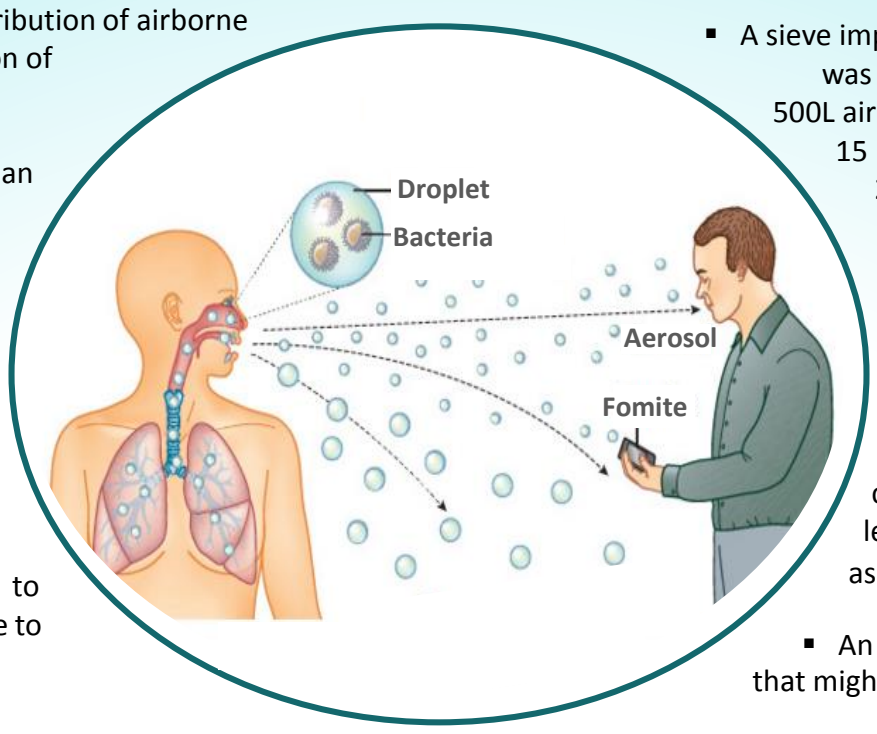
Introduction

- Airborne transmission of infectious microorganisms is a serious public health threat, accounting for ~10-33% of all nosocomial infections.
- Current knowledge of the clinical airborne microflora is limited and there is uncertainty surrounding the contribution of airborne microorganisms to the overall 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 changes, staff rounds and visiting hours.
- The objective of this study was to evaluate the variability in the dynamics and levels of airborne contamination within a hospital ICU in order to establish an improved understanding of the extent to which airborne bioburden may contribute to cross-infection of patients.



Methods

- Environmental monitoring of airborne contamination levels was conducted in GRI ICU, in both occupied and unoccupied patient isolation rooms.
- A sieve impactor sampler was used to collect 500L air samples every 15 minutes over a 24 hour period (8am – 8pm).
- Samples were collected on agar plates, and bacterial contamination levels recorded as CFU/m^3 of air.
- An activity log was collated to record activities that might contribute to spikes in contamination levels.

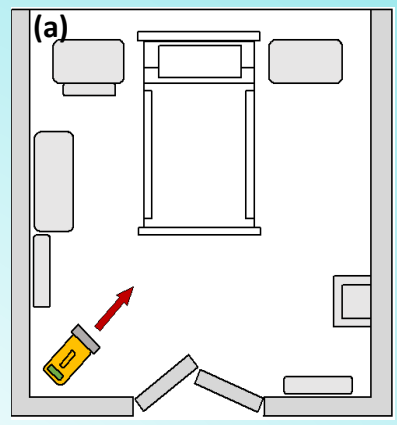


Fig 1. (a) ICU patient isolation room layout showing position of air sampler and (b) air sampler with fitted TSA plate and separate aspirating head.

Results

Study

1. **Room occupied:** 10 days

Patient: 70 year old female, respiratory failure, *C. difficile* infection.

2. **Room occupied:** 6 days

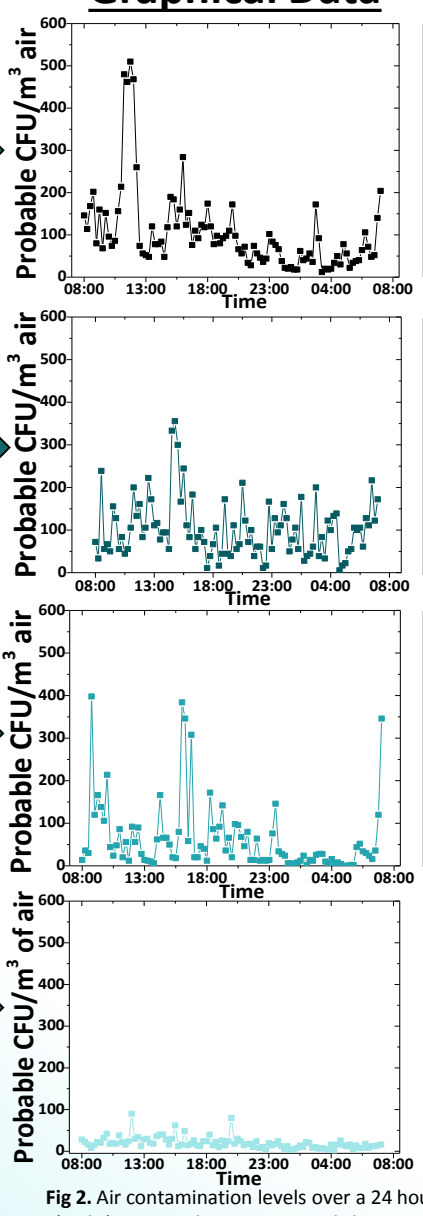
Patient: Male with widespread muscle and nerve weakness from Guillian-Barre disease.

3. **Room occupied:** 1 day

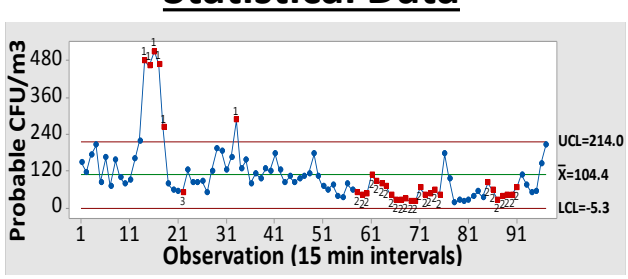
Patient: 56 year old female, respiratory failure with background of rheumatoid arthritis.

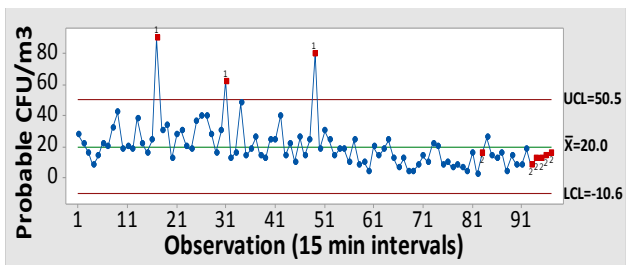
4. **Empty Room:** Unoccupied for 2 days

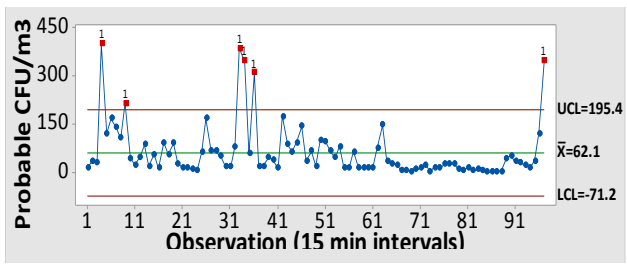
Graphical Data

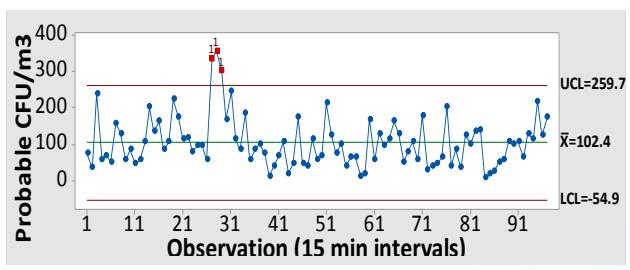


Statistical Data









Analysis

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

Fig 2. Air contamination levels over a 24 hour period in an ICU isolation room. (Left) Probable CFU/m^3 of air and (Right) 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

Microbiology:

Visual representation of variation in air contamination levels throughout the day in an occupied patient isolation room.

Conclusions

- This study demonstrates the degree of airborne contamination that can occur in an ICU over a 24 hour period and how much it can vary.
- Numerous factors were found to contribute to microbial air contamination including patient status, length of stay, 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, whilst the highest counts were observed in an isolation room occupied by a patient with *C. difficile* infection.

Future Work

Consideration should be given to potential improved infection control strategies and decontamination technologies which could be deployed within the clinical environment to reduce the airborne contamination levels, with the ultimate aim of reducing healthcare-associated infections from environmental sources.

Acknowledgements

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