CAN CONTAMINANT AIR QUALITY INDICES BE USED TO ANALYZE THE RISK OF AIRBORNE CROSS INFECTIONS IN HOSPITAL ENVIRONMENTS?

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ABSTRACT

Ventilation systems are designed to remove contaminants from hospital environments. Different air quality indices are used to express the ability of a system to remove airborne contaminants. However, indices related to peak exposure to contaminants can be used to characterize the risk of airborne cross infections in hospital environments. Local air quality index are compared to local exposure coefficient and local maximum exposure coefficient at different air changes rates using tracer gas measurements in an experimental setup with a mixing ventilation system.

KEYWORDS

Ventilation; hospital environment; air quality indices; exposure to contaminants

1 INTRODUCTION

In a hospital environment one of the most important pathogen sources is due to the respiratory activity of a potentially infectious patient. Droplet nuclei are generally considered as the vehicles that transmit airborne transmissible diseases (Qian & et_al., 2008). Infection-control risk assessment in hospital environments requires the use of performance-based approaches in relation to spread of infectious diseases via the airborne route (CDC, 2003). Several contaminant removal indices can be used when detailed information is available on contaminant sources (Mundt E., 2004). Traditionally, indices that express the ability of a ventilation system to remove airborne contaminants are used. However, local maximum exposure to contaminants indices can be used to characterize the risk of airborne cross infections in hospital environments.

2 METHODOLOGY

The experimental setup at the HVAC Laboratory at the University of Cordoba correspond to a typical hospital room with two thermal breathing manikins, a patient (source of contaminants) and a health worker, figure 1. A mixing ventilation system is composed by a grille supply air, G, and a grille exhaust air, E2. Three different air changes rates are used, 6, 9 and 12 h^{-1}.

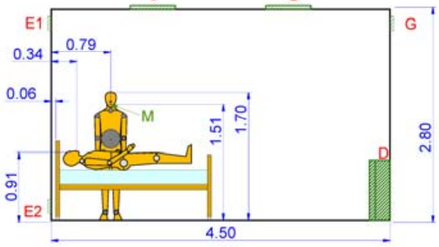

Figure 1: Profile view of the test room. Supply air grille (G); exhaust air grille (E2).

Tracer gas measurements, point M in figure 1, are used to evaluate different air quality indices. Indices representing the ability of a system to remove airborne contaminants such as local air quality index, ϵ_p^c and indices representing the exposure to contaminants such as exposure coefficient, C_{exp}, and the local maximum exposure coefficient, $C_{exp,max}$, are shown in table 1.

Table 1: Local air quality index and exposure coefficients.

Local air quality index	Exposure coefficient	Local maximum exposure coefficient
$\epsilon_p^c = \frac{c_e}{c_p}$	$C_{exp} = \frac{c}{c_e}$	$C_{exp,max} = \frac{\bar{c}_{max}}{c_e}$

The local maximum exposure coefficient is obtained as the average of the maximum values registered in the specified point divided by the average concentration in the exhaust. A concentration measurement is considered as a maximum if its value exceeds a 25% the average concentration in the considered point.

3 RESULTS AND DISCUSSION

Time series analysis of exposure coefficient, figure 2a, show peak values. Concentration peak values are used to calculate local maximum exposure coefficient. Local air quality index, local exposure coefficient and local maximum exposure coefficient at different air changes rates are shown in figure 2b.

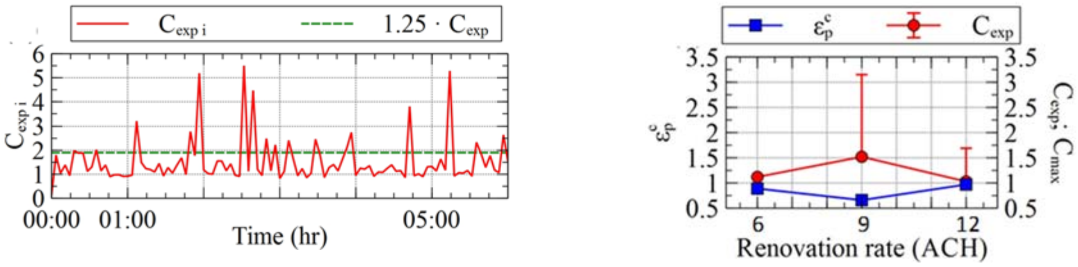

Figure 2: a) Exposure coefficient vs. time; b) Local air quality index, local exposure coefficient and local maximum exposure coefficient at different air changes rates.

4 CONCLUSIONS

The ability of the ventilation system to remove airborne contaminants is not always related to the exposure to contaminants. Indices representing peak exposure to contaminants can be used to characterize the risk of airborne cross infections in hospital environments.

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