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An evaluation of different control measures on SARS airborne transmission in a hospital with a multi-zone modelling method

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Abstract

In this study, the multi-zone modelling method was integrated with the Wells-Riley equation to study the SARS airborne transmission in a nosocomial outbreak and evaluate the effectiveness of different airborne control measures. The results showed increasing the ventilation rates and filter efficiencies, quanta generation control would weaken the air transmission of disease.

Keywords - airborne route transmission; multi-zone modelling; SARS; nosocomial outbreak

1. Introduction

Since the epidemics of SARS, a number of outbreak studies have provided probable evidences for the airborne route transmission and proposed several airborne control measures [1]. In the existing investigations of the airborne disease transmission, the multi-zone model has shown its simplicity and accuracy [2, 3]. To evaluate the effectiveness of different airborne control measures, we integrated the multi-zone modelling method with the Wells–Riley equation, revisited and examined the largest nosocomial SARS outbreak in 2003 in Hong Kong.

2. Methods

In the study, we divided the ward into 6 zones and assumed that the bio-aerosols concentration in each zone was uniform. Bio-aerosols containing viruses from the index patient were thought to be transmitted between zones due to the airflows through each opening. Neglecting the influence of outdoor wind on the indoor environment, we considered the airflow as a result of thermal buoyancy and mechanical ventilations. By solving the mass balance equations of airflow and the conservation equations of energy and bio-aerosols, the airflow rates and bio-aerosol concentrations were acquired. Therefore, the exposure dose for susceptible in different zones could be calculated and according to the Wells-Riley equation, the corresponding infection risk were predicted and then compared with the outbreak data [1] and CFD studies [4]. The infection risk distributions under different

conditions, namely various ventilation rates, filter efficiencies, and quanta generations, were compared to evaluate the relative effectiveness of different airborne control measures.

3. Results

The result showed a reasonable agreement between the results from the multi-zone method and those from the outbreak data and CFD methods. With higher ventilation rates, the infection risk was reduced. As shown in Fig. 1, when the filter efficiencies increased, the infection risk decreased and the reductions were more evident in distant zones. The control of quanta generation was found to be more effective when the quanta generation was lower.

4. Conclusions

From the results, conclusions could be summarized as follows:

- The multi-zone method integrated with the Wells-Riley equation was applicable to evaluating the role of airborne route of disease transmission.
- Increasing the ventilation rates and filter efficiencies was meaningful to weaken the air transmission of disease to distant regions.
- The control of quanta generation was more effective for normal index patients compared to super-spreaders.

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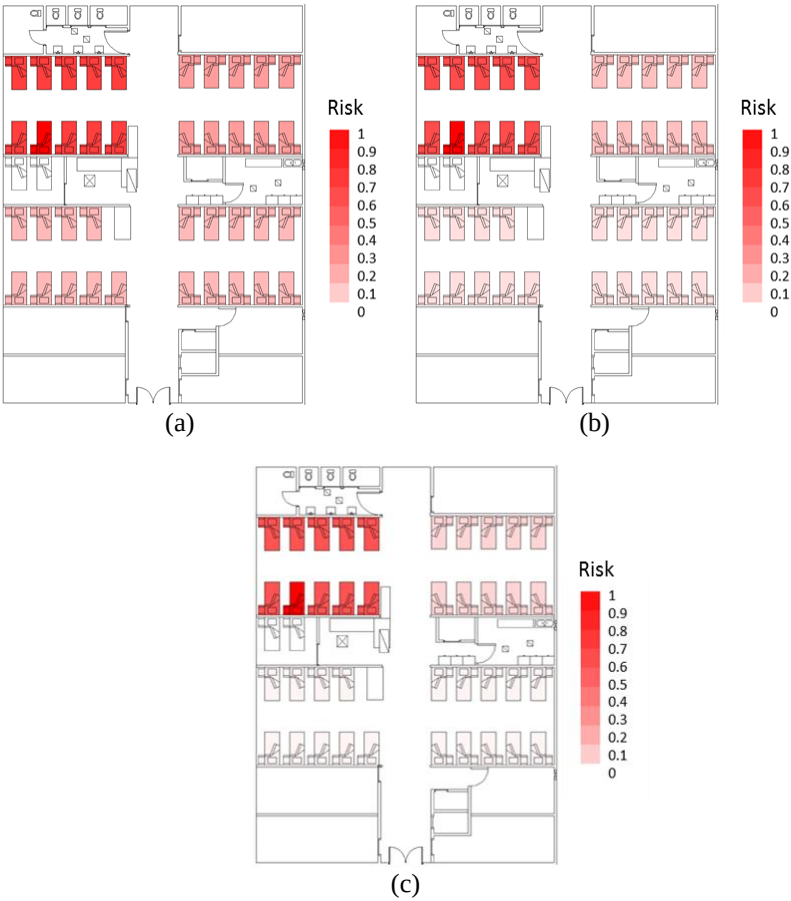

Fig. 1 Predicted spatial risk distribution in ward 8A for normal inpatients during 4 days. (a) Filter efficiency = 0%; (b) Filter efficiency = 50%; (c) Filter efficiency = 100%.