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Multi-route transmission of influenza in a hospital ward

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Abstract

In this study, the relative importance of different transmission routes of influenza in a hospital ward was studied with a multi-route disease transmission model. The Wells-Riley equation was employed to calculate the infection risk of every susceptible. According to the results, the close contact route was dominating way to transmit the influenza viruses, and the contributions from the airborne route and the fomite route are nearly equivalent.

Keywords - multi-route transmission; nosocomial outbreak; influenza

1. Introduction

Nosocomial infections have become a severe health issue due to its prevalence and mortality [1, 2]. The transmission process of influenza is poorly understood [3]. The relative importance of different transmission routes remains controversial and therefore the most appropriate control strategies are usually difficult to decide. In this study, we made use of a newly-developed multi-route disease transmission model to predict the infection risk of different transmission routes of influenza in a hospital ward.

2. Methods

In the new transmission model, three transmission routes, namely the airborne route, close contact route and fomite route, were considered. With regard to the long computational time period, the index patient was assumed to be a steady source. As for the airborne transmission route, the ward was divided into several zones and the exposure dose for the susceptible in each zone was calculated based on a multi-zone airflow model. In the close contact model, an idealized respiratory jet was assumed to exist when the index patient carried out respiratory activities, and the exposure dose caused by direct inhalation of droplet nuclei or large droplet deposition on the mucous membranes was respectively calculated. The fomite transmission model associated all representative environmental surfaces in the ward with human touching behaviors and predicted the exposure doses caused by touching mucous membranes with contaminated hands. With the Wells-Riley equation, the relative importance of different routes was quantitatively compared in the form of infection risk. The new model was validated against the epidemiological data from a seasonal influenza A outbreak in a general medical ward at Princes of Wales Hospital (PWH; Hong Kong) in 2008 [4].

3. Results

According to the simulation results for 1000 times, as shown in Fig.1, the airborne route contributed 18% about to the infection, and the infection risk decreased as the distance increased; the close contact route contributed about 63%, and only those assumed to have close contact with infectors were possible to get infected; the fomite route contributed about 19%, and the infection risk distributions were relatively uniform except those adjacent to the virus source. With higher close contact frequencies and longer durations, the close contact route contributed more to the infection and brought more random to the distribution of the infection risk.

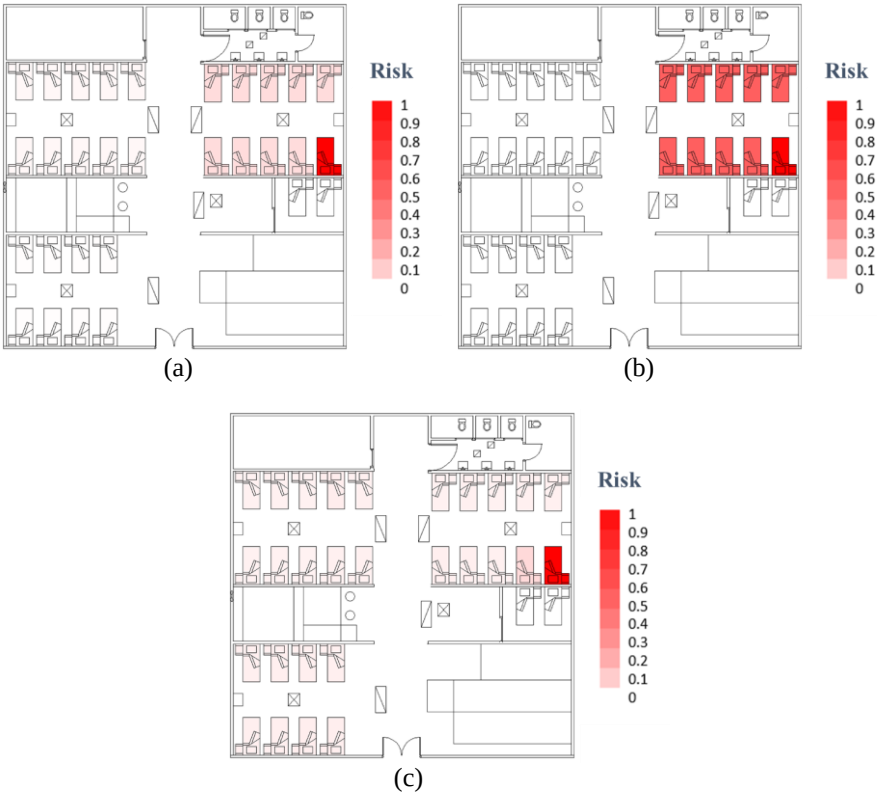

Fig. 1 Predicted spatial risk distribution pattern of different transmission routes in a hospital ward for normal inpatients: (a) airborne route; (b) close contact route; (c) fomite route.

4. Conclusions

The results suggested that close contact transmission control measures were the most meaningful to prevent the transmission of influenza, and proper ventilation system design and enough surface cleaning could be effective invention methods for outbreaks.

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