Building and Environment 46 (2011) 2512–2519

Contents lists available at ScienceDirect

Building and Environment

journal homepage: www.elsevier.com/locate/buildenv

Removing indoor particles using portable air cleaners: Implications for residential infection transmission

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ARTICLE INFO

Article history:
Received 23 February 2011
Received in revised form
1 June 2011
Accepted 3 June 2011

Keywords:
Portable air cleaners
Influenza
Surrogate particles
Expsores
Infection risk

ABSTRACT

Reducing indoor exposure to influenza particles can be an important strategy to manage residential infections. Many portable air cleaning (PAC) technologies are currently employed in residential environments but very little research has been performed to evaluate and compare their performance in terms of particle removal associated with influenza. This study evaluates the effectiveness of portable air cleaners at removing airborne NaCl particles as an analogue to the influenza virus and applies the results to an IAQ mass balance model to evaluate the performance in controlling residential exposures and mitigating infection risks. Various devices representing different PAC technologies were tested using a pull down particle challenge in a full scale stainless steel chamber. Particle generation and measurement were conducted using a 6-jet atomizer and a paired aerodynamic particle sizer (APS)-scanning mobility particle sizer (SMPS), respectively. PAC incorporating HEPA filtration, electrostatic precipitation, ion generation and electret filtration were tested. We found that particle exposures released during a cough or sneeze event in a typical Quebec City residential room in Canada can significantly be reduced using HEPA, electrostatic precipitation and electret filtration PACs when compared with a situation where no PAC is being used. Modelling analysis demonstrates that the use of these PACs can mitigate the risks of influenza infection via airborne route for a caregiver or a spouse sharing the same room. The implications of this study are significant considering low ventilation rates of Quebec City residences.

1. Introduction

Experts agree that when the next influenza pandemic takes place, it may overwhelm health care capacities, forcing many sick people to be cared for at home by family caregivers [1]. Current research on deaths due to influenza showed that care-giving spouses are at great risk of infection from their husbands or wives. Studies that examined data on deaths due to influenza revealed that spouses sharing the household of an infected spouse are subjected to approximately twice the population expected number of deaths due to infection, a relative risk ratio higher than that of any blood relatives [2,3]. Indeed, research on the risks mitigation to those living in the home but not yet infected with flu is needed.

Influenza particles are known to be transmitted naturally via respiratory aerosols produced by infected patients. Such particles may be produced during normal activities by breathing, talking, coughing and sneezing. The mechanism of influenza virus transport from its release to when it infects a new host is still not well understood [4]. Among the three different possible mechanisms (direct contact, indirect contact and airborne spread), airborne spread can be mitigated via biological and physical decay of the influenza virus. Currently, different indoor air quality technologies have the potential to remove airborne influenza particles in the indoor environment. Biological inactivation via UVGI lamps mounted in portable room devices or installed within HVAC systems has been applied to inactivate the influenza particles [5]. Physical removal via air cleaning such as HVAC filtration has been used for removing viral particles from the air stream supplying the indoor environment [6].

Numerous investigations have demonstrated that PACs can reduce concentrations of indoor airborne particles (for example Offermann et al., [7]). Since the 1970s, PACs have been widely promoted as economical and convenient air pollution control devices in homes. Although some studies have reported associations between use of PACs and improvements in respiratory health symptoms, these are focussed more on alleviating asthma and allergic problems [8]. Indeed, their application in terms of reducing exposures and managing influenza infections in homes have not been studied.

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0360-1323/$ – see front matter
doi:10.1016/j.buildenv.2011.06.008