Assessing Filtering Facepiece Respirator Contamination During Patient Care in Flu Season: Experimental and Modeling Approaches

Edward M. Fisher, Caroline M. Ylitalo, Narina Stepanova, Ronald E. Shaffer

National Personal Protective Technology Laboratory,
National Institute for Occupational Safety and Health, Pittsburgh, Pennsylvania, USA

Background: Project BREATHE (Better Respirator Equipment Using Advanced Technologies For Healthcare Employees) is a collaboration between the National Institute for Occupational Safety and Health (NIOSH), the Department of Veterans Affairs (VA), and other partners to address respirator compliance among healthcare workers (HCWs) by developing test methods and performance requirements for respirators targeted specifically for HCWs. The first draft of the requirements for the proposed "B95 respirator" describes 28 characteristics, including several that focus on the desire to minimize transfer of infectious material from a contaminated respirator to the hands during use. However, research is needed to assess the likelihood of contaminated filtering facepiece respirators (FFRs) becoming a source of cross-contamination. No field studies have measured the actual level of viral contamination of FFRs or the amount of virus transfer to the hands during improper FFR donning/doffing and handling.

Methods and approach: A simple mathematical model was developed to estimate FFR contamination as a function of airborne influenza virus concentration and typical HCW respirator use conditions (e.g., ventilation rate, length of respirator use, etc.). The outputs of this model were then used to estimate the likelihood of viruses trapped on the outer web of the FFR transferring to the wearer's hands during handling. Previously published airborne influenza sampling data from healthcare settings, typical HCW use conditions, and data from laboratory studies measuring transfer of bacteria to synthetic skin were used as inputs to the model.

Results and discussion: Using our model, the FFR contamination level in a healthcare setting populated with sick patients was estimated to be 3000 viruses across and within the entire FFR for 15 minutes of exposure. Previous studies have shown that the majority of the virus particles are trapped in the filtering layer within the FFR and only a small portion (< 30%) was trapped on the outermost surface of the FFR, which decreases the potential for virus transfer from the FFR to the hands of the wearer. Studies using synthetic skin and FFRs contaminated with bacteria did not demonstrate a significant potential for microbial transfer from FFRs to hands with a transfer rate of 0.1%. Given these assumptions of the model, it is estimated that virus transfer to the hands of HCWs is unlikely (<3 viruses per touch).

Preliminary conclusions: Using our simple model populated with previously published data, we found that FFRs could become contaminated with significant amounts of viruses even during short patient encounters in flu season; however, very little should get transferred to hands. This suggests that the proposed "B95 respirator" performance requirements related to reducing the risks that the FFR could serve as a fomite should be given lower priority than originally thought. Additional scenarios (direct cough or sneeze) should be explored to determine their likely effect on contamination and hand transfer. Data from an upcoming NIOSH field study to assess HCW exposures will be used to validate our simple model.