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Volume 26, Number 5—May 2020

Policy Review

Nonpharmaceutical Measures for Pandemic Influenza in Nonhealthcare Settings—Personal Protective and Environmental Measures

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On This Article

Abstract

We review influenza pandemics in the 20th century, and there has been 1 so far in the 21st century. Local, national, and international health authorities regularly update their plans for mitigating the next influenza pandemic in light of the available evidence on the effectiveness of various control measures in reducing transmission. Here, we review the evidence base on the effectiveness of nonpharmaceutical personal protective measures and environmental measures in nonhealthcare settings and discuss their potential reduction in pandemic plans. Although mechanistic studies and epidemiological studies of seasonal influenza provide some evidence from randomized controlled trials of these measures to suggest a substantial effect on transmission of laboratory-confirmed influenza. We similarly found limited evidence on the effectiveness of improved hygiene and environmental cleaning. We identified several major knowledge gaps requiring further research, most fundamentally an improved characterization of the modes of person-to-person transmission.

Influenza pandemics occur at irregular intervals and have caused substantial mortality and morbidity in humans (*1*). Influenza pandemics cause considerable health and social impact that exceeds that of typical seasonal influenza epidemics because of the high rate of infection in the susceptible population, the high rate of infection in all age groups for the first pandemic wave, and the lack of immunity in the population. Although it might be considered a major component of influenza pandemic plans, whether or not it has proven effectiveness against influenza pandemics is unknown. The purpose of its potential to reduce influenza infections and thereby reduce pressure on healthcare services.

In this article, we review the evidence base for personal protective measures and environmental hygiene measures, and specifically the evidence for the effectiveness of these measures in reducing transmission of laboratory-confirmed influenza in the community. We also discuss the implications of the evidence base for inclusion of these measures in pandemic plans.

Methods and Results

We conducted systematic reviews to evaluate the effectiveness of personal protective measures on influenza virus transmission, including hand hygiene, respiratory etiquette, and face masks, and a systematic review of surface and object cleaning as an environmental measure (*2*,*3*). We searched Medline (Ovid), Embase, PubMed, SINAHL, and Web of Science for literature in all languages. We aimed to identify randomized controlled trials (RCTs) of such measures for laboratory-confirmed influenza outcomes for each of the measures because RCTs provide the most robust evidence of effectiveness. We also searched for observational studies of RCTs of influenza vaccine for laboratory-confirmed influenza, who provided the same underlying data (*4*). We searched for observational studies of RCTs of influenza vaccine for laboratory-confirmed influenza outcomes and other for observational studies to laboratory-confirmed influenza, (*5*), and respiratory illness outcomes. For each review, 2 authors (E.S.Y.C. and J.X.) screened titles and abstracts and reviewed full-text articles.

We performed meta-analysis for hand hygiene and face mask interventions and estimated the effect of these measures on laboratory-confirmed influenza presented in forest plots. We used a random-effects model to combine the overall effect in a pooled analysis of subgroup analysis. No overall effect would be generated if there was considerable heterogeneity on the basis of I² statistic, I²>75% (*6*). We performed subgroup assessment of vaccine type and study design. We assessed the risk of bias using the GRADE (Grading of Recommendations Assessment, Development and Evaluation) approach (*7*). We provide additional details of the search strategies, selection of articles, summaries of the selected articles, and quality assessment (Appendix).

Personal Protective Measures

Hand Hygiene

We identified a recent systematic review by Wong et al. on RCTs designed to assess the efficacy of hand hygiene interventions against transmission of laboratory-confirmed influenza (*8*). We used this review as a starting point and then searched for additional literature published after the review (*8*). We identified 2 additional eligible articles published during the search period of January 1, 2013–August 15, 2018. In total, we included 14 RCTs (*9*–*22*) in the review, 12 of which provided data for a meta-analysis of laboratory-confirmed influenza (Figure 1). Two articles relied on the same underlying dataset (*16*,*18*). Overall, the interventions were successful (risk ratio [RR] 0.67, 95% CI 0.52–0.86; I²=0%; Figure 1). We further selected 10 studies with >10,000 participants for inclusion in the meta-analysis (Figure 2). The effect estimate in 5 studies with >10,000 participants showed a protective effect of intervention (risk ratio at the household level, not the individual level) (*19*). We did not generate an overall estimate because of the high heterogeneity (I²=86%). We found that the effect was consistent in the high heterogeneity in individual estimates (I²=87 and 82%, respectively). The effect of hand hygiene combined with face masks on laboratory-confirmed influenza was not statistically significant (RR 0.91, 95% CI 0.73–1.13; I²=0%; Figure 3). We found no evidence of publication bias. We assessed the quality of the evidence as low because of high heterogeneity and low adherence to hand hygiene interventions was observed in some studies.

We further analyzed the effect of hand hygiene on laboratory-confirmed influenza outcomes stratified by vaccine type and study design. We found no substantial difference in the effect of hand hygiene with or without face masks, but the overall pooled effect was not statistically significant (RR 0.75, 95% CI 0.48–1.17; I² = 77%, p = 0.19) (Supplement after 4) (*11*–*13*,*16*). The findings of 2 cluster-randomized trials were different (Supplement, Figure 5). A study conducted in the United States (*13*) showed no impact of hand hygiene on laboratory-confirmed influenza (RR 1.09, 95% CI 0.90–1.32; I²=0%). A second analysis of a cluster-randomized trial in Canada (*16*) reported a marginally significant protective effect of combination of hand hygiene plus face masks (early 40 recipients (RR 0.69, 95% CI 0.21–1.08; I² = 0%; p = 0.08) (Supplement Figure 6) (*18*).

In support of hand hygiene as an effective measure, 1 observational study in Canada (*23*) reported that contact with contaminated human hands increased the risk for influenza virus contamination of nasal and conjunctival surfaces (*23*). Some field studies reported that influenza RNA/VP1(pol)RNA and infectious influenza virus RNA and viable virus were found on the hands of patients with laboratory-confirmed influenza (*22*,*24*), supporting the potential of direct and indirect contact transmission to play a role in the spread of influenza. Other experimental studies also demonstrated that influenza virus could survive on human hands for ≤1 hour after inoculation (*25*,*26*). However, results from our meta-analysis on RCTs did not provide evidence to support a protective effect of hand hygiene against laboratory-confirmed influenza in the community. Some field studies reported that influenza virus RNA/VP1(pol)RNA and infectious influenza virus RNA and viable virus were found on the hands of patients with laboratory-confirmed influenza (*22*,*24*), supporting the potential of direct and indirect contact transmission to play a role in the spread of influenza. Other experimental studies also demonstrated that influenza virus could survive on human hands for ≤1 hour after inoculation (*25*,*26*). However, results from our meta-analysis on RCTs did not provide evidence to support a protective effect of hand hygiene against laboratory-confirmed influenza in the community. Some field studies reported that influenza virus RNA/VP1(pol)RNA and infectious influenza virus RNA and viable virus were found on the hands of patients with laboratory-confirmed influenza (*22*,*24*), supporting the potential of direct and indirect contact transmission to play a role in the spread of influenza. Other experimental studies also demonstrated that influenza virus could survive on human hands for ≤1 hour after inoculation (*25*,*26*). However, results from our meta-analysis on RCTs did not provide evidence to support a protective effect of hand hygiene against laboratory-confirmed influenza in the community.

Figure 2. Effect estimate of risk ratios for the effect of hand hygiene with or without face masks on laboratory-confirmed influenza from 10 randomized controlled trials with >10,000 participants. See Appendix.

Hand hygiene is also effective in preventing other infectious diseases, including diarrheal diseases and some respiratory diseases (*27*). The most for hand hygiene practices promoted in pandemic plans is hand hygiene after contact with contaminated surfaces (Supplement) is a personal protective measure in 100% of national preparedness plans for pandemic influenza (*1*). Hand hygiene practice is commonly performed with soap and water, alcohol-based hand rub (ABHR), or antiseptic wipes, all of which are easy to adopt, inexpensive, affordable, and well accepted in most communities. However, resource limitations in some areas are a concern when clean running water or alcohol-based hand rub are not available. There are adverse effects of hand hygiene such as skin irritation and dryness. Academic institutions and hospitals in university settings assessed the effectiveness of hand hygiene measures for pandemic influenza by monitoring the prevalence of laboratory-confirmed influenza in the community and found a decrease in the incidence of influenza (*28*). The overall reduction in IU or laboratory-confirmed influenza cases in the face mask group was not significant in either Australia (*29*,*30*) or Hong Kong (*31*) (Supplement Figure 7). Nevertheless, hand hygiene might be included in pandemic plans and PCI respiratory for household contacts only (*28*), another study evaluated face mask use as a control measure for pandemic influenza in Australia (*32