

## PUBLIC HEALTH

# Next Flu Pandemic: What to Do Until the Vaccine Arrives?

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Experience indicates we are overdue for another influenza pandemic (1, 2). Unless effective action is taken now, we will be in dire straits. Immunization remains the cornerstone of our strategy, with antiviral agents as a backup (3, 4), but producing and distributing a vaccine will take at least 4 to 6 months currently (5). In the meantime, our main defenses will be nonpharmacological interventions, such as hand washing, “respiratory etiquette,” face masks, school closure, and social distancing or isolation (6, 7). These are ironically similar to the measures used in 1918 to combat the greatest of all known influenza pandemics (8, 9).

Recent attempts to identify the most effective nonpharmacological interventions have revealed that these measures have a thin science base (6, 7, 10–13). For example, it is uncertain whether influenza transmission from person to person is primarily by large droplets or by fine particles. Although this may seem a specialist issue, it has a direct bearing on how far apart people should position themselves to prevent infection and on whether relatively inexpensive face masks might be useful. Recent results in the guinea pig (14) indicated that transmission of influenza could occur even when cages were kept ~3 feet apart, which contradicts conventional wisdom. The results should be confirmed in other models.

Another aspect of transmission that we don’t understand is why, when the number of secondary infections arising from each infected individual ( $R_0$ ) is relatively low (15), breaking the transmission chain by nonpharmacological measures has proved so challenging.  $R_0 < 1$  would imply that transmission is no longer self-sustaining.

Many of our assumptions are based on analogies with other respiratory infections, such as rhinoviruses, which are generally more stable than influenza viruses and differ in other physical properties. These analogies are useful, but should be interpreted with caution. Many rhi-

novirus infections can be transmitted via contamination on hands, but there is no evidence to indicate that this transmission mechanism is important for influenza. Although there are excellent literature reviews (6, 7), there are no readily accessible compendia of best practices or even comprehensive databases of community epidemiologic data, which might help to design the most effective interventions.

Community studies and clinical trials in humans are needed. Seasonal influenza provides regular real-world opportunities to fill some of the enormous gaps in our knowledge. Availability of attenuated live influenza vaccines (e.g., FluMist) may allow transmission and intervention studies to be done safely under more carefully controlled conditions than have previously been possible.

Also often neglected are protective measures that fall between individual protection and the whole population—the “excluded middle,” such as buildings, facilities, and smaller areas, including work places and homes. Examples might include improved air-handling systems, room-size fans, portable air-filtration units, or physical barriers such as room dividers and doors. Industrial hygienists and engineers have considerable accumulated expertise that could be more regularly applied to protecting the built environment from pandemics. Lessons learned from protecting buildings or large spaces from bioterrorist agents (17) are also relevant. Protection should be included in new construction and retrofitted in older spaces (17), from work spaces to buildings to indoor public areas.

Individuals must have good information on which to base choices. Guidelines remain a menu of general options with little specific advice. Some modeling results (18) suggest that simple measures could be quite effective. Although many of these suggestions seem just common sense (such as keeping a sick family member in a separate room with a closed door), there is no systematic evaluation of best practices for “home infection control.” A starting point might be modifying experience from health-care settings for the home.

On the positive side, there has been increasing interest in nonpharmacological strategies and in filling the data gaps in epidemiology and transmission (6, 7, 10–13). The Centers for

Most scientists consider another influenza pandemic inevitable, but there is little information on how best to protect the public before a vaccine can be made available.

Disease Control and Prevention (CDC) recently awarded grants to study nonpharmacological interventions in community settings. Although a commendable start, the CDC program so far represents \$5.2 million in a total proposed pandemic influenza budget of \$7.1 billion. The National Institute of Allergy and Infectious Diseases (NIAID) may also include related areas in their funding. We should systematically address knowledge gaps now during upcoming flu seasons, rather than wait to empirically test measures ad hoc when the next pandemic is upon us.

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