

Infection control and pandemic influenza

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If an influenza pandemic occurs, nearly everyone in the community will be at risk until they develop immunity. During a pandemic, people with suspected or confirmed influenza will present to community health care settings (eg, general practitioners) and to hospitals. They will also be living and moving in the general community. Antiviral drugs may have a role in slowing the spread of an influenza virus. However, the main way to decrease the extent and speed of virus spread is with effective infection control practices, good hygiene, and other broad measures that limit the movement of infected people.

The important issues related to infection control have been addressed by many countries and by the World Health Organization.¹⁻⁴ This article is based on the Australian *Interim infection control guidelines for pandemic influenza in healthcare and community settings*.¹

How is the virus transmitted and for how long?

Modes of transmission

Influenza viruses pass from human to human through contact with virus-containing respiratory secretions. Spread occurs mainly by large droplets (> 5 µm), which deposit the virus onto the mucosal surfaces of the eye, mouth or respiratory passages. Hands are a major alternative means for viral spread, and may be contaminated either “directly”, when droplets land on the hands from an infected person coughing nearby, or “indirectly”, when hands pick up the virus through touching contaminated objects or surfaces.¹⁻⁴

Large droplets do not remain suspended in the air for long and generally only travel short distances (usually a metre or less). More distant and prolonged spread can occur with small droplet nuclei (< 5 µm) containing the virus, produced, for example, by evaporation of larger droplets.¹⁻⁴

Humidity, diminished ventilation, and ultraviolet irradiation all affect the airborne transmission of influenza, so the virus is more likely to spread indoors. Influenza viruses can survive on hard, non-porous surfaces for 24–48 hours, and on cloth, paper and tissues for 8–12 hours. Surprisingly, their survival on hands seems much shorter (about 5 minutes).¹⁻⁵

The relative contribution and clinical importance of the different modes of potential transmission of influenza are unknown. However, epidemiological patterns¹⁻⁹ suggest that most spread of the virus is through close contact (ie, deposition of large droplets or direct contact via hands onto susceptible mucosal surfaces). Inhalation of small airborne particles containing the virus may occur, but appears to be a much less common means of transmission. This is an important point, as it means that good hand hygiene, social distancing and isolation, and the use of personal protective equipment (especially masks) are more important factors in decreasing viral transmission than negative pressure rooms and other air-conditioning solutions.¹⁻⁹

A very difficult issue is knowing how much spread might occur by aerosols (small droplets). Available evidence does not suggest that aerosol spread is a major factor.⁹ This is particularly so when considering influenza transmission across long distances; however, transmission may occur through inhalation of

ABSTRACT

- If an influenza pandemic occurs, the spread of the virus should be reduced for as long as possible while an effective vaccine is produced.
- Influenza spreads mainly by large respiratory droplets (> 5 µm) depositing onto the mucosal surfaces of the eye, mouth or respiratory tract. Hands are another major means for spread, and are frequently contaminated by droplets.
- The most effective way to reduce the spread of the virus is with good infection control practices and social distancing.
- Infection control practices include the use of personal protective equipment (PPE), hand hygiene, and respiratory hygiene and cough etiquette. Infected people should be isolated and spatial separation observed in common areas where infected people may be present. Any practices that create aerosols (eg, nebulisation) should be avoided, unless performed with appropriate precautions, especially with all people in the room wearing appropriate PPE.
- Now is the time to re-examine all our current practices so that we are better prepared, well practised and have good infection control practices in place for all transmissible respiratory infections.

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small particle aerosols in shared air spaces with poor air circulation.⁴ It is also likely that some aerosol-generating procedures may increase the potential for disseminating droplet nuclei in the immediate vicinity of the infected person.⁴ In the early stages of a pandemic, the transmission characteristics of a new virus may not be completely known. Therefore, it is prudent to use negative pressure rooms where they are available and minimise the recirculation of air (especially from areas where aerosol-generating procedures are being performed). Once the pandemic has become established, it will be impossible to provide negative pressure rooms for all influenza patients. Therefore, we will need to focus on interrupting the routes associated with most spread (ie, through droplet precautions and hand hygiene).

Periods of human infectivity

People with influenza usually have a short incubation period of 1–3 days. For avian influenza A/H5N1, incubation may be longer, mostly 2–4 days (range, up to 8 days).^{1-4,8} The period for which the patient is infectious is about 7 days for people older than 12 years, 14 days for school-aged children, and 21 days for preschool-aged children.^{1,2,10-12} Individuals may be infectious from 24 hours before the onset of symptoms, although the risk of infection is greatest while the patient is symptomatic.

In ducks and other poultry, the avian H5N1 virus is excreted in faeces, often for prolonged periods. The virus is also excreted in the faeces of people infected with H5N1, but in much lower numbers than in respiratory secretions.^{8,13}

1 Basic infection control principles for health care facilities

- Isolate infected people (eg, confine patients to a defined area within a health care setting — usually a single room with its own facilities). Limit contact to small numbers of health care workers and close family and friends.
- Promote spatial separation in common areas where infected people may be present but undiagnosed (eg, sit or stand as far away as possible, at least 1 metre, from potentially infected people).
- Protect people caring for influenza patients by using personal protective equipment (PPE), especially appropriate masks.
- The sequence and manner for removing PPE is critical, as the outside of PPE (especially gloves) will often be contaminated with virus. PPE should be removed at the doorway (or in an anteroom), with gloves removed first, then goggles, then gown and mask last.
- Contain infectious respiratory secretions through ensuring that patients who have “flu-like” symptoms use respiratory hygiene and cough etiquette and wear surgical masks in public areas (eg, waiting rooms) or when being transported (eg, ambulance).
- Implement widespread hand hygiene.
- Minimise recirculation of air that may contain small droplets with virus. Place patients in a negative pressure room if available. In other patient care areas, such as fever clinics, assess existing ventilation and adjust to increase outdoor air circulation and reduce proportion of recirculated air, where appropriate.
- Avoid any procedures that create aerosols (eg, nebulisation), unless people in the same room are wearing adequate PPE and these procedures are carried out in a suitably ventilated room.
- Patients calling for medical appointments for influenza symptoms should be discouraged in making unnecessary visits to medical facilities. Symptomatic patients should be instructed on infection control measures to limit transmission in the home and when travelling to necessary medical appointments. ♦

Basic infection control principles and practices

During an influenza pandemic, we all (both health care personnel and the general public) should be particularly vigilant to avoid touching our eyes, nose or mouth with contaminated hands. We need to be careful with gloves, as they can give a false sense of security. Gloves can become contaminated with virus, and thus present a risk of transmitting it to susceptible mucosal surfaces (eg, the eye).

If equipment or environmental surfaces become contaminated, they should be disinfected. The most effective disinfectant is usually sodium hypochlorite (1000 parts per million of available chlorine, usually achieved by a 1 in 50 dilution of 5% liquid bleach). For smooth metal surfaces, tabletops and other surfaces on which bleach cannot be used, then alcohol (eg, isopropyl alcohol 70%, or ethyl alcohol 60%) will also be effective.¹

The Australian Government has contracts with two vaccine manufacturers for the production of an influenza vaccine in the event of a pandemic.¹ To minimise the delay before the vaccine can be administered to the population, the vaccine will be packaged in multi-dose vials. This has potential infection control risks. Extra care and precautions should be taken when drawing up the vaccine from the vials, including using a new sterile disposable needle and syringe for each draw-up and injection.¹ Great care will also be needed with storage and refrigeration.

Health care facilities need to ensure now that they have adequate availability and stores of materials that will be needed (such as surgical masks, alcohol-based hand hygiene products, tissues, and no-touch waste receptacles). They also need to ensure there are appropriate (multilingual or diagrammatic) precaution signs in common areas (eg, triage and fever clinics) that promote hand hygiene, cough etiquette, social distancing, and similar precautions. They also need to ensure that signs displaying respiratory and contact precautions, order of removal of personal protective equipment, etc, are available for health care workers and visitors in isolation areas. Basic principles for infection control in health care facilities are summarised in Box 1.

Personal protective equipment

Personal protective equipment (PPE) consists of appropriate masks, gowns, gloves and eye protection. Appropriate PPE (which should be selected according to the nature of the potential contact) should be worn by all people who provide direct patient care (eg, doctors, nurses, radiographers, and physiotherapists) and all supporting staff, including medical aides and cleaning staff, when working in a room where an avian or pandemic influenza patient is being cared for. PPE will also be needed by all laboratory workers handling specimens from patients being investigated for pandemic influenza, all sterilising service workers handling equipment that requires decontamination, and family members or other visitors.

It is important that appropriate procedures are followed so wearers do not contaminate themselves (especially their hands) with any virus-laden droplets when removing the PPE.¹⁴

Masks

Facemasks can decrease the spread of respiratory tract viruses (as shown with health care workers in the recent outbreaks of severe acute respiratory syndrome [SARS]).¹⁵ Masks decrease both the number of virus-laden droplets inhaled or deposited onto the mucous membranes and our ability to touch our nose and mouth and self-inoculate the virus.

Masks commonly used by health care workers include P2 (equivalent to US N95) masks and surgical masks. The latter provide less protection from airborne small droplet nuclei. However, they are effective in protecting wearers from larger droplet contamination of the nasal or oral mucosa.

P2 masks are essential when aerosol-generating procedures are being performed (eg, intubation, suctioning, chest physiotherapy, bronchoscopy, or nebulisation). If P2 masks are in short supply, the first priority for their use should be for health care workers undertaking aerosol-generating procedures. If a P2 mask is not available, then a surgical mask should be worn. Nebulisers and high-airflow oxygen masks have been implicated in the nosocomial spread of SARS, and should only be used with strict precautions.⁸

P2 masks usually provide a good facial fit to the wearer, which ensures inhaled and exhaled air travels through the mask. If a good facial seal cannot be achieved (eg, the intended wearer has a beard or long moustache), alternative protection such as powered air-purifying respirators should be used, provided the wearer is trained in their use. If an alternative respirator is unavailable, then the health care worker should consider removing his facial hair.

Masks should be applied before entering a patient's room. Generally, a mask should be worn once and then discarded. However, if patients are cohorted in a common area and multiple patients must be visited over a short time, it may be more practical to wear one

mask for the duration of that activity. The mask needs to be changed whenever it becomes moist. A mask should never be reapplied after it has been removed, nor left dangling around the neck. Upon touching or discarding a used mask, hand hygiene should always be performed.

Gloves, gowns and protective eyewear

Gloves never replace the need for hand hygiene. Nevertheless, gloves should always be worn when contact with respiratory secretions or other body fluids is likely (eg, for oral care, or handling soiled tissues). Gloves are not necessary during tasks such as changing bed linen unless the linen is visibly soiled. The gloves should always be changed between different patient contacts, and hand hygiene should always be performed after glove removal.

Gowns (preferably long-sleeved) should be worn when caring for pandemic influenza patients. This is to decrease the chance of the influenza virus contaminating clothing or arms, and then hands being subsequently contaminated. Either a disposable gown or a washable cloth gown should be used, and the gown needs to cover the wearer's clothing. A cuffed, fluid-repellent, long-sleeved gown should be used whenever there is a high risk that clothes might be contaminated (eg, during invasive procedures or suctioning, nebulisation, bronchoscopy, chest physiotherapy, or intubation).

If gowns or other protective equipment are in short supply, priorities for use will depend on the likelihood of clothes being contaminated (eg, during intubations). Gowns should be worn only once and then placed in a waste or laundry receptacle, as appropriate, and hand hygiene performed after their removal.

In general, wearing protective eyewear (goggles, visor, or shield) for routine contact with patients with pandemic influenza should not be necessary, unless sprays or splatter of infectious material are likely. Protective eyewear should always be worn during aerosol-generating procedures, as should a disposable theatre-type cap.

Hand hygiene

Hand hygiene includes both hand washing (with soap and water) and use of alcohol-based products (gels, rinses, and foams). The advantage of alcohol-based products is that they do not require water. However, if hands are visibly soiled or contaminated with respiratory secretions, they should be washed with water and soap (either plain or antimicrobial). In the absence of visible soiling of hands, alcohol-based products may be preferred over hand washing because they result in less drying of the skin, are more convenient, and are likely to improve compliance. Alcohol-based products have been shown to have a major benefit in decreasing the spread of bacteria such as methicillin-resistant *Staphylococcus aureus*.¹⁶ Alcohol is also effective in killing many viruses, including influenza.¹⁷

Hand hygiene should always be performed between patient contacts and after removing PPE. It is important that all health care institutions ensure that hand-washing facilities (ie, sinks with running water, soap, and disposable paper towels) and hand disinfection (ie, alcohol-based products) are readily accessible where patient care is provided.

Infection control in community settings

Infection control in the community should focus on respiratory and hand hygiene (Box 2). Keeping a distance from people with respiratory symptoms should be promoted. In a pandemic, this may be extended to keeping a distance of more than 1 metre

2 Basic infection control principles and practices for all situations

- Use personal protective equipment, especially appropriate masks.
- Implement widespread hand hygiene.
- Promote spatial separation in areas where infected people may be present.
- Isolate infected people and limit their contact with well people.
- Practise and promote respiratory hygiene and cough etiquette.
- Minimise the recirculation and movement of air that may contain virus in small droplets.
- Avoid any practices that create aerosols. ◆

3 Respiratory hygiene and cough etiquette

- Cover the nose and mouth with a tissue when coughing or sneezing.
- Use tissues to contain respiratory secretions.
- Dispose of tissues in the nearest waste receptacle after use.
- Perform hand hygiene after contact with respiratory secretions and potentially contaminated objects or materials. ◆

between all people, regardless of symptom status. Respiratory hygiene and cough etiquette (Box 3) should be practised and promoted, along with the use of masks by people with respiratory symptoms, if feasible.

Should people who are well wear masks as part of individual protection strategies that include hand hygiene and avoiding public gatherings? It is hard to be certain how effective these interventions will be. However, in Hong Kong in 2003 during the SARS outbreak, when these and other practices were adopted by most of the population, large decreases were seen in most laboratory-diagnosed respiratory infections (>90%) caused by viruses (influenza, respiratory syncytial virus, parainfluenza virus, and adenovirus).¹⁸

In the 1918 influenza pandemic, the movement of people was often severely restricted to slow the spread of the virus. This included quarantine restrictions on people moving into and within Australia and elsewhere. It also involved closing schools and cancelling many public gatherings, such as meetings and concerts. Such public health measures may need to be introduced again, depending on the rate of spread, virulence, and other factors associated with any new influenza pandemic.

Infection control messages will need to be promoted in the community before and during a pandemic. In the hospital environment, this will be done by infection control staff. However, in the community, this will involve many other means, which may include SMS, email, newspaper advertisements, and the Internet.

Patients at home

Patients who do not require care in hospitals should be managed at home. This will become increasingly important as the demand for hospital beds grows during any pandemic. Infection control principles used in health care settings also apply in the home care setting. As the most efficient modes of spread of influenza are thought to be droplet and contact spread, the use of modified precautions that focus on preventing droplet and contact spread will be very important.

If infected with the pandemic strain of influenza, adults are potentially infectious for 7 days and preschool-aged children for 21 days. However, the risk is likely to be greatest when symptoms are still present. Nevertheless, not leaving the house and discouraging visitors should be maintained for the entire potentially infectious period. This means that the person should not attend work, school or childcare for that period.

While someone in the household is sick, measures such as use of surgical masks for the patient and those caring for them, as well as a separate bedroom and bathroom for the patient (if possible), should be undertaken (although this will be more difficult with children). Once the person is no longer symptomatic, these restrictions may be relaxed.

People who are ill should not leave the home, except as necessary for follow-up medical care. When movement outside the home is necessary, the patient should wear a mask, if tolerated, and not use public transport. Elective medical consultations (including dental) should be deferred. The patient should not visit any residential care facilities.

All people in the household should carefully follow recommendations for hand hygiene after touching body fluids and potentially contaminated surfaces and materials (eg, linen). It is important that people consider obtaining enough hand hygiene supplies (eg, soap) before a pandemic occurs and keeping them available. Other important supplies (eg, alcohol-based hand hygiene products and disposable towels) should also be acquired and stored if practicable, and then replenished as needed.

Conclusion

A pandemic of H5N1 or any other new influenza strain is not inevitable, but if it does occur, we will need to slow the spread of the virus for as long as possible while waiting for the development and delivery of an effective vaccine to protect the population. The most effective way of both slowing the spread of the virus and protecting individuals is with good infection control practices in health care facilities and in the general community. Many of the principles needed to prevent infections are basic principles of infection control that should apply at all times in our hospitals and the community. Now is the time to re-examine our current practices so that we are better prepared and well practised with good infection control procedures for all respiratory infections. Such practice now may be lifesaving for our patients, our families and ourselves, if a pandemic should occur.

Competing interests

None identified.

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