NHS

PANDEMIC INFLUENZA

Guidance for infection control in critical care

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Guidance for infection control in critical care

Prior to a declaration by the World Health Organization that a pandemic has started, hospitals and practitioners should be alert to cases of influenza caused by a novel virus that has not yet fully adapted to humans and that may become a pandemic virus. The number of such cases is expected to be small, and they are most likely to occur in travellers returning from affected parts of the world. The infection control guidance in this document does **not** apply to the management of such cases, and practitioners should follow current guidance as issued by the Health Protection Agency at www.hpa.org.uk/infections/topics_az/influenza/avian/default.htm

Developed by the Department of Health and the Health Protection Agency

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Appendices

Executive summary

This guidance is an adjunct to the document *Pandemic influenza: Guidance for infection control in hospitals and primary care settings*[1] and was developed in response to requests for more detailed guidance to assist critical care units to plan and conduct their pandemic response. The content is considered to be best practice based on scientific evidence and expert opinion. The principles outlined in the primary document[1] continue to apply and it should be used as a reference document for greater detail on specific issues and key points. In addition, there are elements contained within the guidance (eg non-invasive ventilation (NIV)) that are of relevance to other departments such as high dependency units and medical assessment units.

The full guidance has also been summarised in a shorter document: *Pandemic flu: A summary of guidance for infection control in healthcare settings*, which is available via the Department of Health website at www.dh.gov.uk/en/Publichealth/Flu/Pandemicflu/DH_078752

The ubiquitous nature of a pandemic virus means that critical care staff, as with other healthcare staff, are just as likely to encounter pandemic influenza in settings associated with normal daily living, eg in the family home, as they are in the workplace. This is a crucially important contextual difference from the situation currently seen with human cases of avian influenza and the previous situation observed during the severe acute respiratory syndrome (SARS) epidemic.

For planning purposes it is assumed that a pandemic strain of influenza will have properties of transmission, communicability and inactivation that are similar to those of 'routine' seasonal influenza. It is well established that influenza is transmitted from person to person through close contact. Most data point towards short-range transmission in nosocomial outbreaks of influenza. This pattern of transmission is known to be associated with spread by droplet and contact. In view of this, standard infection control principles and droplet precautions are the main control strategies and should be rigorously followed. Aerosol transmission may also occur. In certain circumstances, the standard infection control principles and droplet control measures may need to be augmented.

Scrupulous attention to hand hygiene and containment of respiratory secretions produced by coughing and sneezing are the cornerstones of effective infection control. Other key recommendations include separation of patients with influenza or cohorting (grouping with other patients with influenza and no other infection); prompt identification and exclusion of ill staff and restriction of ill visitors from healthcare settings; wearing appropriate personal protective equipment (PPE); and educating staff, visitors and patients about the transmission and prevention of influenza, using information that is understandable and applicable to their particular situation.

All of the above recommendations apply to critical care units in the same way as they apply to other areas of healthcare settings. However, there is additional detailed guidance applicable to critical care units provided, particularly around aerosol-generating procedures and equipment commonly used in such units, in addition to training issues.

This guidance will be updated if epidemiological and virological information on the eventual pandemic virus indicates that adjustments in the approach to infection control are necessary. Readers are strongly urged to refer to the most up-to-date version of this guidance via the Department of Health website at www.dh.gov.uk/pandemicflu

1 Terminology

Droplet: Droplets are particles propelled by coughing and sneezing and during the performance of some procedures. They are generally regarded to be larger than 5µm in diameter, although there is no consensus on size. Droplets can be deposited on the conjunctiva or mucous membranes of the nose, mouth or respiratory tract and throughout the environment. However, because of their relatively large size, droplets generally travel only short distances (typically less than one metre) before falling to the ground.

Aerosol: Aerosols are very small particles (typically thought to be less than 5µm in diameter, although there is no consensus on size) that, because of their size, can remain suspended in the air and travel over long distances. Aerosols can be generated by certain medical procedures.

Airborne: Some authors use the term 'airborne' to describe transmission only by aerosols; others use it for transmission that had any airborne phase, whether by aerosol, droplet or splash. Therefore this term has not been widely used in this document, but where other authors' intended meaning cannot be deducted, the term airborne remains.

Influenza: Influenza refers to cases of pandemic influenza that are either confirmed by laboratory test(s) or diagnosed according to clinical signs and symptoms. A laboratory-confirmed diagnosis of influenza is more likely to be obtained during the early stages of a pandemic. As the number of patients rapidly increases and health professionals become more proficient at making a clinical diagnosis, confirmatory laboratory testing is likely to diminish significantly, and almost all cases will be diagnosed on clinical grounds alone.

2 Overview of pandemic influenza and infection control*

Key points

Health impacts of an influenza pandemic in the UK

- All age groups are likely to be affected, but children and otherwise fit adults could be at relatively greater risk.
- Clinical attack rates may be of the order of 25% to 35%, but up to 50% is possible.
- Between 55,000 and 750,000 deaths are possible.
- Substantial demand for healthcare services is likely, in both primary care and hospital settings.

Clinical features of influenza

- The most significant features are rapid onset of cough and fever.
- Headache, sore throat, a runny or stuffy nose, aching muscles and joints, and extreme tiredness are other symptoms.
- People are most infectious soon after they develop symptoms, although typically they can continue to excrete viruses for up to five days (seven days in children).

How influenza is spread

- The virus is transmitted from person to person through close contact. The balance of evidence points to transmission by droplet and through direct and indirect contact as the most important routes.
- Aerosol transmission may occur in certain situations, eg during aerosol-generating procedures.

Prevention of influenza transmission

Transmission of the influenza virus can be prevented through:

- strict adherence to infection control practices, especially hand hygiene, containment of respiratory secretions and the use of PPE
- adherence to standard infection control principles and droplet precautions
- administrative controls such as separation or cohorting of patients with influenza
- instructing staff members with respiratory symptoms to stay at home and not come in to work
- restriction of symptomatic visitors
- environmental cleaning
- education of staff, patients and visitors.

* See appendices for more detailed information.

2.1 Emergence of a pandemic

An influenza pandemic will occur when a novel influenza virus emerges to which all or most of the population have no immunity and which spreads easily from person to person. This may originate from an avian influenza virus, eg A/H5N1, which adapts to the human host, as was probably the case in 1918. Alternatively it may emerge through genetic recombination of an avian and human influenza virus, as probably happened in the pandemics of 1957 and 1968. Predictions based on previous pandemics indicate that clinical attack rates will be high (estimated to be 25% to 35% but up to 50%), and almost all the population will potentially be at risk.

The ubiquitous nature of a pandemic virus means that critical care staff, as with other healthcare staff, are just as likely to encounter pandemic influenza in settings associated with normal daily living, eg in the family home, as they are in the workplace. This is a crucially important contextual difference from the situation currently seen with human cases of avian influenza and the previous situation observed during the SARS epidemic, where the disease is limited to small numbers or care is focused in particular healthcare settings, as opposed to the wider community both inside and outside healthcare settings.

Although the clinical severity of the next influenza pandemic cannot be reliably predicted, it is almost certain that the health impacts of a pandemic are likely to be significant and there will be enormous pressures and unprecedented demands on the health service in every respect.

2.2 Assumptions concerning infection control in a pandemic

The principles of containment and infection control for pandemic influenza are based on the premise that pandemic influenza has similar properties to seasonal influenza:

- Person to person spread of human influenza viruses is well established.
- The patterns of transmission observed during outbreaks of influenza in healthcare settings suggest that droplets and contact (direct and indirect) are the most important and most likely routes of spread.
- In the case of some pathogens, aerosols generated under specific circumstances may be associated with an increased risk of transmission.[2,3] While this may be possible for influenza, the general consensus is that droplet and contact transmission are of far greater importance.
- The incubation period of human influenza ranges from one to four days (typically two to three).
- How infectious an individual is depends on how severe their symptoms are; people will be most infectious just after their symptoms start.

- Adults will usually be infectious for up to five days after symptoms begin, although longer periods of virus shedding have been found.[4] Children will usually be infectious for up to seven days, although longer periods of virus shedding have been found in infants and a small proportion of children.
- Virus excretion may be considerably longer in immunocompromised patients.
- Although virus may be recovered from infected people before they show symptoms, there is little published evidence to support person to person transmission of influenza from a pre-symptomatic individual to a person who does not already have the infection.
- Seasonal influenza viruses can survive on surfaces in the environment, especially hard, non-porous materials such as stainless steel.[5]
- Influenza viruses are easily deactivated by washing with soap and water or alcohol handrub[6] and by cleaning surfaces with normal household detergents and cleaners.

2.3 Core principles of containment and infection control

During a pandemic, healthcare workers can be exposed to people with influenza both in their normal daily lives (outside work) and in healthcare settings. Limiting the transmission of influenza in the healthcare setting requires:

- timely recognition of influenza cases
- instructing staff members with respiratory symptoms to stay at home and not come in to work
- segregating staff into those who are dealing with influenza patients and those who are not
- consistently and correctly implementing appropriate infection control precautions to limit transmission (standard infection control principles and droplet precautions)
- using PPE appropriately, according to risk of exposure to the virus
- maintaining separation in space and/or time between influenza and non-influenza patients
- restricting access of ill visitors to the facility and posting pertinent signage in clear and unambiguous language (including in languages other than English)
- environmental cleaning and disinfection
- educating staff, patients and visitors about the transmission and prevention of influenza

- treating patients and staff with antiviral drugs that can reduce infectivity and the duration of illness
- vaccinating patients and staff.

The UK has a stockpile of antiviral oseltamivir (Tamiflu) to treat up to 25% of the population. This should be sufficient to treat all those who fall ill in a pandemic of similar proportions to those that occurred in the 20th century. The number of people affected and the impact on the healthcare system will depend on the nature of the pandemic virus when it emerges. This will not be known in advance, so the Government is planning to double the stock of antiviral drugs to cover treatment of all symptomatic people at a clinical attack rate of up to 50%, a 'reasonable worst-case' scenario. During the first wave of a pandemic, a specific vaccine is unlikely to be available.

The Government is also planning to procure 14.7 million treatment courses of antibiotics to manage the complications arising from pandemic influenza. The clinical management guidelines (at www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_412753) propose the distribution of antibiotics to at-risk groups to ease the burden on healthcare delivery.

In principle, antiviral drugs will be available for all symptomatic patients from the onset of a pandemic. A move to prioritisation of treatment would only need to be made if scientific information became available to suggest that demand for antiviral treatment would outstrip supply. If prioritisation became necessary, it would be based primarily on clinical need. However, attention to non-pharmaceutical methods of control, as outlined in this document, will be particularly important in reducing exposure to the virus.

3 Occupational health and deployment of staff

Key points

- Prompt recognition of cases of influenza among healthcare workers is essential to limit the spread of the pandemic.
- Healthcare workers with influenza should not come to work.
- As a general principle, healthcare workers who provide care in areas for pandemic influenza patients should not care for other patients, although exceptions may be necessary.
- Healthcare workers at high risk of complications from influenza should not provide direct patient care.
- Bank and agency staff should follow the same deployment advice as permanent staff.
- Occupational health departments or providers should lead on the implementation of systems to monitor staff illness and absence.
- Occupational health departments or providers should facilitate staff access to antiviral treatment where necessary and implement a vaccination programme for the healthcare workforce when required.
- As part of their employer's duty of care, occupational health departments or providers have a role to play in ensuring that fit testing programmes are in place for those staff who may need to wear FFP3 respirators.

Critical care staff, as with other healthcare staff, are just as likely to encounter pandemic influenza in settings associated with normal daily living, eg in the family home, as they are in the workplace.

Healthcare workers should be aware of the symptoms of influenza, and those who are beginning to experience symptoms or are recovering from influenza should not come to work, so as to avoid infecting patients, colleagues and others.

Healthcare workers who have recovered from influenza, or who have received a full course of vaccination against the pandemic strain and are therefore considered unlikely to develop or transmit influenza, should be prioritised for the care of patients with influenza.

4 Infection control precautions

Key points

- Standard infection control principles and droplet precautions must be used where patients have or are suspected of having influenza (see appendix B).
- Good hand hygiene among staff and patients is vital for the protection of both parties.
- Good respiratory hygiene is essential.
- The use of PPE should be proportionate to the risk of contact with respiratory secretions and other body fluids and should depend on the type of work or procedure being undertaken.

4.1 Standard infection control principles

Standard infection control principles and droplet precautions must be used if patients have or are suspected of having influenza. Standard infection control principles are a set of broad statements of good practice to minimise exposure to and transmission of a wide variety of micro-organisms. These principles should be applied by **all** healthcare practitioners to the care of **all** patients **all** of the time. Standard infection control principles, which include hospital environmental hygiene, hand hygiene, the use of PPE and the safe use and disposal of sharps, have been published in full elsewhere,[7] and the recommendations are detailed in appendix B. Hand hygiene and PPE are also discussed in sections 4.1.1 and 4.3 respectively.

4.1.1 Hand hygiene

Hand hygiene is the single most important practice needed to reduce the transmission of infection in healthcare settings and is an essential element of standard infection control principles. In any outbreak of pandemic influenza, strict adherence to hand hygiene recommendations should be enforced.

Patients' hands will be heavily contaminated, because of frequent contact with their nose, mouth and the tissues they have used in respiratory hygiene. Their hands will also make frequent contact with their immediate environment. Therefore good hand hygiene among staff before and after contact with patients or their close environment is vital to protect both themselves and other patients. Good hand hygiene among patients should also be encouraged.

Hand hygiene includes hand washing with soap and water and thorough drying, and the use of alcohol-based products containing an emollient that do not require the use of water. If hands are visibly soiled or contaminated (eg with respiratory secretions), they should be washed with soap and water and dried. When an alcohol handrub is used to decontaminate hands, the hands should be free of visible dirt and organic material. The handrub must come into contact with every part of the hand's surface.

Hands must be decontaminated immediately before each and every episode of direct care of or contact with patients and after any activity or contact that potentially results in hands becoming contaminated, including the removal of protective clothing and cleaning of equipment. Hands should be decontaminated between caring for different patients and between different care activities for the same patient, even if gloves have been worn. After hand washing, paper towels should be used to dry the hands thoroughly and should then be discarded in the nearest waste bin. Lined waste bins with foot-operated lids should be used whenever possible.

In addition to the placement of alcohol handrub at the point of use (eg at patients' beds, in examination rooms and on lockers), consideration should also be given to distributing personally carried alcohol handrub to certain groups of transient or migratory staff such as hospital medical staff.

All staff, patients and visitors should clean their hands when entering and leaving areas where care is delivered with either soap and water followed by drying or alcohol handrub.

4.2 Applying droplet precautions in an influenza pandemic*

In addition to the standard infection control principles, droplet precautions should be used if a patient is known or suspected to be infected with influenza and is at risk of transmitting droplets while coughing, sneezing or talking and during some procedures.

4.2.1 Placement of patients within the facility

- Ideally, patients with influenza should be placed in single rooms, but during a pandemic this will not be possible. Therefore, patients should be 'cohorted' (grouped together with other patients who have influenza and no other infection) in a segregated area.
- Where patients are cohorted on the basis of epidemiological and clinical information rather than on laboratory-confirmed diagnosis, beds should be at least one metre apart.
- Special room ventilation is not necessary, and the doors of segregated areas can remain open (unless a patient is being isolated for another reason in addition to influenza that requires the doors to be shut).

4.2.2 Fluid repellent surgical masks

- All surgical masks should be fluid repellent. In addition to wearing a surgical mask in situations as outlined under standard infection control principles (see appendix B), staff must wear surgical masks when working in close contact (within one metre) with a symptomatic patient. For practical reasons, this is likely to mean wearing a surgical mask at all times within cohorted areas.

4.2.3 Transport of patients

- The movement and transport of patients from their rooms or the cohorted area should be limited to essential purposes only.
- If transport or movement is necessary, the dispersal of droplets from spontaneously breathing patients should be minimised by masking them, if possible. The surgical mask should be worn during transport until the patient returns to the segregated area.
- If a surgical mask cannot be tolerated by the patient, then good respiratory hygiene should be encouraged.

*These guidelines are adapted from Garner JS and the Hospital Infection Control Practices Advisory Committee. Guideline for isolation precautions in hospitals. *Am J Infect Control* 1996;24:24–52. See appendix B.

4.2.4 Duration of isolation precautions

Infection control precautions for each patient should be implemented on the patient's admission and be continued for the duration of the illness.[2]

4.2.5 Managing coughing and sneezing

Patients, staff and visitors should be encouraged to minimise potential influenza transmission through the following good hygiene measures.

- Cover nose and mouth with disposable single-use tissues when sneezing, coughing or wiping and blowing noses.
- Dispose of used tissues promptly in the nearest waste bin.
- Wash hands after coughing, sneezing, using tissues or contact with respiratory secretions and contaminated objects.
- Keep hands away from the eyes, mouth and nose.
- Some patients (eg older people and children) may need assistance with containment of respiratory secretions; those who are immobile will need a receptacle (such as a plastic bag) readily at hand for immediate disposal of tissues and a supply of hand wipes and tissues.

- Where possible, in common waiting areas or during transport (eg from the community to an acute hospital or from one area of the hospital to another), coughing or sneezing patients should wear surgical masks to assist in the containment of respiratory secretions and to reduce environmental contamination.

4.3 Personal protective equipment

PPE is worn to protect staff from contamination with body fluids and to reduce the risk of transmission of influenza between patients and staff and from one patient to another. Appropriate PPE for staff who care for patients with pandemic influenza is summarised in Table 1.

Care must be taken to ensure that PPE is worn and removed correctly in order to avoid inadvertent contamination (see section 4.3.2 for guidance on putting on and removing PPE). All staff must remove contaminated clothing – surgical masks or respirators being removed last – and dispose of it appropriately (ie, in an NHS setting, as clinical waste, also known as infectious waste[8]) before leaving a patient care area.

All surgical masks should be fluid repellent, and PPE should comply with the relevant British Standard (BS) EN standards (European technical standards as adopted in the UK) where these apply. Note that standard infection control principles apply at all times.

Depending on the level of patient contact, PPE can consist of surgical masks or respirators, gloves, aprons, gowns and eye protection. Full details can be found in Table 1 and *Pandemic influenza: Guidance for infection control in hospitals and primary care settings.*[1]

Table 1: Personal protective equipment for staff who care for patients with pandemic influenza

	Entry to cohorted area but no contact with patients	Close patient contact (within one metre)	Aerosol-generating procedures[a]
Hand hygiene	✓	✓	✓
Gloves	✗[b]	✓[c]	✓
Plastic apron	✗[b]	✓	✗
Gown	✗	✗[d, e]	✓[e]
Surgical mask	✓[f]	✓	✗
FFP3 respirator	✗	✗	✓
Eye protection	✗	Risk assessment	✓

a Wherever possible, aerosol-generating procedures should be performed in side rooms or other closed single-patient areas with minimal staff present (see section 7.3).

b Gloves and an apron should be worn during certain cleaning procedures (see section 5).

c Gloves should be worn in accordance with standard infection control principles. If glove supplies become limited or come under pressure, this recommendation may need to be relaxed. Glove use should be prioritised for contact with blood and body fluids, invasive procedures and contact with sterile sites.

d Consider a gown in place of an apron if extensive soiling of clothing or contact of skin with blood or other body fluids is anticipated (eg during intubation or when caring for infants).

e If non-fluid repellent gowns are used, a plastic apron should be worn underneath.

f Surgical masks (fluid repellent) are recommended for use at all times in cohorted areas for practical purposes. If mask supplies become limited or come under pressure, then in cohorted areas their use should be limited to close contact with a symptomatic patient (within one metre).

4.3.1 Eye protection

Eye protection should be considered when there is a risk of contamination of the eyes by splashes and droplets, eg by blood, body fluids, secretions or excretions. The risk to healthcare workers from patients with influenza is from droplets from their coughs and sneezes or splashes produced during some procedures. Individual risk assessments should be carried out at the time of providing care to patients to identify those at risk and decide on reasonable precautions to reduce the risk, eg by keeping the number of staff to a minimum and requiring that those who are in close contact with the patient, protect their eyes.

Eye protection should always be worn during aerosol-generating procedures. This requirement extends to all those present in the room during a procedure that has the potential to produce an aerosol (see section 7.3).

Eye protection can be achieved by using any one of:

- a surgical mask with integrated visor
- a full-face visor
- polycarbonate safety spectacles or equivalent.

Disposable single-use eye protection is recommended. Non-disposable eye protection (eg polycarbonate safety spectacles issued to staff as personal equipment on a long-term basis) poses a potential infection risk. It is important that any such items are decontaminated after each use by using agents recommended by the manufacturer.

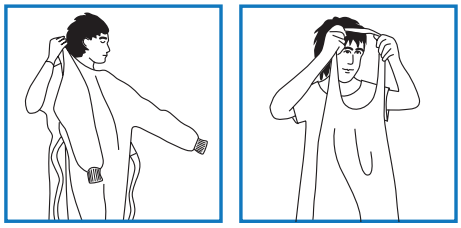
4.3.2 Putting on and removing personal protective equipment

The level of PPE used will vary according to the procedure being carried out, and not all items of PPE will always be required. Standard infection control principles apply at all times.

Putting on PPE

Healthcare workers should put on PPE before they enter a single room or cohorted area (see section 6.1). The order given here for putting on PPE is practical, but the order for putting it on is less critical than the order of removal.

1 Gown (or apron if it is not an aerosol-generating procedure)



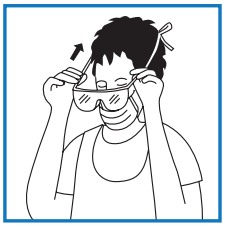
- Fully cover the torso from the neck to the knees and the arms to the end of the wrists, and wrap around the back.
- Fasten at back of neck and waist.

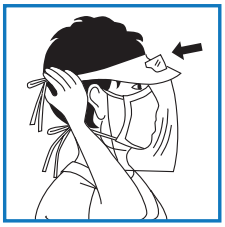
2 Surgical mask (or FFP3 respirator if it is an aerosol-generating procedure)

- Secure ties or elastic bands at middle of head and neck.
- Fit flexible band to nose bridge.
- Fit snug to face and below chin.
- Fit check the respirator.

3 **Goggles or face shield (in aerosol-generating procedures and as appropriate after risk assessment)**

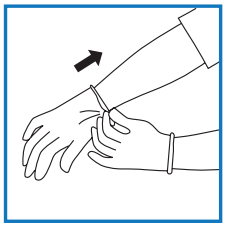
- Place over face and eyes and adjust to fit.





4 **Disposable gloves**

- Extend to cover wrist of gown if a gown is worn.

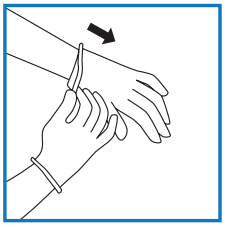


Removing PPE

Healthcare workers should remove PPE upon leaving the room or cohorted area (see section 6.1) in an order that minimises the potential for cross-contamination. If a single room has been used for an aerosol-generating procedure, those involved in the procedure should, **before** leaving the room, remove their gloves, gown and eye goggles (in that order) and dispose of them as clinical waste. **After** they leave the room they can remove the respirator and dispose of it as clinical waste. Hand hygiene should be performed after all PPE has been removed. The order for removing PPE is important to reduce cross-contamination. The order outlined as follows always applies, even if not all items of PPE have been used.

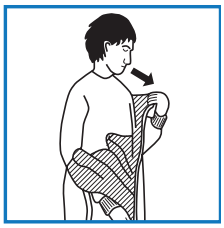
1 **Gloves**

Assume that the outside of the glove is contaminated.



- Grasp the outside of the glove with the opposite gloved hand; peel off.
- Hold the removed glove in the gloved hand.
- Slide the fingers of the ungloved hand under the remaining glove at the wrist.
- Peel off second glove over first glove.
- Discard appropriately.

2 Gown or apron




Assume that the front and sleeves of the gown or apron are contaminated.

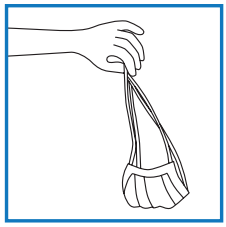
- Unfasten or break the ties.
- Pull the gown or apron away from the neck and shoulders, touching the inside of the gown only.
- Turn the gown inside out.
- Fold or roll it into a bundle and discard appropriately.

3 Goggles or face shield


Assume that the outside of the goggles or face shield is contaminated.

- To remove, handle by the head band or ear pieces.
- Discard appropriately.

4 Respirator or surgical mask

Assume that the front of the respirator or surgical mask is contaminated.

- Untie or break the bottom ties, followed by the top ties or elastic, and remove the respirator or mask by handling the ties only.
- Discard appropriately.

Perform hand hygiene immediately after removing all PPE.

5 Environmental infection control

Key points

- Freshly prepared neutral detergent and warm water should be used for cleaning cohorted patient areas and clinical rooms in critical care units.
- As a minimum, areas used for cohorted patients should be cleaned daily and after patient discharge.
- Domestic staff must be trained in the correct methods of using PPE and the precautions to take when cleaning cohorted areas.
- Dedicated or single-use/disposable equipment should be used where possible.

5.1 Environmental cleaning and disinfection

- Freshly prepared neutral detergent and warm water should be used for cleaning cohorted patient areas and clinical rooms in critical care units.
- As a minimum, areas used for cohorted patients should be cleaned daily and after patient discharge.
- Neonatal incubators and transport incubators should be cleaned as normal using neutral detergent, and in line with local cleaning policy in event of blood spillage.
- Frequently touched surfaces such as medical equipment and door handles should be cleaned at least twice daily and when known to be contaminated with secretions, excretions or body fluids.
- Domestic staff should be allocated to specific areas and not moved between influenza and non-influenza areas.
- Domestic staff must be trained in the correct methods of using PPE and the precautions to take when cleaning cohorted areas. They should wear gloves and an apron; and when cleaning in the immediate patient environment in cohorted areas they should wear a surgical mask as well.
- Dedicated or single-use/disposable equipment should be used when possible. Non-disposable equipment should be decontaminated or laundered after use in line with local policy. Non-essential objects (eg toys and books) should be removed.
- Any spillage or contamination of the environment with secretions, excretions or body fluids should be treated in line with the local spillage policy.

5.2 Equipment used for care of patients

Effective cleaning of equipment used for patient care is an essential prerequisite to both disinfection and sterilisation. Standard practices for handling and reprocessing used and soiled patient care equipment, including reusable medical devices, should be followed in both influenza and non-influenza areas of the unit.

Non-critical patient equipment should, whenever possible, be dedicated to the use of influenza patients only.

Use of equipment that recirculates air (such as fans) should be avoided.

5.3 Furnishings

All non-essential furniture, especially soft furnishings, should be removed from patient and visitor areas in the unit. The remaining furniture should be easy to clean and should not conceal or retain dirt and moisture. Toys, books, newspapers and magazines should be removed from the waiting area.

6 Patient placement, segregation and cohorting

Key points

- In all healthcare settings, patients with symptoms of influenza should be segregated from non-influenza patients as rapidly as possible.
- Whenever possible, different teams of staff should care for influenza and non-influenza patients.
- Careful consideration should be given to flexible accommodation and staffing arrangements.
- Patients with influenza should be managed separately until they are discharged.

6.1 Selection of segregated areas for cohorted patients

Cohorting (grouping patients together who have the same infection and no other infection) in segregated areas should be carried out from the outset of the pandemic to help contain influenza and reduce the risk to other patients. To achieve the desired goal of separating patients with influenza from those without, a designated self-contained area of the unit should be used for the treatment and care of patients with influenza whenever possible. Ideally, this area should not be used as a thoroughfare by other patients, visitors or staff. This includes patient transfers (which should be minimised as much as possible anyway), staff going for meal breaks and staff and visitors entering and exiting the unit.

To control entry, signage should be displayed warning of the segregated influenza area. Arrangements should be made for changing facilities and refreshments within the segregated area. Appropriate entry and exit arrangements should be in place to ensure that staff and visitors can exercise the required infection control procedures, including putting on and removing PPE, with the minimum risk of contaminating themselves, others and the surrounding area.

Patients with influenza being discharged from critical care to another ward, but still deemed to be infectious, should only be moved to an area segregated for influenza patients on that ward.

6.2 Infection control measures for cohorted patients

6.2.1 Entry procedures

A recording sheet should be placed at the entrance of the cohorted area. All staff entering should sign in so that there is a record of staff working in influenza areas. Personnel should be limited to those needed for patient care and support. A sign should be placed at the entrance alerting everyone to the precautions to be adopted.

6.2.2 Infection control precautions

Standard infection control principles must be strictly applied in conjunction with droplet precautions (see appendix B). These precautions should be maintained for all patients in the segregated area.

6.2.3 Unit entrance

To hold PPE, an equipment station should be set up outside the entrance to any area where patients are cohorted.

6.2.4 Patient area

In accordance with droplet precautions, the distance between beds should be at least one metre. A physical barrier, such as curtains, will help reduce environmental contamination and droplet spread between patients, but their use must be balanced against other aspects of patient safety, and they must be cleaned in line with local policy. Patients' personal belongings should be kept to a minimum.

6.2.5 Patient equipment

Where feasible, each patient should be allocated their own non-critical items of patient equipment, or disposable items should be used. Reusable equipment must be decontaminated between patients.

6.2.6 Cleaning

Cohorted areas should be scrupulously cleaned at least once a day, with a focus on frequently touched surfaces such as bed rails and horizontal surfaces. Cleaning after patient discharge should be carried out as normal. Close liaison with housekeeping/domestic services will be required.

6.3 Family visitors

During a pandemic, visitors to all areas of the hospital should be kept to a minimum. In paediatric settings, children should have the right to be accompanied by a parent, relative or guardian at all times. Visitors with influenza symptoms should be strongly discouraged from entering the clinical area and encouraged to return home.

Visitors entering a cohorted area must be instructed on standard infection control principles, including hand hygiene practice and the wearing of protective clothing, as appropriate. Visitors' use of PPE should be determined by their level of interaction with the patient. Surgical masks would be appropriate PPE for visitors who sit close to the patient but are not involved in their care. Other PPE such as gloves and plastic aprons will be required if there is contact with the patient or the patient's environment.

7 Other considerations relevant to critical care

7.1 Infection control precautions

Critical care units should maintain infection control precautions in line with current guidance.[1] Standard precautions should be followed at all times as these are the cornerstone of prevention of communicable diseases and are vitally important. These should be augmented with droplet precautions (section 4.2) and respiratory protection (when necessary), in addition to environmental infection control measures (section 5). Compliance with all measures is critical to ensure effective infection control. The literature indicates that failure to implement appropriate barrier precautions was responsible for most nosocomial spread during the recent SARS outbreaks.[9]

Although there is a need within critical care units to address these key points, just as in other healthcare settings, there are a number of additional issues particularly relevant to critical care areas due to the nature of the work undertaken within such units.

7.2 Stocking and storing

Case-mix issues make it inevitable that some aerosol-generating procedures are more likely to be carried out in critical care units than in many other areas of a healthcare setting. It is therefore important that preparation is carried out in such units. Assessment of stocks of PPE, bacterial/viral filters and other consumables and essential equipment should be carried out prior to the onset of a pandemic. When considering respirators, attention should be paid not only to the likely quantity required but also to the fact that one make or brand of respirator is unlikely to fit all staff members and a range of models may be required. A trigger point for ordering extra supplies should also be established locally.

Units should identify an appropriate area for consumables to be stored. Items that may be needed frequently in a cohorted area (eg PPE) may be stored at an equipment station or trolley nearby.

7.2.1 Suggested checklist for cohorted area trolley*

- Face shield/visor/goggles (if not integral to surgical masks)
- Single-use gloves for clinical use (small, medium and large)
- FFP3 respirators
- Fluid repellent surgical masks
- Single-use long-sleeved fluid repellent gowns

- Single-use plastic aprons
- Alcohol handrub
- Liquid soap
- Single-use paper towels
- Sharps container
- Neutral detergent for environmental cleaning
- Appropriate clinical waste bags
- Linen bags
- Collection container for used equipment

*Adapted from World Health Organization. *Infection prevention and control of epidemic- and pandemic-prone acute respiratory diseases in health care* (2007). Available at: www.who.int/csr/resources/publications/WHO_CD_EPR_2007_6/en/index.html

7.3 Aerosol-generating procedures

Several medical procedures have been reported to generate aerosols, and it has been suggested that some of these are associated with an increased risk of pathogen transmission.[2,3] However, the risk associated with many aerosol-generating procedures is not yet well defined, and the understanding of the aerobiology involved in such procedures may change as further studies in this area are carried out. In a recent (2007) revised World Health Organization (WHO) document, *Infection prevention and control of epidemic- and pandemic-prone acute respiratory diseases in health care*, based on epidemiological studies on tuberculosis (TB) and/or SARS, the following aerosol-generating procedures were considered to be associated with a documented increase in risk of pathogen transmission in patients with acute respiratory disease:[3]

- intubation and related procedures, eg manual ventilation and suctioning
- cardiopulmonary resuscitation
- bronchoscopy
- surgery and post-mortem procedures in which high-speed devices are used.

The authors of the WHO document make the comment that there are other procedures that **may** be associated with an increased risk of pathogen transmission but that some of the studies have methodological flaws that preclude using their conclusions to make recommendations. They categorise these as procedures with only a 'controversial/possible' increase in risk of respiratory pathogen transmission. The 'controversial/possible' procedures specified by WHO are non-invasive positive pressure ventilation, high-frequency oscillating ventilation and nebulisation.

7.3.1 Infection control and personal protective equipment in aerosol-generating procedures

Only essential aerosol-generating procedures should be carried out and only those healthcare workers who are needed to perform the procedure should be present in the immediate vicinity. Although the preferred option would be to perform any potential aerosol-generating procedures in side rooms with the doors shut (or in other closed single-patient areas), it is acknowledged that owing to urgency or limitation of such areas this will generally not be achievable during a pandemic. It is therefore recommended that other components of the infection control guidance are strictly adhered to in order to reduce the risk of disease transmission.

A gown, gloves and eye protection must be worn during such procedures. An FFP3 respirator should be worn for:

- intubation and related procedures, eg manual ventilation and suctioning
- cardiopulmonary resuscitation
- bronchoscopy.

The inclusion by WHO of surgery with high-speed devices as an aerosol-generating procedure is extrapolated from a report of TB transmission after the use of a high-speed saw during the post-mortem examination of a patient with lung and bone marrow TB.[10] Individual risk assessments should be used to select appropriate respiratory protection in surgery where high-speed devices are used. Although not directly relevant to the critical care setting, for post-mortem examinations Health and Safety Executive (HSE) advice stipulates the use of a powered respirator when high-speed devices are used.[11]

For procedures with only a 'controversial/possible' increase in risk of pathogen transmission, use of an FFP3 respirator instead of a surgical mask may be considered prudent until data are available that allow better assessment of the risks associated with different procedures.

Almost all aerosol-generating procedures will also generate copious splashes and droplets. It is important that standard infection control principles and droplet precautions are adhered to at all times for all close patient contact.

7.4 Respiratory care issues

Critical care settings can present some situations that may pose an increased risk of potential exposure to respiratory secretions. In patients receiving mechanical ventilatory support, pressures within the breathing circuits of ventilated patients are higher than those used for spontaneously breathing patients; high oxygen flow rates may also be required for spontaneously breathing patients who are in a precarious condition, and there exists the possibility that such severely ill patients will have higher viral loads and hence a greater risk of disease transmission.[12] Following initial observation of a number of critical care

ventilators and spontaneous breathing circuits, aerobiology expert observations indicated that, in most cases, droplets were more likely to be produced than aerosols (Peter Hoffman, Health Protection Agency, personal communication, 2008).

A number of practical measures can be taken to reduce exposure, such as anticipating those who are likely to require respiratory support, careful preparation for procedures and modifying techniques, such as using deep sedation with or without neuromuscular paralysis for intubation.[13] Procedures such as intubation should be carried out by experienced members of staff so as to reduce as much as possible the time required and the need for multiple attempts.[13]

7.4.1 Respiratory procedures

- Prepare a kit in advance for procedures such as intubation, including all necessary medical equipment.
- Only essential staff should be in a patient's room or bedside area when airway management or cough-inducing activities are being carried out.
- Appropriate PPE must be worn during procedures involving airway management (see Table 1).

7.4.2 Respiratory equipment

- Disposable patient respiratory equipment must be used wherever possible. Reusable equipment must be decontaminated in accordance with local policy and the manufacturer's guidelines.
- Closed systems should be used wherever possible (eg suction).
- All respiratory equipment used on patients, including transport ventilator circuits and manual resuscitation aids, should include a high-efficiency bacterial/viral breathing system filter (BS EN 13328-1).
- Breathing filters should be changed in accordance with the manufacturer's guidelines.
- The ventilatory circuit should not be broken unless absolutely necessary.
- Staff should be alert to the potential for unplanned breathing circuit disruption:
  - breathing circuits should be checked regularly for tightness of fit of component parts
  - caution should be exercised when moving or performing other care on patients who are ventilated, so as to minimise the risk of accidental disconnection.

- For planned circuit breaks, appropriate PPE and FFP3 respirators should be worn, as for aerosol-generating procedures.
- Procedures for the rapid deployment and use of appropriate PPE and FFP3 respirators in the event of an unplanned breathing circuit disruption should be developed and rehearsed.
- In some circumstances, a continual leak of unfiltered gas from the respiratory circuit may be anticipated, and consideration should be given to the adoption of a policy of staff working in close proximity to the patient wearing FFP3 respirators and eye protection for extended periods throughout a shift. Examples of leaks of unfiltered gas include:
  - situations where no bacterial/viral filters are available and ventilator circuits therefore have to be used unfiltered
  - when high-frequency oscillatory ventilators are used
  - in the paediatric setting – although the use of cuffed endotracheal tubes should be considered in an influenza pandemic, if uncuffed endotracheal tubes are clinically appropriate and used, use of FFP3 respirators is strongly recommended.

7.5 Non-invasive ventilation

The use of non-invasive ventilation (NIV) and the risks it may pose to healthcare workers via aerosol generation were debated during the SARS outbreaks in Canada and Hong Kong.[14,15] However, this was complicated by other factors including a lack of the use of PPE, and other studies have shown that NIV can be used effectively and safely in such situations if infection control procedures are strictly followed.[16,17] Although the transmissibility of SARS may not be the same as influenza, general principles of infection control apply to both.

7.5.1 Current suggested best practice for delivery of non-invasive ventilation in pandemic influenza pneumonia*

- Staff should be trained in infection control.
- A gown, gloves and eye protection should be worn for all aerosol-generating procedures; use of an FFP3 respirator instead of a surgical mask may be prudent until data are available that allow better assessment of the risk associated with different procedures (see section 7.3).
- Ideally, patients should be managed in negative pressure single rooms with anterooms, where these are available. If such facilities are not available, they should be cared for in standard single rooms or, if there is no other option, in cohorted groups.

- A non-vented patient mask or helmet should be used.
- Although bi-level pressure support NIV (bi-level positive airway pressure or BiPAP) is likely to be the preferred method of NIV support, in certain circumstances continuous positive pressure ventilation may also be used.
- A high-efficiency bacterial/viral breathing system filter (BS EN 13328-1) should be used between the non-vented mask and the expiratory port and at the outlet of the ventilator.
- Expiratory port options include a whisper swivel valve or controlled leak (each with a proximal filter as above). Ideally, expiratory flow should be directed in a single jet away from patients and staff.
- NIV masks should be applied to the patient's face and secured before the ventilator is turned on.
- Ventilators that function with double-hose tubing (an inspiratory and an expiratory limb) may be advantageous.
- The ventilator should be turned off before removal of the close-fitting mask or when lifting the mask away from the face, eg for mouth care or sips of fluid.
- Water humidification should be avoided.

*Adapted from Simonds AK (ed). *Non-invasive respiratory support: a practical handbook*, 3rd edition (2007). London: Arnold.

7.6 Training

Training of staff, patients and visitors should take place. Much of the training of staff members can and should take place **before** the onset of a pandemic. It is important to involve all staff likely to be on the unit, such as domestic staff, and not just clinical staff.

Staff members should be trained in the following:

- symptoms of influenza
- transmission routes of influenza and their relevance to control measures
- standard and droplet precautions for all patients with acute febrile respiratory symptoms and the importance of compliance
- environmental infection control measures and the importance of cohorting
- the appropriate use of PPE in different circumstances, ie what to use and when to use it
- how to put on, remove and dispose of PPE correctly

- the need to put on PPE in a patient emergency (eg emergency intubation) and the fact that the correct procedures should not be compromised by the need to act quickly in an emergency
- local arrangements for the self-reporting of illness.

Staff should also be made aware of local contingency plans and management arrangements. In order to assist with the planning of training, a log should be kept of dates and details of training given to individual staff members.

As staff on critical care units may be subject to greater numbers of aerosol-generating procedures than in some other areas of the healthcare setting, it is also important that staff should be trained specifically in the use of FFP3 respirators.

As per HSE requirements, every user should be fit tested and trained in the use of such respirators in advance. Fit is critically important and a fit check (not a full fit test) should be carried out each time a respirator is worn. The respirator must seal tightly to the face or air will enter from the sides. Fitted respirators have been shown to have much lower aerosol penetration than those that are unfitted.[18,19] Additionally, there can be a variation of fit depending on the brand used, and so fit testing in advance of any pandemic is critical.[9] Evidence from the SARS outbreaks in Hong Kong and Singapore suggests that attempting to fit test all staff members at the start of an outbreak is impractical[20] and it needs to be planned in advance. Therefore, it makes planning sense to evaluate fit testing in each staff population prior to any outbreak and prior to the mass purchase of one particular make of respirator, which is unlikely to fit all staff members. A good fit can be achieved only if the area where the respirator seals against the skin is clean-shaven. Beards, long moustaches and stubble may cause leaks around the respirator.

Other types of respiratory protective equipment (eg hoods or helmets – ie powered air-purifying respirators) are available if the local risk assessment indicates that they would reduce the risk of exposure. This is particularly important if the wearer is not suitable for a half-mask respirator because of fit issues. For example, a powered respirator might be the only type suitable for someone who, perhaps for cultural reasons, prefers not to remove their beard.

7.7 Compliance

Evidence from the SARS outbreaks showed that some of the most important factors involved in compliance with infection control precautions were the healthcare workers' perception that their facilities had clear policies and protocols, the perceived attitudes and actions of management regarding the importance of occupational health and safety, and having adequate training in infection control procedures.[21,22] Additionally, feedback to staff on their adherence to precautions has been identified as an important factor in facilitating compliance with infection control practices.[22] Therefore, units may wish to develop a role for a nominated individual in the event of a pandemic. This individual could be involved

with the training of staff in infection control and then could monitor and audit staff on their compliance with infection control policies, including the correct use of PPE, and provide feedback and guidance to them.

7.8 Things to do now

Much of the planning for pandemic influenza needs to be carried out well in advance of any pandemic. As outlined above, there are many aspects of infection control planning that units could start to work on now. These include:

- developing clear protocols for:
  - an overarching infection control policy
  - the training of staff
  - the management of ill staff and contingency planning
  - unit layout and plans for cohorting, based on a local risk assessment
  - the overall coordination and management structure
- development and delivery of an infection control training programme as outlined in section 7.6
- plans for stocking and storing infection control equipment, including kits for various procedures.

Appendix A: The epidemiology of pandemic influenza

Transmission of influenza virus

It is well established that influenza is transmitted from person to person through close contact. Transmission almost certainly occurs through multiple routes, including droplets and direct and indirect contact.[23] Aerosol transmission may also occur in certain situations[24] but is hotly debated.[25]

Although the respiratory tract is the main route of infection, infection via the human eye is theoretically possible. No data exist that document human infection with seasonal influenza solely via conjunctival inoculation. While it is true that avian influenza outbreaks (notably H7N7) have produced conjunctivitis in human subjects involved in culling etc,[26] these circumstances are unlikely to be generalisable to pandemic influenza because during outbreaks of avian influenza in poultry the aetiological agent is a pure avian virus and cullers are exposed to very high quantities of virus from the environment (in faecally contaminated material and dust) within poultry sheds.

Transmission of influenza has been well described in hospitals, nursing homes and community settings. Epidemiological patterns of disease occurrence in these settings strongly support close contact with an infected individual as being responsible for the vast majority of transmission. However, most reports, both in clinical and non-clinical settings, do not provide data (eg on patient bed locations, contacts between healthcare workers and patients, laboratory evaluation of healthcare workers for influenza, and clustering in time and space of illnesses in patients and healthcare workers) to determine precisely whether spread is by droplet, contact or aerosol. Furthermore, outbreaks in healthcare settings are almost always confounded by concurrent community-based epidemics, which make it difficult to pinpoint the exact source of exposure among healthcare workers and patients.

Salgado *et al* summarised the findings from 12 outbreaks of nosocomial influenza and concluded that multiple routes of transmission were probably responsible.[27] In none of these outbreaks were isolation precautions instituted or required to halt 'airborne' [sic] transmission; instead, droplet and/or contact precautions were usually implemented, along with various other approaches (eg the use of antiviral drugs and vaccines and limiting the number of visitors). One of this study's authors noted that her institution had not documented any clusters of influenza among hospitalised patients in 15 years, despite placing most patients with recognised influenza in positive pressure single rooms and not in negative pressure isolation rooms. Transmission of influenza at another US hospital occurred principally among paediatric patients who were housed in the same room, especially those in cots adjacent to the index patient.[28] Infection in patients located in separate rooms off the

same corridor was rarely observed, despite opportunities for airborne [sic] transmission to occur (eg through open doors and housing patients in positive pressure rooms). Blumenfeld *et al* described a nosocomial outbreak of A/H2N2 influenza that occurred at the beginning of the 1957/58 pandemic before evidence of widespread cases in the community.[29] The outbreak was traced to admission of a symptomatic patient who was subsequently documented to have influenza. Within 48 hours, the patient in the adjacent bed developed symptoms, and 12 other cases in healthcare workers and patients occurred soon afterwards. Isolation precautions had not been instituted and the pattern of disease was most compatible with short-range transmission, suggesting that contact and droplet transmission were likely routes. Further evidence for a role for contact transmission can be derived from experimental studies of survival of human influenza viruses, which suggest that the virus can survive on some environmental surfaces for up to 72 hours.[5]

Limited data are available to assess the possible role of aerosol transmission in humans. One source of information is from human volunteer studies. In these studies, experimental infection by inhalation of virus (aerosol) was observed to induce symptomatic illness far more readily than infection by instillation of nasal drops (direct contact) and at 10-fold to 100-fold lower doses.[30] However, it is not certain how closely experimental inoculation mimics the natural setting.

Observational data derived from a minority of outbreaks of influenza in the literature suggest a possible role for aerosol transmission. In one frequently cited report, the rate of serologically confirmed A/H2N2 pandemic influenza infection was significantly less among TB patients housed in a veterans' hospital ward equipped with ultraviolet lighting (four out of 209 patients (2%), compared with 75 out of 396 patients (19%) in a non-radiated ward), suggesting that the ultraviolet radiation had inactivated viral-laden aerosols.[31] However, interpretation of this observational report is severely limited because critical elements that could have confounded the observations were either not recorded or not reported. Importantly, the study lacked suitable controls, which limits firm conclusions.[25]

In a second study, 72% of 53 airline crew and passengers developed an influenza-like illness within 72 hours of sharing a flight with a febrile coughing passenger who was subsequently documented to have influenza A.[32] The flight was delayed by more than four hours on the ground, during which time the ventilation system, which normally completely exchanged the air in the passenger cabin every four-and-a-half minutes, was turned off. The risk of clinical illness among passengers was found to correlate with increasing time spent aboard the grounded aircraft. Two different replacement planes flew passengers to their final destination; interestingly, passengers who flew on the same replacement plane as the ill passenger had the same rate of illness as those who flew on a second plane, suggesting that additional time spent with the ill passenger, albeit under routine air flow conditions, did not increase the risk of transmission. The findings of this outbreak mimic those of Schulman's studies of air flow effect on transmission in mice,[33] and suggest that standard air exchange rates used in hospital rooms would assist in limiting transmission of influenza. In both these

studies, however, it was not possible to delineate carefully other routes of exposure and to assess individuals' susceptibility to infection. For example, in the airline study, transmission may also have resulted from droplet or contact spread, as passengers moved freely about the cabin while it was grounded, including in and around the area where the index case was seated.

In summary, although there is no evidence that establishes a clear hierarchy for modes of transmission, the patterns of transmission observed during nosocomial outbreaks frequently point to short-range transmission. This suggests that droplet and contact transmission are the most important and the most likely routes.

Infection control measures to interrupt transmission of influenza virus

Surgical masks are worn by healthcare workers to provide a physical barrier and minimise contamination of the nose and mouth by droplets. Although there are few well-designed experimental or observational studies to conclusively demonstrate that surgical masks protect healthcare workers from respiratory infections during routine ward work,[7] the use of face masks to protect healthcare workers has a long history[34,35] and has been incorporated into international[3] and national infection control guidance.[2] Two recent retrospective studies of the SARS epidemic suggested that surgical masks afforded healthcare professionals some measure of protection when in close contact with patients.[36,37] The impact of PPE use by visitors has not been addressed specifically in the literature, but its use should be determined by their level of interaction with the patient.[2]

Epidemiological evidence has defined the area of risk around the patient as being a distance of less than one metre.[38] Recent isolation guidance from the US Centers for Disease Control and Prevention suggests that this should be used as an approximation rather than an absolute distance.[2] Nevertheless, applying a one-metre threshold for using surgical masks has been effective in preventing transmission of infectious agents via the droplet route. In a recent systematic review, a meta-analysis of six case-control studies assessed the impact of several measures taken to reduce the spread of SARS. Frequent hand washing and wearing masks, gloves and gowns were among the measures found to be effective.[39]

Common sense suggests that strict adherence to respiratory hygiene, such as covering the nose and mouth when coughing and sneezing, will interrupt droplet transmission. A recent 'cover your cough' campaign was found to prevent exposure of hospital employees to pertussis, which is spread by droplet transmission.[40]

Several studies have documented both the major contribution played by contaminated hands in the transfer of infection and the effectiveness of hand hygiene in healthcare[7,41] and community settings.[42,43,44] Hands have been shown to donate and receive viruses during contact with animate and inanimate surfaces, so thorough and regular decontamination by carers is crucial in preventing spread.[45] UK guidelines for preventing healthcare-associated infections indicate that effective hand decontamination results in significant reductions in

the carriage of potential pathogens on the hands and therefore decreases the incidence of preventable healthcare-associated infection.[7] Alcohol handrubs are recognised to have broad antimicrobial efficacy, including efficacy against enveloped viruses. At least one study has demonstrated that influenza virus is readily inactivated within 30 seconds by a commercially marketed alcohol hand disinfectant following experimental contamination of hands.[6]

There are few data specifically demonstrating the effectiveness of environmental cleaning in reducing transmission of influenza. However, alcohol is effective against influenza viruses, and influenza viruses are deactivated by washing with soap and water, household detergents and cleaners. Therefore, sensible environmental cleaning appropriate to the specific environment and, in healthcare settings, in line with national specifications[46] is important.

Micro-organisms are removed and killed during all stages of the laundering process. NHS laundry guidelines provide specifications for cleaning hospital linen on an industrial scale.[47] Although some hospitals launder staff uniforms according to these guidelines, increasingly these are laundered at home. There is no strong scientific evidence to suggest that home laundering of uniforms is inferior to industrial processing as a means of decontaminating uniforms, nor that domestic machines pose a risk of transmitting hospital pathogens to other items in the wash load.[48] However, dilution is an important element in the process, so, to avoid overloading, uniforms should be washed separately and at the highest temperature they can tolerate to ensure that micro-organisms are killed.[49] Although evidence shows that the washing process itself adequately removes microbes, components such as ironing and tumble-drying are also beneficial in reducing microbial counts. The authors of one study that looked specifically at laundering hospital uniforms at home concluded that domestic laundering of uniforms was an acceptable alternative to hospital laundering if combined with tumble-drying or ironing.[50]

Influenza virus survival and inactivation

Studies of mice exposed to aerosols of fine, uniformly sized droplets of influenza virus found that under conditions of low humidity (17–24%) mice could become infected for up to 24 hours after the virus was first aerosolised in a room in which a slowly rotating fan was used to continuously agitate the air.[51] Loosli *et al* postulated that the low humidity allowed for rapid drying of infectious particles. That desiccation does not eliminate infectivity was supported by an increased rate of infection in mice following 'vigorous sweeping of the floor' 22 hours after the virus had first been sprayed into the experimental room.[51]

Indirect support for the feasibility of contact transmission of influenza virus can be derived from experimental data regarding the survival of influenza A viruses (as judged by the ability to recover and culture virus) on various environmental surfaces at 35–40% humidity.[5] Virus survived on hard, non-porous surfaces (a stainless steel counter and plastic washing-up bowl) for up to 72 hours, but only small quantities were detectable beyond 48 hours. In contrast, virus was recovered from soft, porous items (pyjamas, handkerchiefs, tissues and magazines) for up to 24 hours, but only small quantities were detectable after 12 hours.

The authors of this study also evaluated the transferability of influenza A virus from contaminated surfaces to hands.[5] Measurable virus could be transferred to hands from hard, stainless steel surfaces for up to 24 hours after the surface had been contaminated and from soft, porous items for up to two hours after (albeit in very low quantities after 15 minutes). On the basis of their results, the authors suggested that people shedding large amounts of virus could transmit via stainless steel surfaces for two to eight hours and via paper tissues for a few minutes. It should be noted that once virus was transferred to hands it survived for only five minutes – albeit long enough for self-inoculation of conjunctiva or mucous membranes theoretically to occur or for the virus to be transferred to other surfaces by touch.

Incubation and communicability

Estimates of the incubation period of influenza vary from one to four days, with most ranging from two to three days.[52]

The period of communicability of influenza virus (ie the period of viral shedding) can be inferred from the length of time during which virus can be recovered from respiratory secretions and is influenced by the age of the person infected, the level of immunocompetency and treatment with antiviral agents. Early live-virus challenge studies indicated that adults shed virus from the day before symptoms through the three to five days after onset of the illness. The level of virus shedding before symptoms appear is lower than in the symptomatic period and usually subsides to low levels by day five.[52,53] A more recent study found that adult patients could shed virus (detected by polymerase chain reaction (PCR) or culture) beyond this traditional period. However, it was unclear whether influenza A virus detected by PCR was infectious.[4]

Viral shedding is proportional to the severity of the illness and temperature elevation.[12] It is estimated that approximately 50% of all influenza infections are asymptomatic.[28] Infected people (typically adults) can shed influenza virus yet have no evidence of respiratory symptoms.[54] The importance of transmission from infected people during the incubation period or from those with asymptomatic infection is uncertain but appears to be substantially less than from symptomatic people.

There has been only one published report implicating transmission of influenza between adults during the incubation period. This involved a group of adults who worked bagging fertiliser in New Zealand. One worker, considered to be the probable index patient, had felt unwell during work, although he did not have respiratory symptoms; six hours after he finished work he developed an influenza-like illness. Subsequently 16 of his 26 colleagues became ill with influenza-like symptoms 24 to 48 hours later.[55]

Studies of naturally occurring influenza B infection in children have shown that 93% shed detectable virus during the first three days of symptomatic illness, 74% on day four and roughly 25% on day six.[12] In general, children cease shedding influenza virus seven to eight days after the onset of symptoms, but they can shed infectious virus several days before the onset of illness.[56]

Studies involving hospitalised children with underlying medical conditions who acquired influenza A virus in hospital have demonstrated isolation of the virus 7 to 21 days after the onset of symptoms.[57,58] Case reports of severely immunocompromised adults and children indicate that viral shedding can occur for even longer periods of time.[59,60]

Appendix B: Infection control precautions

Standard infection control principles*

Standard infection control principles are a set of broad statements of good practice to minimise exposure to and transmission of a wide variety of micro-organisms. Standard principles should be applied by **all** healthcare practitioners to the care of **all** patients **all** of the time.

Hospital environmental hygiene

The hospital environment must be visibly clean, free from dust and soiling and acceptable to patients, their visitors and staff.

Increased levels of cleaning should be considered during outbreaks of infection where the pathogen concerned survives in the environment and environmental contamination may be contributing to spread.

The use of hypochlorite and detergent should be considered in outbreaks of infection where the pathogen concerned survives in the environment and environmental contamination may be contributing to spread.

Shared equipment used in the clinical environment must be decontaminated appropriately after each use.

All healthcare workers need to be aware of their individual responsibility for maintaining a safe care environment for patients and staff.

Every healthcare worker needs to be clear about their specific responsibilities for cleaning equipment and clinical areas (especially those areas in close proximity to patients). They must be educated about the importance of ensuring that the hospital environment is clean and that opportunities for microbial contamination are minimised.

Hand hygiene

Hands must be decontaminated immediately before each and every episode of direct patient contact or care and after any activity or contact that potentially results in hands becoming contaminated.

Hands that are visibly soiled or potentially grossly contaminated with dirt or organic material, eg after removal of gloves, must be washed with liquid soap and water.

Hands should be decontaminated between caring for different patients and between different care activities for the same patient. For convenience and efficacy, an alcohol

handrub is preferable unless hands are visibly soiled. Local infection guidelines may advise an alternative product in some outbreak situations.

Hands should be washed with soap and water after several consecutive applications of alcohol handrub.

Before a shift of clinical work begins, all wrist and, ideally, hand jewellery should be removed. Cuts and abrasions must be covered with waterproof dressings. Fingernails should be kept short, clean and free of nail polish. False nails and nail extensions must not be worn by clinical staff.

An effective hand-washing technique involves three stages: preparation, washing and rinsing, and drying. Preparation requires wetting hands under tepid running water **before** applying the recommended amount of liquid soap or an antimicrobial preparation. The hand wash solution must come into contact with all the surfaces of the hand. The hands must be rubbed together vigorously for a minimum of 10 to 15 seconds, and particular attention should be paid to the tips of the fingers, the thumbs and the areas between the fingers. Hands should be rinsed thoroughly prior to drying with good-quality paper towels.

When an alcohol handrub is used to decontaminate hands, hands should be free of dirt and organic material. The handrub solution must come into contact with all surfaces of the hand. The hands must be rubbed together vigorously, with particular attention paid to the tips of the fingers, the thumbs and the areas between the fingers, until the solution has evaporated and the hands are dry.

Clinical staff should be aware of the potentially damaging effects of hand decontamination products. They should be encouraged to use an emollient hand cream regularly, eg after washing hands before a break, when going off duty and when off duty, to maintain the integrity of the skin.

If a particular soap, antimicrobial hand wash or alcohol-based product causes skin irritation, review the methods described above before consulting the occupational health team.

Alcohol handrub should be made available at the point of care in all healthcare facilities.

Hand hygiene resources and individual practice should be audited at regular intervals and the results fed back to healthcare workers.

Education and training in risk assessment, effective hand hygiene and glove use should form part of all healthcare workers' annual updating.

The use of personal protective equipment

The selection of PPE must be based on an assessment of the risk of transmission of micro-organisms to the patient or to the carer, and the risk of contamination of the healthcare practitioner's clothing and skin by patients' blood, body fluids, secretions or excretions.

Everyone involved in providing care should be educated about standard principles and trained in the use of PPE.

Adequate supplies of disposable plastic aprons, single-use gloves and face protection should be made available wherever care is delivered. Gowns should be made available when this is advised by the infection control team.

Gloves must be worn:

- for invasive procedures
- when there is any contact with sterile sites, non-intact skin or mucous membranes
- for all activities that have been assessed as carrying a risk of exposure to blood, body fluids, secretions and excretions
- when handling sharp or contaminated instruments.

Gloves must be worn as single-use items. They are put on immediately before an episode of patient contact or treatment and removed as soon as the activity is completed. Gloves are changed between caring for different patients and between different care or treatment activities for the same patient.

Gloves must be disposed of as clinical waste and hands decontaminated by washing after the gloves have been removed with, ideally, liquid soap and water.

Gloves that are acceptable to healthcare personnel and CE marked must be available in all clinical areas.

Sensitivity to natural rubber latex among patients, carers and healthcare personnel must be documented, and alternatives to natural rubber latex must be available.

Neither powdered nor polythene gloves should be used in healthcare activities.

Disposable plastic aprons should be worn when close contact with the patient, materials or equipment is anticipated and when there is a risk that clothing may become contaminated with pathogenic organisms or blood, body fluids, secretions or excretions, with the exception of perspiration.

Full-body fluid-repellent gowns must be worn where there is a risk of extensive splashing of blood, body fluids, secretions or excretions, with the exception of perspiration, onto the skin or clothing of healthcare personnel (eg when assisting with childbirth).

Plastic aprons and gowns should be worn as single-use items, for one procedure or episode of patient care, and then discarded and disposed of as clinical waste. Non-disposable protective clothing should be sent for laundering.

Face masks and eye protection must be worn where there is a risk of blood, body fluids, secretions or excretions splashing onto the face and eyes.

Respiratory protective equipment, ie a particulate filter mask, must be correctly fitted and used when recommended for the care of patients with respiratory infections transmitted by airborne particles.

The safe use and disposal of sharps

Sharps must not be passed directly from hand to hand, and handling should be kept to a minimum.

Needles must not be recapped, bent, broken or disassembled after use.

Used sharps must be discarded into a sharps container (conforming to UN 3291 and BS 7320 standards) at the point of use by the user. These must not be filled above the mark that indicates that the bin is full.

All sharps bins should be positioned out of the reach of children and at a height that enables safe disposal by all members of staff. They should be secured to avoid spillage.

All staff, both clinical and non-clinical, must be educated about the safe use and disposal of sharps.

Consider the use of needlestick-prevention devices where there are clear indications that they will provide safe systems of working for healthcare practitioners.

Conduct a rigorous evaluation of needlestick-prevention devices prior to widespread introduction to determine their effectiveness, acceptability to practitioners, impact on patient care and cost/benefit.

*From Pratt RJ, Pellowe C, Wilson JA *et al.* epic2: National evidence-based guidelines for preventing healthcare-associated infections in NHS hospitals in England. *J Hosp Infect* 2007;65(suppl):S1–64.

Droplet precautions

In addition to the standard precautions, use droplet precautions if a patient is known or suspected to be infected with micro-organisms that can be transmitted by droplets generated by the patient during coughing, sneezing or talking or in the performance of some procedures.

Patient placement

Place the patient in a single room (an isolation room, side room or cubicle). When a single room is not available, place the patient in a room with patients who have active infection with the same micro-organism but with no other infection (cohorting). When a single room is not available and cohorting is not achievable, maintain spatial separation of at least one metre between the infected patient and other patients and visitors. Special air handling and ventilation are not necessary, and the door may remain open.

Surgical masks

In addition to wearing a surgical mask as outlined under the standard precautions (ie the standard infection control principles), a surgical mask should be worn for close contact (within one metre) with a symptomatic patient. (Logistically, some hospitals may want to implement the wearing of a surgical mask to enter the room.)

Patient transport

Limit the movement and transport of the patient from the room or cohorted area to essential purposes only. If transport or movement is necessary, minimise the patient's dispersal of droplets by masking the patient, if the patient tolerates this, and encourage good respiratory hygiene.

Adapted from Garner JS and the Hospital Infection Control Practices Advisory Committee. Guideline for isolation precautions in hospitals. *Am J Infect Control* 1996;24:24–52.

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