Chapter 11: Infection control precautions for the infectious patient

Non-emergency cases should be postponed until the patient is deemed to no longer be infectious. Units should develop their own facility-based protocols. Precautions should be based on the mode of transmission of the specific microorganism.

Modes of transmission[36]

Direct contact

- Physical contact with patient and body fluid, soil or vegetation
- Droplet spread:
  - Large particles > 5 µm.
  - Short distance spread usually within one meter but can be further as has been demonstrated with smallpox and SARS viruses.
  - Airway instrumentation such as intubation, suctioning and extubation.
  - Sneezing, coughing, singing.

Indirect contact

- Airborne/aerosol spread:[286]
  - Particles are less than 5 µm.
  - Can remain suspended in air for prolonged periods.
  - Can spread over large areas and possibly further than physical barriers such as rooms or operating theatres.

- Can be deposited on environmental surfaces. Depending on the type of surface, it can remain viable for a couple of hours or up to a couple of days.
- Small size means the particles can travel further down the respiratory tract into alveoli.
- Aerosol-generating procedures (AGP):[287]
  - Airway instrumentation:
    - Intubation, extubation
    - Manual mask ventilation prior to intubation
    - Tracheostomy
    - Suctioning of airways (unless a closed system is used)
    - Placement of supraglottic airway device
    - Bronchoscopy
  - Chest physiotherapy
  - Nebulisation
  - Non-invasive ventilation including high nasal flow oxygen
  - Cardio-pulmonary resuscitation
  - Surgeries where high speed devices are used
  - Plume from cauterisation
  - Sneezing, coughing, vocalisation
  - Autopsy
- Vehicle spread:
  - Contaminated hands.
  - Inanimate objects such as laryngoscopes, pens, cell phones.
- Vector spread:
  - E.g. flies and mosquitoes.

Type of precautions

Standard precautions[36,288,289]

- Hand hygiene.
- Use of PPE.
- Respiratory etiquette.
- Environmental cleaning and disinfection.
- Proper handling of patient care equipment and waste management.
- Proper handling of needles and sharps.
- Healthcare workers should have documented immunity to hepatitis B virus.

Contact precautions[36,288,289]

- Standard precautions as above.
- Adhere to hand hygiene standards.
- Isolation cubicle until no longer infectious.
- Use PPE including a gown.
- Remove PPE before leaving the immediate environment of the patient.
- Take care not to self-contaminate when removing PPE.
- Maintain contact precautions throughout the entire perioperative period.
- Appropriate environmental decontamination of the operating theatre at the end of the case.

Droplet precautions[36,288,289]

- Standard precautions as above.
- Adhere to hand hygiene standards.
- Ideally, to be isolated. If isolation not available, keep patient at least one meter from any other patients.
- Educate patients on respiratory hygiene, e.g. coughing and sneezing etiquette.
- Patient to wear a standard face mask when outside the isolation area.
- Healthcare workers must use standard PPE.
- Use N95 masks/respirators during AGP such as airway instrumentation.
- Maintain these precautions throughout the entire perioperative period.

Airborne precautions[36,288,289]

- Standard precautions as above.
- Adhere to hand hygiene standards.
- Patient should be in an airborne isolation room.
- Patient should remain in the isolation room except for medical/surgical procedures that require the patient to leave the room.
- Any non-emergency case should be postponed until the patient no longer needs respiratory isolation.
- Patient to wear a standard face mask when outside the isolation area.

Healthcare workers donning of PPE[290,291]

- There are various different guidelines that differ in the sequence of events. The most important thing to consider is to minimise the risk of contamination, especially during the doffing procedure. It is advisable to have a "buddy system" where a colleague uses a checklist to guide the sequence of events. In addition, it is valuable to choose one method and use that routinely to become familiar with such a method.
  - Remove jewellery and any other personal items.
  - Empty pockets.
  - Tie hair back and cover ALL hair.
  - Perform hand hygiene and don disposable apron.
  - Perform hand hygiene and change shoes or apply overshoes.
  - Perform hand hygiene and don first pair of gloves.
  - Perform hand hygiene and don an impermeable disposable gown or coverall.
    - Ensure that gown covers area from the neck to knees, arms to the end of wrists and wrapped around the back.
    - Tie behind with a simple knot that can be easily untied.
  - Perform hand hygiene and don respiratory protection
    - Use N95 or higher mask/respirator.
    - Secure ties at middle of head and neck.

- Fit flexible nose piece over the bridge of the nose.
- Fit snuggly to face and chin.
- Perform fit test: Mask collapses inward on inspiration and expands without a leak on exhalation.

◦ Hand hygiene and don goggles.
◦ Hand hygiene and don head cover or balaclava. Ensure that the sides of the goggles, the ears and nape of the neck are covered. Ideally, the neck should be covered as well.
◦ Hand hygiene and don second pair of gloves. Extend to cover wrist. No skin should be exposed.
◦ Hand hygiene and don face shield.

Healthcare workers doffing of PPE[290,291]

- Careful doffing is extremely important to prevent contamination.
  ◦ Use the method that you are familiar with.
  ◦ Perform hand hygiene on outer pair of gloves.
  ◦ Remove gown (Remember that the front of the gown and the arms are the most contaminated areas). Undo ties and carefully pull the gown down from neck and shoulders. Turn gown inside out.
  ◦ Outside gloves are removed with the gown as it reaches the wrist and hands.
  ◦ Carefully roll the gown with inside facing outwards into a bundle and discard.
  ◦ Perform hand hygiene on inner gloves using alcohol sanitiser.
  ◦ Remove face shield (remember that front is contaminated).
  ◦ Take off head covering – grasp from behind and carefully lift from the back of the head and into waste packet.
  ◦ Perform hand hygiene on inner gloves with alcohol sanitiser
  ◦ Carefully remove goggles.
  ◦ Hand hygiene.
  ◦ Remove overshoes.
  ◦ Hand hygiene.
  ◦ Exit doffing area and then remove N95 mask/respirator.
  ◦ Hand hygiene.
  ◦ Remove inner pair of gloves followed by hand hygiene.
- Maintain these precautions throughout the entire perioperative period.

Precautions for common pathogens

Pathogen	Level of precautions
HIV	Standard, post-exposure prophylaxis
Hepatitis (viral)	Standard precautions
Human papillomavirus (HPV)	Standard, droplet and airborne if plume from cauterisation of airway papillomas or genital warts are present
Measles	Standard and airborne
Mycobacterium tuberculosis	Standard and airborne precautions
Multidrug-resistant organisms Meticillin-resistant *Staphylococcus Aureus* (MRSA) Vancomycin-resistant enterococci (VRE) Extended-spectrum beta-lactamase-producing organisms (ESBL)	Standard and contact precautions
Neisseria	Standard and droplet precautions
Clostridium difficile	Standard and contact precautions
Haemophilus influenza	Standard and droplet precautions
Seasonal influenza	Standard and droplet precautions
Coronaviruses	Standard, droplet and airborne precautions

Rationale

Modes of transmission[36]

Microorganisms have different modes in which they are transmitted. These modes largely dictate what type of precautions should be adhered to in order to minimise the risk of transmission.

Direct contact occurs when there is physical contact with the organism, such as when there is contact with blood, body fluids or a contaminated environment. Droplet spread is a type of direct contact as the expelled droplets travel over a distance and make direct contact with the surrounding surfaces. Sneezing, coughing and talking are the most common ways in which droplets are generated. Procedures such as intubation, extubation, airway suctioning, cough induction by physiotherapist, and cardiopulmonary resuscitation can also produce large amounts of droplets and aerosols. Droplets are typically more than 5 µm and travel over short distances. This distance is generally considered to be about one meter but can be more than two meters. A study in Hong Kong has demonstrated the spread of SARS viruses to medical students that were further than one meter away from a single infected patient.[292] Factors that may contribute to droplets travelling further include the velocity of the expulsion of droplets (i.e. sneezing versus talking), the density of the respiratory secretions, ambient temperature and humidity as well as the ability of the microorganism to retain infectivity for longer periods.[36]

Indirect contact occurs when small particles become suspended in air currents. Droplet nuclei also become airborne pathogens. The size of these particles is generally smaller than 5 µm. They remain suspended for an undefined period of time. As such, they have the ability to spread over large areas and even past physical barriers such as rooms and operating theatres. Aerosoles can also be deposited on environmental surfaces and instruments such as laryngoscopes, pens, cell phones, etc. When such contaminated surfaces are touched, the microorganisms can then be transferred to hands that act as vehicles for the transmission of the organism. Vectors such as mosquitoes and flies are also examples of spread via indirect contact.

Precautions[36,289]

Standard precautions are applicable to any patient and not just the infectious patient. It involves following of all the guidelines set out in this document and specifically hand hygiene. In addition, healthcare workers should protect themselves where possible such as in the case with the hepatitis B vaccine.

Contact precautions include standard precautions with strict adherence to hand hygiene and donning and doffing of PPE. Care should be taken to avoid self-contamination when removing PPE. Contact precautions should remain in place for the entire time that the patient is occupying the operating theatre. PPE should be removed before leaving the immediate environment of the patient. Appropriate environmental decontamination should be performed after the patient has left the operating theatre.

The patient should further be nursed in an isolation cubicle until no longer deemed to be infectious. Whilst there is a major focus on droplet and airborne precautions, it is important to adhere to contact precautions, especially in those patients who may potentially harbour multidrug-resistant microorganisms. A recent study by Arriero et al.[293] showed the compliance rate of healthcare workers with empirical contact precautions to be 39.5% and 43.1% in patients known to be colonised. Compliance was better before patient contact than after, except for hand hygiene that showed better compliance after patient contact.

Droplet precautions include standard precautions with strict adherence to hand hygiene. PPE should be used when airway procedures are performed and should include a surgical mask and eye protection. MacIntyre et al.[294] looked at the efficacy of medical masks to reduce the risk of infection with influenza virus in healthcare workers. The continuous use of N95^{+} masks/respirators was associated with lower infection rates indicating that droplets can become aerosols even over short distances and that pathogens that are presumed to have droplet transmission only can also have airborne transmission. This sentiment is shared by Shiu et al.[288] This is especially important for AGPs. Anyone closer than one meter to the source patient should wear PPE, including surgical facemask. Proper airborne precautions should be in place for AGPS. Precautions should remain in place throughout the entire procedure. Organisms transmitted through droplets usually do not remain infective over long distances. Isolation is thus not crucial, but the patient should be more than one meter from other patients. Patients should also be educated on proper respiratory hygiene such as coughing and sneezing etiquette.

Airborne precautions are important as aerosols containing microorganisms can remain suspended in air for long periods and can travel over long distances. When these particles are inhaled, they colonise the naso- and oropharynx. Due to their small size, they also travel deep into the respiratory tree leading to lower respiratory tract infection and more severe disease. These patients should remain in an airborne isolation room until there is proof that they are no longer infectious. Non-emergency surgery should be postponed until the patient is no longer infectious. For emergency surgical procedures the patient should wear a surgical face mask before leaving the isolation cubicle. They should bypass the reception area and go straight to the operating theatre. All personnel, including porters, should wear fit tested N95 masks or respirators with more than 95% filtration in addition to standard PPE. These precautions should remain in place for the entire time where there is patient contact. All non-essential personnel should leave the operating theatre and non-essential trolleys and equipment should be removed. The patient should be recovered in theatre and returned straight to the isolation cubicle. The operating theatre should remain vacant after the source patient has left theatre until a 99.9% turnover of air has occurred. Air changes per hour differ between institutions and vary between 2–400 changes per hour. At two air changes per minute, 207 minutes will be required to ensure 99.9% removal of airborne particles. At the standard of 15 air changes per hour, a total of 28 minutes would result in 99.9% removal.[295,296] Cleaning of the operating theatre should only commence *after* this mandatory period has elapsed. Cleaners should also don proper PPE and should also be included in training on appropriate donning and doffing procedures.