

BI.2 Personal protective equipment

BI.2.1 What are the risks?

Any infectious agent transmitted by the contact or droplet route can potentially be transmitted by contamination of healthcare workers' hands, skin or clothing. Cross-contamination can then occur between the healthcare worker and other patients or healthcare workers, or between the healthcare worker and the environment. Infectious agents transmitted through droplets can also come into contact with the mucous membranes of the healthcare worker.

Personal protective equipment (PPE) refers to a variety of barriers, used alone or in combination, to protect mucous membranes, airways, skin and clothing from contact with infectious agents. PPE used as part of standard precautions includes aprons, gowns, gloves, surgical masks, protective eyewear and face shields. Selection of PPE is based on the type of patient interaction, known or possible infectious agents, and/or the likely mode(s) of transmission.

There have been few controlled clinical studies evaluating the relationship between the use of PPE and risk of HAIs. However, the use of barriers reduces opportunities for transmission of infectious agents (Pratt et al 2001; Clark et al 2002). PPE also protects patients from exposure to infectious agents in the surrounding environment carried by healthcare workers.

This section discusses the routine use of PPE as part of standard precautions. Specific PPE used when transmission-based precautions are applied is discussed in Section B2. The use of PPE during specific procedures is discussed in Section B4.

BI.2.2 Decision-making about personal protective equipment

Selection of protective equipment must be based on assessment of the risk of transmission of infectious agents to the patient or carer, and the risk of contamination of the clothing or skin of healthcare workers or other staff by patients' blood, body substances, secretions or excretions. Local policies and current health and safety legislation should also be taken into account (Clark et al 2002).

Factors to be considered are:

- probability of exposure to blood and body substances
- type of body substance involved
- probable type and probable route of transmission of infectious agents.

Appropriate sequences and procedures for putting on and removing PPE¹⁰ are shown in Section B1.2.7. Relevant Australian Standards are listed in B1.2.9.

All PPE must meet relevant Therapeutic Goods Administration (TGA) criteria for listing on the Australian Register of Therapeutic Goods (ARTG) or equivalent and should be used in accordance with manufacturer's recommendations.

¹⁰ While it is acknowledged that 'donning' and 'doffing' are accepted terms for putting on and removing PPE, in these guidelines plain English terms are used for simplicity and clarity.

Where to wear PPE

PPE is designed and issued for a particular purpose in a protected environment and should not be worn outside that area. Protective clothing provided for staff in areas where there is high risk of contamination (e.g. operating suite/room) must be removed before leaving the area. Even where there is a lower risk of contamination, clothing that has been in contact with patients should not be worn outside the patient-care area. Inappropriate wearing of PPE (e.g. wearing operating suite/room attire in the public areas of a hospital or wearing such attire outside the facility) may also lead to a public perception of poor practice within the facility.

BI.2.3 Aprons and gowns

International guidelines recommend that protective clothing (apron or gown) be worn by all healthcare workers when (Garner 1996; Pratt et al 2001; Clark et al 2002; Pratt et al 2007):

- close contact with the patient, materials or equipment may lead to contamination of skin, uniforms or other clothing with infectious agents
- there is a risk of contamination with blood, body substances, secretions or excretions (except sweat).

The type of apron or gown required depends on the degree of risk, including the anticipated degree of contact with infectious material and the potential for blood and body substances to penetrate through to clothes or skin:

- a clean non-sterile apron or gown is generally adequate to protect skin and prevent soiling of clothing during procedures and/or patient-care activities that are likely to generate splashing or sprays of blood or body substances
- a fluid-resistant apron or gown should be worn when there is a risk that clothing may become contaminated with blood, body substances, secretions or excretions (except sweat).

Gowns and aprons must be changed between patients.

Clinical and laboratory coats or jackets worn over personal clothing for comfort and/or purposes of identity are not considered to be PPE. These items of clothing need to be changed dependant on activity and the extent of exposure to potential pathogens.

Aprons/gowns are routinely used upon entering the room of a patient requiring contact precautions. This is discussed in Section B2.2.3.

Plastic aprons

Single-use plastic aprons are recommended for general use when there is the possibility of sprays or spills, to protect clothes that cannot be taken off (Garner 1996; Pratt et al 2001; Clark et al 2002; Pratt et al 2007). Unused aprons should be stored in an appropriate area away from potential contamination (Callaghan 1998).

Gowns

Gowns are used to protect the healthcare worker's exposed body areas and prevent contamination of clothing with blood, body substances, and other potentially infectious material (Boyce et al 1994; Boyce et al 1995; Hall 2000; Kohn et al 2004).

Considerations in choosing a type of gown (e.g. long or short-sleeved) that is appropriate for the activity are:

- the volume of body substances likely to be encountered
- the extent and type of exposure to blood and body substances
- the probable type and route of transmission of infectious agents.

If a fluid-resistant full body gown is required, it is always worn in combination with gloves, and with other PPE when indicated. Full coverage of the arms and body front, from neck to the mid-thigh or below, ensures that clothing and exposed upper body areas are protected.

Table B1.4: Characteristics of aprons/gowns

Plastic apron	<ul style="list-style-type: none"> • Impervious /fluid resistant • Single-use, for one procedure or episode of patient care • Disposable • Worn when there is a risk that clothing may become exposed to blood or body substances (usually from the environment) during low-risk procedures and where there is low risk of contamination to the healthcare worker's arms • Worn during contact precautions when contact with the patient or the patient environment is likely
Gown	<ul style="list-style-type: none"> • Single-use* • Disposable • Worn to protect skin and prevent soiling of clothing during procedures and/or patient-care activities that are likely to generate splashing or sprays of blood or body substances • Choice of sleeve length depends on the procedure being undertaken and the extent of risk of exposure of the healthcare worker's arms
Full body gown	<ul style="list-style-type: none"> • Fluid resistant • Single-use* • Long sleeved • Worn when there is a risk of contact of the healthcare worker's skin with a patient's broken skin, extensive skin to skin contact (e.g. lifting a patient with scabies or non-intact skin), or a risk of contact with blood and body substances which are not contained (e.g. vomiting, uncontrolled faecal matter) • Worn when there is the possibility of extensive splashing of blood and body substances • Worn when there is a risk of exposure to large amounts of body substances eg in some operative procedures
Sterile gown*	<ul style="list-style-type: none"> • Pre-packaged • Used for procedures requiring an aseptic field

* Some gown types can be re-used. Reusable gowns need to be laundered or reprocessed according to AS/NZS4146—2000 Laundry Practice

Removing aprons and gowns

Removal of aprons and gowns before leaving the patient-care area (e.g. in the room or anteroom) prevents possible contamination of the environment outside the patient's room. Aprons and gowns should be removed in a manner that prevents contamination of clothing or skin. The outer, 'contaminated', side of the gown is turned inward and rolled into a bundle, and then discarded into a designated container for waste or linen to contain contamination (see Section B1.2.7).

Recommendation

5 Wearing of aprons/gowns

Grade

Aprons or gowns should be appropriate to the task being undertaken. They should be worn for a single procedure or episode of patient care and removed in the area where the episode of care takes place.

C

BI.2.4 Face and eye protection

The mucous membranes of the mouth, nose and eyes are portals of entry for infectious agents, as are other skin surfaces if skin integrity is compromised (e.g. by acne, dermatitis) (Sartori et al 1993; Rosen 1997; Keijman et al 2001; Hosoglu et al 2003).

Face and eye protection reduces the risk of exposure of healthcare workers to splashes or sprays of blood and body substances (Dancer 1999; Pratt et al 2001; Clark et al 2002) and is an important part of standard precautions. Procedures that generate splashes or sprays of blood, body substances, secretions or excretions require either a face shield or a mask worn with protective eyewear (CDC 1978; Davidson et al 1995; Gehanno et al 1999; Scales et al 2003; Seto et al 2003; Fowler et al 2004; Loeb et al 2004; ADA 2008).

Face and eye protection is worn as part of transmission-based precautions as discussed in Sections B2.2.3, B2.3.3 and B2.4.3.

Table BI.5: Use of face and eye protection as part of standard precautions

Type of care	Examples	Face and eye protection required
Routine care	General examination (e.g. medical, physiotherapy, nursing) Routine observations	Not required unless caring for a patient on droplet precautions (surgical mask) (see Section B2.3) or airborne precautions (P2 respirator) (see Section B2.4)
Procedures that generate splashes or sprays	Dental procedures Nasopharyngeal aspiration Emptying wound or catheter bag	Protective eyewear/full-length face shield Surgical mask
Procedures involving the respiratory tract (including the mouth)	Intubation Nasopharyngeal suction	Protective eyewear P2 respirator

Surgical masks

Surgical masks are loose fitting, single-use items that cover the nose and mouth. They are used as part of standard precautions to keep splashes or sprays from reaching the mouth and nose of the person wearing them. They also provide some protection from respiratory secretions and are worn when caring for patients on droplet precautions. Surgical masks differ from P2 respirators, as outlined in Table B1.6.

Table B1.6: Properties of different types of mask

Properties	Surgical masks	P2 respirator (see Section B2.4.3)
Other names	Single-use face mask, medical mask, patient-care mask, general purpose mask	P2 respirator, N95 respirator, respiratory protection device, particulate respirator
Characteristics	<ul style="list-style-type: none"> • Pleated face • 2–3 polypropylene layers • Filtration through mechanical impaction • Fluid resistant 	<ul style="list-style-type: none"> • Raised dome or duckbill • 4–5 layers (outer polypropylene, central layers electret [charged polypropylene]) • Filtration through mechanical impaction and electrostatic capture
Sealing	<ul style="list-style-type: none"> • Ties at crown and bottom of head 	<ul style="list-style-type: none"> • Ties at crown and bottom of head, pliable metal nose bridge • Fit testing and fit checking required (see B2.4.3)
Australian standards	<ul style="list-style-type: none"> • AS4381:2002 	<ul style="list-style-type: none"> • AS1715:2009
Intended use	<ul style="list-style-type: none"> • Procedures that generate splashes or sprays of large droplets of blood, body substances, secretions and excretions • Procedures requiring a surgical aseptic technique (to protect patients from exposure to infectious agents carried in a healthcare worker's mouth or nose) • Routine care of patients on droplet precautions 	<ul style="list-style-type: none"> • Routine care of patients on airborne precautions • High-risk procedures such as bronchoscopy when the patient's infectious status is unknown • Procedures that involve aerosolisation of particles that may contain specific known pathogens
Notes		<ul style="list-style-type: none"> • Care must be taken when placing respirators on patients and must suit clinical need (i.e. if the patient has chronic obstructive airways disease [COAD] or is in respiratory distress, the respirator will exacerbate symptoms).

Surgical masks can be placed on coughing patients to limit potential dissemination of infectious respiratory secretions from the patient to others (see Section B2.3.3).

Considerations when using a surgical mask include:

- masks should be changed when they become soiled or wet
- masks should never be reapplied after they have been removed
- masks should not be left dangling around the neck
- touching the front of the mask while wearing it should be avoided
- hand hygiene should be performed upon touching or discarding a used mask.

Children should wear a specifically designed child mask and their oxygen saturation should be monitored.

Eye protection

Goggles with a manufacturer's anti-fog coating provide reliable, practical eye protection from splashes, sprays, and respiratory droplets from multiple angles. Newer styles of goggles fit adequately over prescription glasses with minimal gaps (to be efficacious, goggles must fit snugly, particularly from the corners of the eye across the brow).

Other types of protective eyewear include safety glasses with side-shield protection, which are widely used in dentistry and other specialties that use operating microscopes (ADA 2008).

While effective as eye protection, goggles and safety glasses do not provide splash or spray protection to other parts of the face.

Personal eyeglasses and contact lenses are not considered adequate eye protection.

Face shields

Single-use or reusable face shields may be used in addition to surgical masks, as an alternative to protective eyewear. Compared with other forms of protective eyewear, a face shield can provide protection to other parts of the face as well as the eyes. Face shields extending from chin to crown provide better face and eye protection from splashes and sprays; face shields that wrap around the sides may reduce splashes around the edge of the shield.

Removing face and eye protection

Removal of a face shield, protective eyewear and surgical mask can be performed safely after gloves have been removed and hand hygiene performed. The ties, earpieces and/or headband used to secure the equipment to the head are considered 'clean' and therefore safe to touch with bare hands. The front of a mask, protective eyewear or face shield is considered contaminated.

Cleaning reusable face and eye protection

Reusable face shields and protective eyewear should be cleaned according to the manufacturer's instructions, generally with detergent solution, and be completely dry before being stored. If they are to be disinfected, they should be disinfected using either a TGA-registered instrument grade disinfectant - low level, or by heat as per AS/NZS 4187:2003.

Recommendation

6 Use of face and protective eyewear for procedures	Grade
A surgical mask and protective eyewear must be worn during procedures that generate splashes or sprays of blood, body substances, secretions or excretions into the face and eyes.	C

B1.2.5 Gloves

Gloves can protect both patients and healthcare workers from exposure to infectious agents that may be carried on hands (Duckro et al 2005). As part of standard precautions, they are used to prevent contamination of healthcare workers' hands when (Siegel et al 2007):

- anticipating direct contact with blood or body substances, mucous membranes, non-intact skin and other potentially infectious material
- handling or touching visibly or potentially contaminated patient-care equipment and environmental surfaces (Boyce & Pittet 2002; Bhalla et al 2004; Duckro et al 2005).

The capacity of gloves to protect healthcare workers from transmission of bloodborne infectious agents following a needlestick or other puncture that penetrates the glove barrier has not been determined (Siegel et al 2007).

Gloves are an essential component of contact precautions (in particular for patients with MROs) (see Sections B2.2.3 and B3.1.2) and may also be used as part of droplet precautions (see Section B2.3.3).

When and how should gloves be worn?

As with all PPE, the need for gloves is based on careful assessment of the task to be carried out, the related risk of transmission of microorganisms to the patient; and the risk of contamination of the healthcare worker's clothing and skin by the patient's blood and body substances (Pratt et al 2001; Clark et al 2002). Risk assessment includes consideration of:

- who is at risk (whether it is the patient or the healthcare worker)
- whether sterile or non-sterile gloves are required, based on contact with susceptible sites or clinical devices and the aspect of care or treatment to be undertaken
- the potential for exposure to blood or body substances
- whether there will be contact with non-intact skin or mucous membranes during general care and invasive procedures
- whether contaminated instruments will be handled.

When gloves are worn in combination with other PPE, they are put on last (see Section B1.2.7).

When should gloves be changed?

International guidance suggests that changing of gloves is necessary:

- between episodes of care for different patients, to prevent transmission of infectious material (Pratt et al 2001; Siegel et al 2007)
- during the care of a single patient, to prevent cross-contamination of body sites (CDC 1995; Boyce & Pittet 2002)
- if the patient interaction involves touching portable computer keyboards or other mobile equipment that is transported from room to room (Siegel et al 2007).

Prolonged and indiscriminate use of gloves should be avoided as it may cause adverse reactions and skin sensitivity (Pratt et al 2001; Clark et al 2002).

Hand hygiene should be performed before putting on gloves and after removal of gloves. Single-use gloves should not be washed, but discarded.

Recommendations

7 Wearing of gloves

Gloves must be worn as a single-use item for:

- each invasive procedure;
- contact with sterile sites and non-intact skin or mucous membranes; and
- activity that has been assessed as carrying a risk of exposure to blood, body substances, secretions and excretions.

Gloves must be changed between patients and after every episode of individual patient care.

8 Sterile gloves

Sterile gloves must be used for aseptic procedures and contact with sterile sites.

Grade

GPP

GPP

What type of gloves should be worn?

Non-sterile single-use medical gloves are available in a variety of materials, the most common being natural rubber latex (NRL) and synthetic materials (e.g. nitrile). NRL remains the material of choice due to its efficacy in protecting against bloodborne viruses and properties that enable the wearer to maintain dexterity (Pratt et al 2001; Clark et al 2002). However, sensitivity to NRL in patients, carers and healthcare workers may occur (see below) and must be documented. A local policy is required on using alternative glove types when patients have latex allergies.

The selection of glove type for non-surgical use is based on a number of factors (Korniewicz et al 1994; Bolyard et al 1998; Korniewicz & McLeskey 1998; Ranta & Ownby 2004):

- the task to be performed (i.e. glove type should be fit for purpose and aim to avoid interference with dexterity, friction, excessive sweating or finger and hand muscle fatigue);
- anticipated contact with chemicals and chemotherapeutic agents; and
- personal factors, such as latex sensitivity and size.

Facility policies for creating a latex-free environment should also be taken into account.

Table BI.7: Selection of glove type

Glove	Indications for use	Examples
Non-sterile gloves	<ul style="list-style-type: none"> • Potential for exposure to blood, body substances, secretions or excretions • Contact with non-intact skin or mucous membranes 	<ul style="list-style-type: none"> • Venepuncture • Vaginal examination • Dental examination • Emptying a urinary catheter bag • Naso-gastric aspiration • Management of minor cuts and abrasions
Sterile gloves	<ul style="list-style-type: none"> • Potential for exposure to blood, body substances, secretions or excretions • Contact with susceptible sites or clinical devices where sterile conditions should be maintained 	<p>Surgical aseptic technique procedures e.g.</p> <ul style="list-style-type: none"> • Urinary catheter insertion • Complex dressings • Central venous line insertion site dressing • Lumbar puncture • Clinical care of surgical wounds or drainage sites • Dental procedures requiring a sterile field
Reusable utility gloves	<ul style="list-style-type: none"> • Indicated for non-patient-care activities 	<ul style="list-style-type: none"> • Handling or cleaning contaminated equipment or surfaces • General cleaning duties • Instrument cleaning in sterilising services unit
Gloves suitable for clinical use		
NRL (latex) gloves	<ul style="list-style-type: none"> • Preferable for clinical procedures that require manual dexterity and/or will involve more than brief patient contact • Select powder-free latex gloves to minimise the risk of latex sensitivity or allergies 	
Synthetic gloves (e.g. nitrile)	<ul style="list-style-type: none"> • Procedures involving high risk of exposure to blood-borne virus and where high barrier protection is needed • Provides suitable alternative to latex if there are no issues with glove fit or sensitivity 	
Utility/cleaning gloves		
<ul style="list-style-type: none"> • Intended for use when a more physically protective glove is required (e.g. for instrument cleaning and housekeeping activities) • Reusable, cleaned according to the manufacturer's instructions and stored dry between uses • Should be replaced when they are showing signs of deterioration 		

Sources: Derived from Kotilainen et al 1989; Korniewicz et al 1989; Korniewicz et al 1993; Rego & Roley 1999; Pratt et al 2001; Korniewicz et al 2002; Schulster & Chinn 2003; Siegel et al 2007; Queensland Health 2010.

Latex allergy

Latex allergy is a reaction to certain proteins in latex rubber. The amount of latex exposure needed to produce sensitisation or an allergic reaction is unknown. However, current understanding of latex allergy is as follows (NIOSH 1998):

- increasing the exposure to latex proteins increases the risk of developing allergic symptoms—most people who are allergic to latex have had frequent exposure to latex over many years; the majority are nurses, doctors, dentists or patients who have had a number of operations
- in sensitised people, symptoms usually begin within minutes of exposure; but they can occur hours later and can be quite varied—mild reactions involve skin redness, rash, hives, or itching; more severe reactions may involve respiratory symptoms such as runny nose, sneezing, itchy eyes, scratchy throat, and asthma (difficult breathing, coughing spells, and wheezing); and rarely, shock may occur although a life-threatening reaction is seldom the first sign of latex allergy
- the risk of latex allergy is influenced by the amount of protein/allergen and powder in the latex glove; not by powder alone (Hunt et al 2002).

Healthcare workers with latex allergies should inform their managers to ensure that their work areas can be latex free.

If latex gloves are used, they should be non-powdered due to the risks associated with aerosolisation and an increased risk of latex allergies.

Removing and disposing of gloves

Gloves (other than utility gloves) should be treated as single-use items. They should be put on immediately before a procedure and removed as soon as the procedure is completed.

When removing gloves, care should be taken not to contaminate the hands. After gloves have been removed, hand hygiene should be performed in case infectious agents have penetrated through unrecognised tears or have contaminated the hands during glove removal (Olsen et al 1993; Tenorio et al 2001; Boyce & Pittet 2002).

Gloves must not be washed for subsequent re-use—infectious agents cannot be removed reliably from glove surfaces and continued glove integrity cannot be ensured. Glove re-use has been associated with transmission of methicillin-resistant *Staphylococcus aureus* (MRSA) and Gram-negative bacilli (Doebbeling et al 1988; Maki et al 1990; Olsen et al 1993).

Gloves should be disposed of as soon as they are removed, with disposal complying with local policies and standards.

BI.2.6 Other items of clothing

Ties and lanyards

There is some evidence to suggest that lanyards and neckties may play a role in transmission of infection but it is difficult to demonstrate the precise role (Kotsanas et al 2008).

Footwear

Footwear suitable for the duties being undertaken must be worn and preferably be designed to minimise the risk of injury from dropped sharps.

Uniforms

In areas of clinical practice where there is a high risk of repeated exposure to blood and other body substances, it is recommended that uniforms be worn as well as the appropriate PPE.

While some studies show that uniforms and white coats become progressively contaminated during clinical care, no studies have demonstrated that uniforms transmit infectious agents or lead to HAIs (Loveday et al 2007).

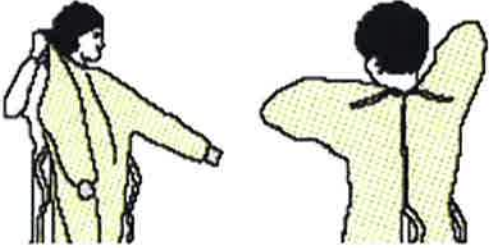



Uniforms should be washed daily. There is no evidence to suggest that home laundering is inferior to commercial reprocessing of uniforms (Loveday et al 2007).

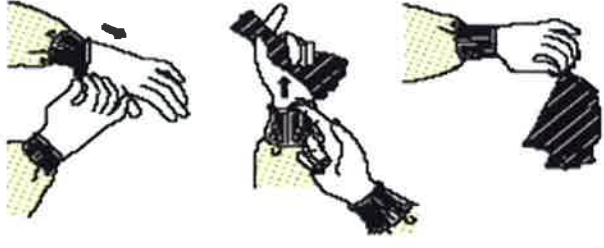



BI.2.7 Sequence for putting on and removing PPE

To reduce the risk of transmission of infectious agents, PPE must be used appropriately. The following table outlines sequences and procedures for putting on and removing PPE.

Hand hygiene must be performed before putting on PPE and after removing PPE

Table BI.8: Putting on and removing PPE

SEQUENCE FOR PUTTING ON PPE	
<p>GOWN</p> <ul style="list-style-type: none"> • Fully cover torso from neck to knees, arms to end of wrists, and wrap around the back • Fasten at the back of neck and waist 	
<p>MASK</p> <ul style="list-style-type: none"> • Secure ties or elastic bands at middle of head and neck 	
<p>PROTECTIVE EYEWEAR OR FACE SHIELD</p> <ul style="list-style-type: none"> • Place over face and eyes and adjust to fit 	
<p>GLOVES</p> <ul style="list-style-type: none"> • Extend to cover wrist of isolation gown 	

SEQUENCE FOR REMOVING PPE	Remove PPE at doorway or in anteroom.
<p>GLOVES</p> <ul style="list-style-type: none"> • Outside of gloves is contaminated! • Grasp outside of glove with opposite gloved hand; peel off • Hold removed glove in gloved hand • Slide fingers of ungloved hand under remaining glove at wrist • Peel glove off over first glove • Discard gloves in waste container 	
PERFORM HAND HYGIENE	
<p>PROTECTIVE EYEWEAR OR FACE SHIELD</p> <ul style="list-style-type: none"> • Outside of eye protection or face shield is contaminated! • To remove, handle by head band or ear pieces • Place in designated receptacle for reprocessing or in waste container 	
<p>GOWN</p> <ul style="list-style-type: none"> • Gown front and sleeves are contaminated! • Unfasten ties • Pull away from neck and shoulders, touching inside of gown only • Turn gown inside out • Fold or roll into a bundle and discard 	
<p>MASK*</p> <ul style="list-style-type: none"> • Front of mask is contaminated—DO NOT TOUCH! • Grasp bottom, then top ties or elastics and remove • Discard in waste container 	
PERFORM HAND HYGIENE IMMEDIATELY AFTER REMOVING ALL PPE	

Source: Adapted from <http://www.cdc.gov/hicpac/2007ip/2007isolationprecautions.html>.

* Surgical masks can be removed at the point of care. To remove a P2 respirator, perform hand hygiene and step outside the room or into an anteroom before removing and disposing of the respirator in a closed container and performing hand hygiene again.

Note that for surgical procedures and dentistry, the sequence for putting on PPE differs. In these situations, masks and protective eyewear are applied first prior to hand preparation. Gown and gloves are then put on. (see Section B4.3.2).