

Infection prevention and control workbook



Published by the Australian Commission on Safety and Quality in Health Care
Level 5, 255 Elizabeth Street, Sydney NSW 2000

Phone: (02) 9126 3600

Fax: (02) 9126 3613

Email: hai@safetyandquality.gov.au

Website: www.safetyandquality.gov.au

ISBN: 978-1-922880-16-1

© Australian Commission on Safety and Quality in Health Care 2022

All material and work produced by the Australian Commission on Safety and Quality in Health Care is protected by copyright. The Commission reserves the right to set out the terms and conditions for the use of such material.

As far as practicable, material for which the copyright is owned by a third party will be clearly labelled. The Commission has made all reasonable efforts to ensure that this material has been reproduced in this publication with the full consent of the copyright owners.

With the exception of any material protected by a trademark, any content provided by third parties, and where otherwise noted, all material presented in this publication is licensed under a Creative Commons Attribution-Non Commercial-No Derivatives 4.0 International license.



Enquiries about the license and any use of this publication are welcome and can be sent to communications@safetyandquality.gov.au.

The Commission's preference is that you attribute this publication (and any material sourced from it) using the following citation:

Australian Commission on Safety and Quality in Health Care. IPC Workbook. Sydney; ACSQHC, 2022.

Disclaimer

The content of this document is published in good faith by the Australian Commission on Safety and Quality in Health Care for information purposes. The document is not intended to provide guidance on particular healthcare choices. You should contact your healthcare provider about individual healthcare choices.

Contents

Introduction	2
Module 1: Principles of infection prevention and control.....	3
Colonisation, infection and ‘The Chain of Infection’	4
Standard precautions.....	8
Transmission-based precautions	33
Other strategies used for infection prevention and control.....	42
Module 2: Risk management for infectious agents and diseases	47
Risk management and the hierarchy of controls	48
Risk management in infection prevention and control programs.....	54
Risk management for specific infectious agents and diseases.....	58
Module 3: Basic microbiology and multidrug-resistant organisms.....	78
Basic microbiology	79
Multidrug-resistant organisms	88
Antimicrobial resistance and stewardship	97
Module 4: Clean and safe healthcare environment	98
Environmental cleaning in the healthcare environment.....	100
Environmental sustainability and recycling.....	114
The role of risk assessment in environmental cleaning	116
Cleaning schedules and cleaning programs.....	118
Staff training and safety for environmental cleaning	119
Environmental cleaning audits	122
Module 5: Basics of surveillance and quality improvement	124
What is surveillance for infection prevention and control and why is it important?	125
What are the components of an infection surveillance program?	126
National infection surveillance systems	138
Using infection surveillance for quality improvement.....	139
Quality improvement systems.....	140
Module 6: Preventing and managing occupational exposures.....	146
Occupational exposure in the healthcare environment.....	147
Governance systems to prevent and manage occupational exposures.....	150
Management of occupational exposures.....	157
Module 7 Infectious agent screening and immunisation of HCWs (under review)	165
Module 8 Outbreak management (Under review).....	170
Module 9 Renovation, repairs and redevelopment risk management	174
Module 10 Basic epidemiology and statistics (Under review)	187

Introduction

The Australian Commission on Safety and Quality in Health Care (the Commission) leads and coordinates national improvements in the safety and quality of health care. Infection prevention and control (IPC) is a key area in which the Commission works to improve care standards and patient outcomes by supporting implementation of evidence-based health care.

The [Infection Prevention and Control – advanced education modules](#) and this Workbook have been developed to support healthcare workers to understand the principles of IPC and apply these principles to meet the actions of the [National Safety and Quality Health Service \(NSQHS\) Standards](#), particularly the [Preventing and Controlling Infections Standard](#), and the recommendations of the [Australian Guidelines for the Prevention and Control of Infection in Healthcare](#).

The [Infection Prevention and Control – advanced education modules](#) can be undertaken individually, or as a suite, dependent on need.

Learners are encouraged to use this Workbook alongside the modules, as it provides additional material relating to the content of each module. **This workbook should not be used as a substitute for national, state, territory or local guidelines and policies.**

This Workbook is being progressively updated to complement the content of the infection prevention and control- advanced learning modules. This version of the Workbook contains updated content for:

- Module 1 (Principles of infection prevention and control)
- Module 2 (Risk management for infectious agents and diseases)
- Module 3 (Basics of microbiology and multidrug-resistant organisms)
- Module 4 (Clean and safe healthcare environment)
- Module 5 (Basics of surveillance and quality improvement)
- Module 6 (Preventing and managing occupational exposure).

Updated content is currently being developed to support Module 7 (Epidemiology and outbreak prevention and management), Module 8 (Health workforce screening and immunisation for vaccine- preventable diseases) and Module 9 (Introduction to reprocessing reusable medical devices). Content for Module 10 (Renovation, repairs and redevelopment risk management) will be updated in 2023–24 in line with the updated [Australasian Health Facility Guidelines](#).

Module 1: Principles of infection prevention and control

This module provides an understanding of the basic principles of infection prevention and control, providing a framework for further study in infection prevention and control. By completing this module, you will understand:

- How healthcare-associated infections (HAIs) occur
- The difference between colonisation and infection
- Standard precautions and transmission-based precautions
- When and how transmission-based precautions should be implemented
- The elements of invasive device use and management
- The elements of antimicrobial stewardship.

Everybody working in, and visiting, a healthcare facility including administrators, staff, patients, and carers has a role and responsibility in preventing and controlling infection in the healthcare setting.

Healthcare-associated infections are one of the most common complications affecting patients in hospitals. Healthcare-associated infections cause unnecessary complications for patients and their families, and often result in extended hospital stays for the patient. Healthcare-associated infections can occur in many settings, from hospitals to community-based health services. Patients and all members of the health workforce are at risk of acquiring a healthcare-associated infection.

The [National Safety and Quality Health Service \(NSQHS\) Preventing and Controlling Infections Standard](#), requires all health service organisations to have systems and strategies in place to:

- Prevent infections
- Manage infections effectively when they occur
- Limit the development of antimicrobial resistance (AMR) through prudent use of antimicrobials as part of effective antimicrobial stewardship (AMS)
- Promote appropriate and sustainable use of infection prevention and control resources.

Colonisation, infection and 'The Chain of Infection'

Most infectious agents are microorganisms. Microorganisms exist naturally in the environment and do not always cause infection (e.g. there are 'good' bacteria, which are present in the body's normal flora that provide protection or other health benefits). Parasites, prions, and several classes of microorganisms, including bacteria, viruses, fungi, and protozoa can be involved in either colonisation or infection, depending on the susceptibility of the host.

Colonisation is the sustained presence of replicating infectious agents on, or in, the body without causing infection or disease. Colonisation is a potential source of transmission to others and may progress to infection.

Infection involves the invasion by, and reproduction of, pathogenic (disease-causing) organisms inside the body.

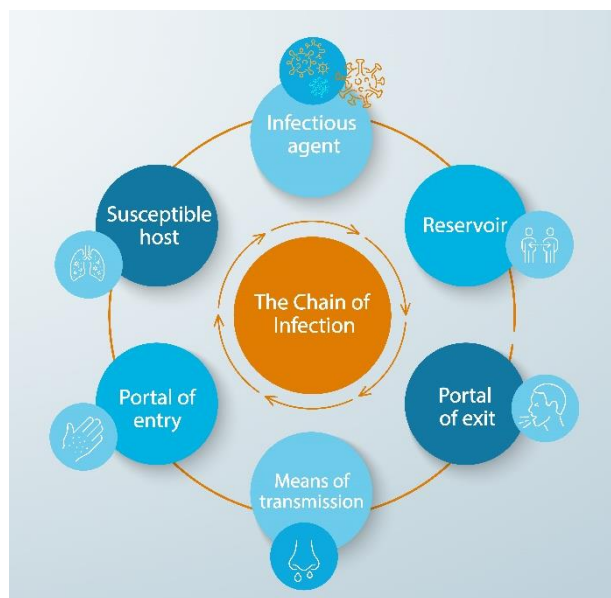
Healthcare-associated infections (HAIs) are infections acquired in health service organisations (also known as 'nosocomial' infections). Some of these infections occur because of healthcare interventions ('iatrogenic' infections). Healthcare-associated infections may manifest after people leave the health service organisation.

The Chain of Infection

The transmission of infectious agents within a health service organisation occurs via a series of interlinked events. This is called the Chain of Infection. The Chain of Infection illustrates the interaction between a susceptible host and an infectious agent, leading to the transmission of infection. For transmission of an infectious agent to occur within a healthcare setting, all the following elements are required:

- Infectious agent (pathogen)
- Reservoir
- Portal of exit
- Means of transmission
- Portal of entry
- Susceptible host.

The objective of infection prevention and control is to interrupt the Chain of Infection.



Infectious agents are the microorganisms that may be transmitted during health care, such as bacteria, viruses, fungi, and protozoa.

Reservoirs are habitats where microorganisms survive. In the health service organisation, a reservoir may include individuals, contaminated water or food, or a fomite. A fomite is an inanimate object that can carry microorganisms on its surface. In the hospital setting, fomites are important sources of infection. Fomites include items, such as:

- Medical equipment and instruments
- Clothing, uniforms
- Soiled linen and dressings
- Keys, pens, and other utensils.

The **portal of exit** is the path by which an infectious agent leaves its host. The portal of exit usually corresponds to the site where the infectious agent is localised. Examples include:

- Coughing or sneezing, via the mouth and nose
- Diarrhoea via the anus
- Blood or pus from a wound site or injury.

The **means of transmission** is the way an infectious agent is transmitted from the reservoir to a susceptible host. Transmission can be via contact, droplet, and airborne transmission.

The **portal of entry** refers to the way a pathogen enters a susceptible host. Often, infectious agents use the same portal to enter a new host, that they used to exit the source host. For example:

- Inhalation via nose
- Ingestion via the mouth
- Blood or body fluids exposure via breaks in the skin.

A **susceptible host** is an individual who, due to a range of factors, may become infected after exposure to an infectious agent. Factors affecting the susceptibility of an individual include:

- Age
- Comorbidities
- Previous and recent healthcare
- The presence of invasive medical devices (e.g. intravascular cannula, mechanical ventilators)
- Immune status, which is influenced by immunosuppressive therapy or disease, previous exposure, pregnancy, age, and vaccination.

Infection prevention and control

Infection prevention and control aims to prevent the spread of infectious agents in the healthcare setting. There are two types of precautions that should be used to prevent and control infection in health care:

- Standard precautions
- Transmission-based precautions.

Understanding the means of transmission of an infectious agent and knowing how and when to apply the basic principles of infection prevention and control, is critical to preventing and controlling the spread of infection.

Infection prevention and control is integral to clinical care and often requires a range of strategies to be successful. Infection prevention and control is part of, not additional to, standard care. Successful approaches for preventing and reducing harm arising from healthcare-associated infections involve applying a risk management framework to manage 'human' and 'system' factors associated with the transmission of infectious agents. This approach ensures that infectious agents, whether common (e.g. gastrointestinal viruses) or evolving (e.g. influenza or multidrug-resistant organisms), can be managed effectively.

Involving patients and their carers is an essential component of infection prevention and control. Patients need to be sufficiently informed to be able to participate in reducing the risk of transmission of infectious agents. For more information on partnering with consumers, refer to the [Partnering with Consumers Standard](#).

Standard precautions

Standard precautions are work practices that provide a first-line approach to infection prevention and control in the healthcare environment and should be adopted by all healthcare workers when caring for all patients, regardless of suspected or confirmed infection status. Standard precautions are used to reduce or prevent the transmission of infectious agents and to render and maintain objects and healthcare settings as free as possible from infectious agents. Standard precautions should be used when handling blood (including dried blood), all other body fluids (excluding sweat), non-intact skin and mucous membranes.

Standard precautions are the minimum infection prevention and control practices that must be used at all times, for all patients, in all situations.

Standard precautions include:

- Hand hygiene, consistent with the [5 Moments for Hand Hygiene](#)
- The use of appropriate personal protective equipment
- The safe use and disposal of sharps
- [Environmental cleaning](#)
- Respiratory hygiene and cough etiquette
- [Aseptic technique](#)
- Reprocessing of reusable medical equipment and instruments
- Waste management
- Appropriate handling of linen.

Actions 3.06 to 3.09 of the [National Safety and Quality Health Service \(NSQHS\) Preventing and Controlling Infections Standard](#) require health service organisations to implement practices that support standard and transmission-based precautions.

Hand hygiene

Hand hygiene is the single most effective intervention to reduce the risk of HAIs, and the spread of infectious diseases. Hand hygiene is a general term referring to any action of hand cleansing, which includes:

- Applying an alcohol-based hand rub (ABHR) to the surface of hands (including liquids, gels, and foams)
- Washing hands with water and either antimicrobial or non-antimicrobial soap, or soap solution.

Hand hygiene products

Both soap and ABHR products are necessary for hand hygiene in healthcare settings.

Soap and water should be used when hands are visibly soiled. As wet hands can more readily acquire and spread microorganisms, the proper drying of hands is an integral part of routine hand hygiene. Single-use paper towels are the most effective way to dry hands and reduce the risk of the transmission of microorganisms.

Alcohol-based hand rubs containing 60-80% v/v ethanol or equivalent should be used for all routine hand hygiene practices in most healthcare environments.

There are some infectious agents against which ABHRs have limited effectiveness, such as *Clostridioides difficile* (previously known as *Clostridium difficile*) and norovirus and other non-enveloped viruses. When caring for patients who have diarrhoea, soap and water should be used for hand hygiene after contact with the patient and their immediate environment.

Even when gloves have been worn, hand hygiene is essential.

The National Hand Hygiene Initiative (NHHI)

The Commission established the NHHI in 2008 as part of a suite of initiatives to prevent and reduce HAIs in Australian healthcare settings. The NHHI uses a multimodal approach to improving hand hygiene. Implementation of the NHHI is led by states, territories, and health service organisations (public and private), and includes:

- Promoting the use of ABHR at the point-of-care
- Ensuring uniform hand hygiene and infection prevention and control education
- Monitoring hand hygiene compliance and performance feedback
- Using hand hygiene programs that ensure culture change.

Standard 3.10 Hand Hygiene of the NSQHS Standards requires that health service organisations have a hand hygiene program incorporated into their overarching infection prevention and control program. The hand hygiene program needs to:

- Be consistent with current NHHI and jurisdictional requirements
- Address healthcare workforce noncompliance or inconsistency with benchmarks and the current NHHI
- Provide timely reports on the results of hand hygiene compliance audits, and actions in response to audits, to the workforce, governing body, consumers, and other relevant groups
- Use results of audits to improve hand hygiene compliance.

The [NHHI](#) website has more information on the 5 Moments for Hand Hygiene, hand hygiene product selection and hand hygiene auditing.

What are the 5 Moments for Hand Hygiene?



[The 5 Moments for Hand Hygiene](#) is based on a theoretical model of how infectious agents can be transferred between healthcare workers and patients. Hand hygiene must be performed at critical points during the provision of health care to prevent the spread of infection to patients and healthcare workers, and to limit contamination of the healthcare environment.

Figure 1.1: [5 Moments for Hand Hygiene](#): Source: The Australian Commission on Safety and Quality in Health Care (accessed Dec 2021)

Moment 1 - Before touching a patient

When: Perform hand hygiene on entering the patient zone before touching the patient.

Why: To protect the patient against acquiring infectious agents from the hands of the healthcare workers.

To prevent: Patient colonisation with infectious agents.

Rationale: Healthcare workers are likely to have potentially infectious agents on their hands. Performing hand hygiene before touching a patient prevents potentially infectious agents being transferred to the patient during patient contact.

Moment 2 - Before a procedure

When: Immediately before a procedure. Once hand hygiene has been performed, the patient's environment should not be touched before the procedure starting.

Why: To protect the patient from potential organisms (including their own) from entering their body during a procedure.

To prevent: Endogenous and exogenous infections in patients.

Rationale: Healthcare workers are likely to have potentially infectious agents on their hands or may pick up potentially infectious agents from the patient's skin. Performing hand hygiene immediately before a procedure prevents these microorganisms entering the patient's body during the procedure.

Moment 3 - After a procedure or body fluid exposure

When: Hand hygiene immediately after a procedure or body fluid exposure as hands may be contaminated with body fluid.

Why: To protect the healthcare worker and the healthcare environment from becoming contaminated with potential microorganisms from the patient.

To prevent: Colonisation/infection in healthcare workers, contamination of the healthcare environment, and transmission of microorganisms from a colonised site to a clean site on the same patient or another patient.

Rationale: After touching a patient the healthcare worker will have the patient's microorganisms on their hands. These microorganisms can be transmitted to the next patient and/or an environmental surface that the healthcare worker touches.

Moment 4 - After touching a patient

When: After touching a patient. Perform hand hygiene before you leave the patient zone.

Why: To protect the healthcare worker and the healthcare environment from becoming contaminated with potentially infectious agents from the patient.

To prevent: Colonisation/infection of the healthcare worker and contamination of the healthcare environment.

Rationale: After touching a patient the healthcare worker will have the patient's microorganisms on their hands. These microorganisms can be transmitted to the next patient and/or an environmental surface that the healthcare worker touches.

Moment 5 - After touching a patient's surroundings

When: Hand hygiene after touching a patient's surroundings even when the patient has not been touched. Always perform hand hygiene before leaving the patient's room.

Why: To protect the healthcare worker and the healthcare environment from becoming contaminated with potentially infectious agents from the patient's surroundings.

To prevent: Colonisation/infection of the healthcare worker and contamination of the healthcare environment.

Rationale: After touching a patient the healthcare worker will have the patient's microorganisms on their hands. These microorganisms can be transmitted to the next patient and/or an environmental surface that the healthcare worker touches.

Enhancing hand hygiene

The effectiveness of hand hygiene is improved when:

- The skin is intact - breaks in the skin should be covered with an occlusive dressing
- Fingernails are natural, short, and unvarnished
- Hands and forearms are free of jewellery and clothing (this is known as 'bare below the elbows')
- Jewellery is kept to a minimum when caring for patients (e.g. plain wedding band), and removed when performing hand hygiene, to ensure that all surfaces of the hands are cleaned
- Hand hygiene products are available at the point of care, highly accessible and staff are included in decisions about product choice and placement
- Staff are provided with education and training on hand hygiene.

Measuring, monitoring, and improving hand hygiene

Improving healthcare worker hand hygiene is an important way to reduce the risk of healthcare-associated infections. Healthcare worker hand hygiene compliance can be monitored using reliable indicators, such as hand hygiene compliance, hand hygiene product placement, product utilisation, patient experience and rates of healthcare-associated infections.

Hand hygiene observational audits are the most common method used to monitor hand hygiene compliance. Hand hygiene observational audits can be used to accurately assess hand hygiene compliance by published guidelines, using a standardised hand hygiene assessment tool. Information from hand hygiene monitoring can be used to identify where gaps in knowledge or practice exist, and where there may be issues related to access to hand hygiene products or handwashing facilities.

For further information on measuring, monitoring, and improving hand hygiene, refer to the [National Hand Hygiene Initiative \(NHHI\) User Manual](#).

Personal protective equipment

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. Selection of personal protective equipment is based on the type of interaction with a patient, as well as known or possible infectious agents and the likely mean(s) of transmission. Personal protective equipment should always be made available to the healthcare worker at the point of care.

PPE, when used as part of [standard precautions](#), protects against anticipated blood and body fluid exposure.

When used as part of [transmission-based precautions](#), PPE serves as a physical barrier against the specific mean(s) of transmission.

Factors to be considered when selecting PPE are:

- The probability of exposure to blood and body substances
- The type and amount of body substance involved
- The probable presence of an infectious agent and the means of transmission.

Selecting personal protective equipment

Aprons and gowns

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. Gowns and aprons used in clinical areas should be fluid impervious.

Removing aprons and gowns

Aprons and gowns are single-use and should always be removed immediately after use and before leaving the patient care area. Apron and gowns should be removed in a manner which avoids contaminating clothes or skin. This can be done by pulling from the shoulders, turning the gown inward and rolling it into a bundle for disposal into the appropriately labelled waste bin.

Reusable aprons and gowns should be used for one procedure or patient care episode only. These gowns need to be laundered or reprocessed according to AS/NZS4146 (2000) Laundry Practice.

Table 1.1 provides information on the characteristics of aprons and gowns suitable for standard and transmission-based precautions.

Table 1.1: Types of aprons and gowns

Type	Recommended use	Characteristics
Plastic apron	For general use when there is the possibility of sprays or spills, or exposure to blood or body fluids during low-risk procedures.	<ul style="list-style-type: none"> • Fluid impervious • Single use (one procedure or episode of patient care) • Disposable
Gown	To protect the healthcare workers exposed body areas and prevent contamination of clothing with blood, body fluids and other potentially infectious material.	<ul style="list-style-type: none"> • Fluid impervious • Single use • Disposable • Choice of sleeve length depends on procedure being undertaken, extent of risk of exposure of the healthcare workers arms, volume of body substances likely to be encountered, and the probable presence of an infectious agent and the means of transmission.
Full body gown	<p>When there is a risk of contact with a patient's broken skin, extensive skin to skin contact (e.g. lifting a patient with scabies), or a risk of contact with blood and body fluids which are not contained (e.g. vomiting).</p> <p>When there is the possibility of extensive splashing of blood and/or body fluids or risk of exposure to large amounts of blood or body fluids (e.g. in some operative procedures).</p>	<ul style="list-style-type: none"> • Fluid impervious • Single use • Long sleeved to protect clothing and exposed upper body areas. • Always worn in combination with gloves and other PPE where indicated
Sterile gown	For procedures that require an aseptic field.	<ul style="list-style-type: none"> • Pre-packaged • Maybe single-use or reusable

Adapted from: [Australian Guidelines for the Prevention and Control of Infection in Healthcare](#) (2019), Section 3.3

Note: Some types of gowns are designed to be re-used. When used, these gowns should be used for one procedure or patient care episode. These gowns need to be laundered or reprocessed according to **AS/NZS4146 (2000)** — Laundry Practice.

Face and eye protection

Protective eyewear reduces the risk of exposure to splashes or sprays of blood and body fluids. Protective eyewear should fit snugly with minimal gaps. While effective as eye protection, goggles and safety glasses do not provide splash or spray protection to other parts of the face. If this is anticipated, a face shield and/or mask should be considered. Contact lenses and personal eyeglasses do not provide adequate eye protection.

Removing face and eye protection

Face shields, protective eyewear and masks should be removed after gloves have been removed, and hand hygiene has been performed. The back of the face shield, protective eyewear or mask should only be touched when removing. The front is considered contaminated and, if reusable, should not be touched with bare hands before cleaning.

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-included sterilant or medical device low level disinfectant listed on the Australian Register of Therapeutic Goods (ARTGA), or by heat as per Standard AS/NZS 4187: 2014.

Table 1.2 provides examples of the use of protective eyewear and face shields as part of standard precautions.

Table 1.2: Types of protective eyewear

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) or airborne precautions (N95/P2 particulate filter respirator).
Procedures that generate splashes or sprays	Dental procedures, Nasopharyngeal aspiration, emptying wound drainage or catheter bags	Protective eyewear/ full-length face shield Surgical mask
Procedures involving the respiratory tract (including the mouth)	Intubation Nasopharyngeal suction	Protective eyewear Surgical mask

Adapted from: [Australian Guidelines for the Prevention and Control of Infection in Healthcare](#) (2019), Section 3.3

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.

Considerations when using a surgical mask include:

- Masks should be changed between patients and 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.

Surgical masks are categorised into three types, based on the level of protection provided. Table 1.3 provides information on these categories and use of surgical masks.

Table 1.3: Types of surgical masks

Characteristics*	Level 1 barrier	Level 2 barrier	Level 3 barrier
Application	For general purpose medical procedures, where the wearer is not at risk from blood or body fluid splash or spray, or to protect staff and/or the patient from droplet exposure to microorganisms.	For use in emergency departments, dentistry, changing dressings on wounds where minimal blood droplet exposure may occur.	For all surgical procedures, major trauma first aid or in any area where the healthcare worker is at risk of blood or body fluid splash or spray.
Bacterial filtration efficiency (BFE)%	≥95	≥98	≥98
Differential pressure, mm, H₂O/cm²	<4.0	<5.0	<5.0
Resistance to penetration by synthetic blood, minimum pressure in mmHg for pass result	80 mmHg	120 mmHg	160 mmHg

Adapted from: [Australian Guidelines for the Prevention and Control of Infection in Healthcare](#) (2019), Section 3.3

Gloves

Gloves should be used when there is anticipated contact with blood and body fluids as a key part of standard precautions. Gloves can also be used by healthcare workers when touching surfaces that may be contaminated.

Gloves should be changed when performing multiple tasks with the same patient. To minimise the transmission of infectious agents, multiple tasks with the same patient should progress from clean to dirty (where possible), with gloves being changed between each task and hand hygiene performed at each glove change.

Removing gloves

When removing gloves, care should be taken not to contaminate the hands. Hand hygiene must be performed immediately after the removal and disposal of gloves, in case infectious agents have penetrated through unrecognised holes, or have contaminated the hands during glove removal.

Table 1.4 provide practical information on use the different types of gloves available for use in health service organisations.

Table 1.4: Types of gloves







Glove	Indication of use	Examples
Non-sterile gloves	<ul style="list-style-type: none"> • Potential for exposure to blood, body fluids, secretions, and excretions • Contact with mucus membranes 	<ul style="list-style-type: none"> • Venipuncture • Vaginal examination • Dental examination • Emptying of 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 fluids • Contact with susceptible sites or clinical devices where sterile conditions should be maintained 	<ul style="list-style-type: none"> • Aseptic technique • Urinary catheter insertion • Complex dressings • Central venous line site dressing • Lumber puncture • Clinical care of surgical wounds or drain sites • Dental procedures requiring a sterile filed
Reusable utility gloves	<ul style="list-style-type: none"> • Indicated for non-patient-care activities • May be decontaminated for reuse (according to the glove manufacturer's directions) provided the integrity of the glove is not compromised. 	<ul style="list-style-type: none"> • Worn for cleaning the environment or cleaning and disinfection patient care equipment • Instrument cleaning in sterilizing services units
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 allergy 	
Synthetic gloves (e.g. nitrile)	<ul style="list-style-type: none"> • Procedures involving high-risk exposure to blood-borne viruses where high barrier protection is needed • Suitable alternative to latex if there are no issues with glove fit or sensitivity 	

Adapted from: [Australian Guidelines for the Prevention and Control of Infection in Healthcare](#) (2019), Section 3.3

Putting on and removing PPE





Healthcare workers should follow the sequence for putting on and removing personal protective equipment as shown in Tables 1.5 and 1.6, taking care to perform hand hygiene before putting on personal protective equipment, and between each step when removing personal protective equipment, especially before touching the face.

Table 1.5: Sequence for putting on personal protective equipment*

	<p>1. Perform hand hygiene</p>
	<p>2. Put on gown</p> <ul style="list-style-type: none"> • Fully cover torso from neck to knees, wrap around the back • Fasten at the back of the neck and waist
	<p>3. Put on mask</p> <ul style="list-style-type: none"> • Secure ties or elastic bands at the middle of head and neck
	<p>4. Put on protective eyewear</p> <ul style="list-style-type: none"> • Place over face and eyes and adjust to fit
	<p>5. Perform hand hygiene</p>
	<p>6. Put on gloves</p> <ul style="list-style-type: none"> • Extend to cover wrists of gown

* Adapted from : [Australian Guidelines for the Prevention and Control of Infection in Healthcare, Section 3.3 PPE \(2019\)](#)

Table 1.6: Sequence for removing personal protective equipment*

	<p>1. Remove and dispose of gloves</p>
	<p>2. Perform hand hygiene</p>
	<p>3. Remove and dispose of gown</p>
<p>Alternatively gloves and gown can be removed as one step. Then perform hand hygiene</p>	
	<p>4. Remove protective eyewear</p>
	<p>5. Perform hand hygiene</p>
	<p>6. Remove mask and dispose of mask</p>
	<p>7. Perform hand hygiene</p>

* Adapted from: [Australian Guidelines for the Prevention and Control of Infection in Healthcare \(2019\), Section 3.3 PPE](#)

Respiratory hygiene and cough etiquette

Respiratory hygiene and cough etiquette must always be used as a standard infection prevention and control precaution. Respiratory hygiene and cough etiquette prevents the dispersal of respiratory secretions into the air.

HCWs and visitors who are unwell with respiratory or other infections should not attend a healthcare service while symptomatic.

Patients, visitors, and healthcare workers should always:

- Cover the nose and mouth when coughing or sneezing
- Use tissues
- Dispose of tissues after use
- Cough or sneeze into their inner elbow rather than the hand if tissues are not available
- Perform hand hygiene after coughing or sneezing, or after having contact with respiratory secretions and contaminated objects or materials.

Aseptic technique

Aseptic technique is a set of practices that protect patients from healthcare-associated infections and healthcare workers from contact with blood, body fluids and body tissue. Aseptic technique, when performed correctly, will:

- Minimise contamination of key sites
- Protect patients from their own pathogenic microorganisms that may cause infection
- Reduce the transmission of microorganisms
- Maintain the sterility of equipment and key parts used for aseptic procedures.

A key site is a site on the patient that must be protected from contamination during an aseptic procedure (e.g. a drain site, a cannula site, a wound site)

A key part is the equipment or item that must be protected from contamination during an aseptic procedure (e.g. the hub of an injection port, or the contents of a dressing pack)

The difference between aseptic technique and sterile technique

Often the terms aseptic technique and sterile technique are incorrectly used interchangeably. There are important differences between these two techniques.

An **aseptic technique** aims to prevent pathogenic organisms, in sufficient quantities to cause infection, from being introduced into susceptible body sites by the hands of staff, or from surfaces or equipment. Aseptic technique protects patients during invasive clinical procedures by utilising infection prevention and control measures that minimise the presence of microorganisms. Aseptic technique is achievable in clinical and non-clinical settings by applying the [five principles of aseptic technique](#) and modifying practice to mitigate infection risks.

A **sterile technique** uses practices that are aimed at preventing the introduction of all microorganisms into a sterile field, on to equipment or into a procedure site. This is near impossible to achieve in the clinical setting due to the presence of microorganisms in the air and the clinical environment. True sterile conditions are only achievable in strictly controlled environments, such as laminar flow hoods used in laboratories and pharmacies.

Five essential principles of aseptic technique

There are essential principles that should be applied when performing a procedure that requires aseptic technique. These principles are:

1. Sequencing

Sequencing involves a series of actions that ensure each procedure is performed in a safe and appropriate order. Sequencing includes assessing for risks to the patient and the healthcare worker and identifying strategies to mitigate these risks before starting the procedure. When considering the steps for sequencing, the healthcare worker should consider the following points:

Perform a risk assessment:

- Are there environmental or patient factors that increase the risk for this procedure?
- Is the procedure technically difficult or being performed in an emergency?
- Will the procedure require a standard or surgical aseptic technique?
- Is there a risk of infection transmission or contamination risk with the procedure?
- Do you know how to perform this procedure?
- What personal protective equipment is needed for the procedure?
- What action is required to mitigate these risks?

Pre-procedure preparation:

- Prepare the environment
- Select the correct equipment; check the condition, integrity and expiry date of each item required for the procedure
- Plan each step of the procedure to avoid a breach in asepsis
- Inform the patient and prepare them for the procedure.

Performing the procedure:

- Set up the equipment immediately before performing the procedure
- Maintain standard precautions
- Perform the procedure in a safe, logical order.

Post procedure practices:

- Remove gloves and perform hand hygiene
- Settle the patient
- Pack away equipment and dispose of waste
- Document the outcome from the procedure, including any breaches in asepsis, any corrective actions taken at the time of the procedure to minimise any infection risks, or if multiple attempts were required to complete the procedure.

2. Environmental control

There are many factors in the clinical environment which can increase the risk of infection and patient harm during a procedure. Part of the risk assessment should include, if practical, the removal of the risk factor. These factors include:

- Other activities that are occurring in the nearby environment that may increase the risk of contamination during the procedure (e.g. for example bed making, dusting, cleaning, open windows or fans that can cause air turbulence)
- Whether the environment is a controlled setting, such as a laboratory, pharmacy, or operating suite, or an uncontrolled setting, such as an emergency department
- The condition of the work area, surface and equipment used for this procedure (e.g. how clean is the equipment? Is the equipment damaged or rusty?)

Where practical, these factors should either be removed (e.g. wait until cleaning has finished, replace damaged equipment), or otherwise controlled, to reduce the risk of contamination and infection transmission.

3. Hand hygiene

Healthcare workers should always follow the [5 Moments for Hand Hygiene](#) during aseptic procedures. There are critical moments before, during and after an invasive procedure, or a procedure requiring aseptic technique, when hand hygiene should be performed. These moments are:

- Before and after collecting the equipment
- After setting up an aseptic field
- Immediately before putting on gloves (if gloves are required)
- Immediately after completing the procedure and removing gloves
- Immediately after cleaning up and disposing of equipment and waste.

Hand and wrist jewellery must be removed before the procedure and before performing hand hygiene. If gloves become grossly contaminated or torn during a procedure, the gloves need to be removed, hand hygiene must be performed, and new gloves applied.

4. Maintenance of aseptic fields

The healthcare worker should ensure that the aseptic field, the key parts, and the key sites are always protected. The healthcare worker should:

- Prepare the key sites with the correct solution (e.g. cleanse with normal saline, chlorhexidine, or other suitable solutions)
- Clean and/or disinfect all the equipment and key parts to be used
- Establish an aseptic field (e.g. by using a sterile tray or using a laminar flow hood)
- Use techniques that protect the key sites and all key parts used for the procedure
- Use the most suitable technique for the type of procedure (e.g. a non-touch technique if suitable or sterile gloves if sterile equipment or the procedure site requires handling).

5. Personal protective equipment (PPE)

Personal protective equipment is important for protecting both the patient and healthcare worker during an aseptic procedure. The healthcare worker should consider the following points:

- Is sterile or non-sterile personal protective equipment required (gowns, gloves)?
- What is the correct sequence for putting on and removing personal protective equipment?

Simple procedures

Simple procedures are generally technically simple, use simple equipment with minimal key parts, involve small key sites, and are of a short duration of time (usually less than 20 minutes). Examples of these procedures include:

- Simple wound dressings
- Maintenance of vascular access devices
- Collection of clinical specimens (blood, swabs, or urine)
- Parental medication preparation.

Complex procedures

Complex procedures are generally technically difficult, invasive, require specialised equipment, involve many key parts, large or many key sites, and require extended periods of time to complete. These procedures may be performed in dedicated clinical environments such as operating theatres, procedural suites, or at the bedside.

Examples of these procedures include:

- Surgery
- Wound debridement
- Vascular access insertions
- Drain insertions
- Catheterisations (urinary, cardiac, or peritoneal dialysis).

The Commission on Safety and Quality in Health Care has resources available to support health service organisations implement the recommendations for aseptic technique from the [NSQSH Standards](#) and the [Australian Guidelines for the Prevention and Control of infection in Healthcare](#). These resources are available at: safetyandquality.gov.au/aseptictechnique.

Safe sharps management

Using sharp devices exposes the user to the risk of sharps injuries and to bloodborne infectious agents, such as hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV).

Hollow-bore needles are implicated in the transmission of bloodborne infections more than any other device. Hollow-bore needles used for blood collection or intravascular catheter insertion are of particular concern because they are more likely to contain residual blood. Other sharps, including suture needles and blades, have also been associated with the transmission of bloodborne infections.

Sharps handling and disposal

When handling and disposing of sharps, the following practices should be observed:

- Handling should be kept to a minimum
- Sharps must not be passed directly from hand to hand
- Needles must not be recapped, bent, broken, or disassembled after use
- The person who used the sharp is responsible for its immediate safe disposal

- Used sharps must be discarded into a sharps disposal container at the point-of-use. If this is not possible then the used sharp must be transported in a puncture-resistant container to the nearest sharps container and discarded
- Sharps containers should be clearly labelled, puncture and leak proof, and conform to Standards AS 4031: 1992 and Amendment 1: 1996, AS/NZS 4261: 1994 and Amendment 1: 1997 or relevant international standard e.g. ISO 23907: 2019
- Sharps containers must not be filled above the maximum fill level.

Safety-engineered devices

A broad range of devices have been designed with built-in safety features that reduce the risk of injury involving a sharp. These include:

- Needles with guards
- Sliding sheaths
- Shields, blunted tips, or retracting needles
- Blunt suture needles and surgical blades with protective covers.

Devices designed with built-in safety features reduce the risk of sharps injury. Users should be educated to use these devices properly and safely.

A systems approach to sharps injury reduction

The elements of a systems approach to sharps injury reduction includes:

- Championing a culture of safety underpinned by the concepts of patient-centred care
- Adopting and evaluating the use of passive or active safety-engineered devices as an alternative to sharps without safety-engineered features
- Standardising changes to work practices that will reduce risks (e.g. using instruments rather than fingers to grasp needles, retract tissue and load/unload needles; using appropriately designed single-handed devices to unload needles and scalpels)
- Providing education in the use of new devices and work practices
- Ensuring comprehensive reporting of injuries and preventive strategies
- Applying engineering controls (e.g. sharps disposal containers and passive or active sharps devices engineered to prevent sharps injury)
- Occupational exposure protocols
- Occupational vaccination programs.

Environmental cleaning

Environmental cleaning involves the physical removal of dirt and foreign material from environmental surfaces, with the use of water and neutral detergent. Environmental cleaning is an essential component of any IPC program to ensure a clean and safe environment for patients, visitors, and HCWs.

Patient care environment and equipment

The patient care environment includes the immediate area around the patient and any equipment that may directly, or indirectly, come into contact with the patient. The environment in a healthcare setting is the physical space including floors, walls, and the ceiling; and includes the furnishings that are in that space, such as curtains, bedside lockers, taps, sinks and door handles.

Some surfaces and equipment need to be cleaned more often. These include frequently touched surfaces, such as door handles, bed rails, telephones, taps and light switches. Other areas may need to be cleaned less often, such as minimally touched surfaces including floors, walls, ceilings, windows, and blinds. Other considerations include:

- Items that are used for more than one patient must be cleaned between patients to reduce the risk of infection transmission (e.g. blood pressure cuffs, thermometers, mobility aids)
- Where common use of equipment for multiple patients is unavoidable, a risk assessment should be performed, and cleaning carried out according to the manufacturer's instructions
- The use of disposable equipment should be balanced against consideration of environmental and resource sustainability.

Cleaning frequency

- Health service organisations should have a local cleaning policy in place and use a cleaning schedule that is tailored to the needs of the organisation and local disease epidemiology
- The risk of transmission of infectious agents should be regularly assessed, and the cleaning schedule adjusted to respond to a new or increased infection risk
- The organisation should have a mechanism in place to monitor the quality of environmental cleaning within the organisation.

Processes and product selection for routine environmental cleaning

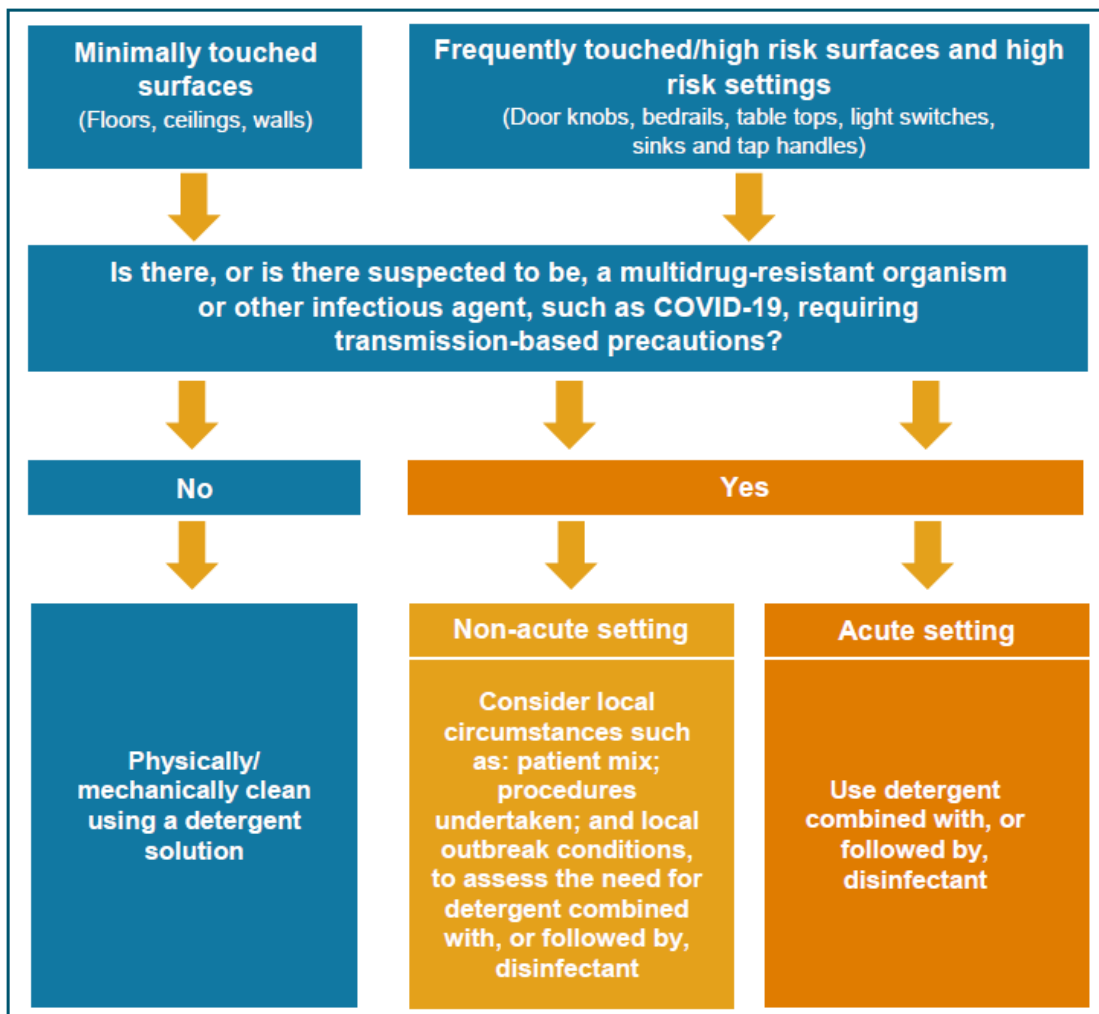
Routine cleaning with detergent and water, followed by rinsing and drying, is the most effective method for removing microorganisms from surfaces. Mechanical cleaning (scrubbing) physically reduces the number of infectious agents and dirt on a surface, which can then be rinsed away with clean water.

Neutral detergents contain a surfactant that facilitates the removal of dirt and organic matter. A neutral detergent and warm water are suitable for most cleaning processes.

Disinfectants are chemical agents that rapidly kills or inactivates most infectious agents. Disinfectants are not to be used as general cleaning agents, unless combined with a detergent as a combination cleaning agent (detergent/disinfectant). If required, Disinfection should always be undertaken following a detergent cleaning. Disinfectants are only necessary if a surface may have been or is known to have been contaminated by a multi-resistant organism or potentially infectious material, including blood and other bodily fluids. Disinfectants might be used after routine cleaning during an outbreak.

When assessing and selecting a disinfectant in the healthcare setting, factors such as kill claims, wet contact time, compatibility, safety, ease of use and value for money should be considered. Figure 1.2 provides general advice for cleaning product selection.

Figure 1.2: Cleaning product selection.



* Principles of Environmental Cleaning: Product Selection, Australian Commission on Safety and Quality in Healthcare (2020).

Source: [Principles of Environmental cleaning: Product Selection, Australian Commission on Safety and Quality in Healthcare \(2020\)](#)

Management of blood and body fluid spills

A spill kit should be readily available in each clinical area and should include the following equipment:

- A scoop and scraper
- Single-use personal protective equipment including gloves, protective apron, surgical mask, and protective eyewear
- Absorbent agent to absorb fluids
- Clinical waste bags and ties
- Detergent.

To manage biological spills:

- Ensure the affected area is safe and no further spills occur
- Put on personal protective equipment from the spill kit
- Confine and contain the spill
- Use disposable absorbent material provided in the spill kit or paper towel to absorb the spill and then discard into the clinical waste bag
- Using detergent and water, clean the area with disposable cloth or paper towel, dispose of cloth or paper towel into the clinical waste bag
- Remove and dispose of personal protective equipment into the clinical waste bag, dispose of clinical waste bag into a clinical waste bin.

The area may require a second clean with a disinfectant based on an assessment of the risk of transmission of infectious agents involved in the spill.

Further information on environmental cleaning is covered in the [Clean and safe healthcare environment](#) module of this workbook.

The Commission has a suite of resources available to support HSOs implement the recommendations from the [NSQSH Standards](#), and the [Australian Guidelines for the Prevention and Control of Infection in Health Care](#) for environmental cleaning. These resources include:

- [Environmental cleaning practices for small HSOs](#)
- [Environmental cleaning: Information for cleaners](#)
- [Environmental cleaning: Emerging environmental cleaning technologies](#)
- [Principles of environmental cleaning product selection](#)
- [Principles of environmental cleaning auditing](#)
- [Benefits of environmental cleaning - infographic](#)
- [The process and product selection for routine environmental cleaning - flowchart](#)

Reprocessing of reusable medical devices

Any medical device (instruments or equipment) that is to be reused requires reprocessing.

For the purposes of reprocessing, reusable medical devices are categorised as:

- **Critical:** these devices have a high risk for infection if they are contaminated with microorganisms. These devices must be sterile at the time of use. Examples include surgical instruments, intravascular devices, cystoscopes, and bronchoscopes.
- **Semi-critical:** These devices come into contact with mucous membranes or non-intact skin and should be single use or sterilised after each use. If this is not possible, high-level disinfection is the minimum level of reprocessing that is acceptable. Examples include laryngoscope blades, endoscopes, vaginal ultrasound transducers and breast pump accessories.
- **Non-critical:** These devices come into contact with intact skin but not mucous membranes. Thorough cleaning is sufficient for most non-critical devices after each individual use, although either intermediate or low-level disinfection may be appropriate in specific circumstances. Examples include bedpans, commodes, blood pressure cuffs, pulse oximeter probes and stethoscopes.

These categories are based on the level of infection risk related to the use of the device. Cleaning of semi-critical and critical instruments to remove organic material must always precede any further processing, including disinfection and sterilisation.

Further information on environmental cleaning is covered in full detail in the [Disinfection and sterilisation learning module and chapter of this workbook](#).

Waste management

Health service organisations, including community healthcare settings, need to conform to relevant state or territory legislation and regulations on the management of clinical and related wastes. Health service organisations should also refer to Standard [AS/NZS 3816: 2018](#) and the Waste Management Association of Australia's industry code of practice.

When handling waste:

- Use [standard precautions](#) to protect against exposure to blood and body fluids
- and perform hand hygiene
- Segregate waste into appropriate streams at the point of generation
- Ensure waste is contained in an appropriate receptacle (identified by colour and label) and disposed of according to the health service organisation's waste management plan
- Ensure healthcare workers are trained in the correct procedures for handling waste.

Further information on waste management is covered in full detail in the Clean and Safe Environment module and chapter of this workbook.

Handling of linen

Health service organisations must have documented policies on the collection, transport, and storage of linen. Health service organisations that launder linen must have documented operating policies consistent with [Standard AS/NZS 4146: 2000](#).

Clean linen must be stored in a clean and dry place that prevents contamination by aerosols, dust, moisture, and vermin, and is separate from used linen.

When handling used linen:

- Used linen should be handled with care to avoid dispersal of microorganisms into the environment and contact with HCW clothing
- Appropriate personal protective equipment should be worn to prevent exposure of skin and mucous membranes to blood and body substances
- Ensure it is 'bagged' at the location of use into an appropriate laundry receptacle
- Do not rinse or sort laundry in patient-care areas
- Do not wash laundry in domestic washing machines
- Place linen soiled with body substances into leak-proof laundry bags for safe transport
- Perform hand hygiene after handling.

Domestic-type washers and dryers

Some health service organisations may use domestic-type washers and dryers on site for laundering patient or resident clothes. Domestic type washing machines may be used for a patient's personal items only, using appropriate detergent and hot water. If hot water is not available, items from different patients should not be mixed in the same load. Domestic-type clothes dryers must only be used for drying clothes. Health service organisations should have a schedule in place for the cleaning and maintenance of these machines.

Further information on handling linen is covered in full detail in the [Clean and safe healthcare environment](#) module of this workbook.

Transmission-based precautions

Transmission-based precautions are precautions, used in addition to standard precautions, that interrupt the specific means of transmission of a particular infectious agent. Understanding the means of transmission of an infectious agent is important for deciding the most appropriate transmission-based precautions to use.

Key elements of transmission-based precautions include:

- Personal protective equipment
- Patient placement
- Minimising patient movement.

Clear and accurate communication and documentation is essential to support the application of transmission-based precautions.

The Commission has a suite of standardised standard and transmission-based precautions signage is available for download [here](#).

There are three categories of transmission-based precautions:

- **Contact precautions** are used when there is a known or suspected risk of transmission of infectious agents by direct or indirect contact
- **Droplet precautions** are used when there is a known or suspected risk of transmission of infectious agents by respiratory droplets
- **Airborne precautions** are used when there is a known or suspected risk of transmission of infectious agents by the airborne route.

For some infectious agents, a combination of precautions may be required (for example, seasonal influenza requires both contact and droplet precautions).

Contact precautions

Contact precautions are used for infectious agents that may be transmitted by direct or indirect contact with the patient or the patient's environment.

Direct contact transmission

Direct contact transmission occurs when infectious agents are transferred from one person to another person without a contaminated intermediate object or person. For example, blood or other body substances from an infectious person may come into contact with a mucous membrane or breaks in the skin of another person.

Indirect contact transmission

Indirect contact transmission involves the transfer of an infectious agent through a contaminated intermediate object (fomite) or person. Contaminated hands of healthcare workers have been shown to be important contributors to indirect contact transmission. Other examples of indirect contact transmission in the healthcare environment include:

- Shared patient equipment which is not cleaned and disinfected between patients
- Contaminated environmental surfaces.

Infectious agents for which contact precautions are indicated include:

- *Clostridioides difficile* (previously known as *Clostridium difficile*)
- Norovirus and other intestinal tract pathogens
- Hepatitis A
- Respiratory syncytial virus (RSV)
- Methicillin-resistant *Staphylococcus aureus* (MRSA)
- Vancomycin-resistant *Enterococcus* (VRE)
- Multidrug-resistant gram-negative (MRGN) organisms, including carbapenemase-producing *Enterobacterales* (CPE)
- Highly contagious skin infections, such as impetigo
- Infestations, such as scabies.

The key elements of applying contact precautions are:

- Use of appropriate personal protective equipment, such as aprons, gowns, and gloves
- Patient placement (e.g. single room cohorting)
- Minimising patient movement

Use of appropriate personal protective equipment for contact precautions

Putting on an apron or gown, followed by gloves upon entering the patient care area helps to contain infectious agents, that can transmit disease via the contact route. As part of standard precautions, a surgical mask and protective eyewear or face shield must also be worn if there is the potential for generation of splashes or sprays of blood and body substances to the face and eyes.

When moving between patients, personal protective equipment must always be changed, and hand hygiene must always be performed.

Patient placement for contact precautions

A single-patient room is recommended for patients who require contact precautions. If a single room is not available, consultation with local infection prevention and control expertise is recommended to assess the risks associated with other patient placement options (e.g. cohorting). A tool to assist in cohorting patients with known or suspected infectious conditions can be found [here](#). If cohorting is required, it is recommended that patient beds are separated by 1.5 metres.

Important: There is a high risk for infection in patients sharing isolation with non-identical strains of disease.

Minimising patient movement for contact precautions

Limiting the movement of a patient on contact precautions reduces the risk of environmental contamination. If transfer within or between health service organisations is necessary, it is important to ensure that infected or colonised areas of the patient's body are contained and covered. Both the transferring and receiving organisations must be made aware of the precautions required before the transfer.

Droplet precautions

Droplet precautions prevent transmission of infectious agents spread through respiratory droplets (i.e. droplets >5microns in size). These are generated by a patient who is coughing, sneezing, or talking. Transmission via droplets requires close contact as the droplets do not remain suspended in the air, and generally only travel short distances. Therefore, special air handling and ventilation are not required.

Droplets can contaminate horizontal surfaces close to the source patient, and the hands of healthcare workers can become contaminated through direct contact with those surfaces.

Infectious agents for which droplet precautions are indicated include:

- Seasonal influenza virus
- *Neisseria meningitidis*
- Whooping cough (pertussis)
- Rubella (German measles)
- Parainfluenza
- Adenovirus
- Rhinovirus
- Group A Streptococcal species.

The key elements of applying droplet precautions are:

- Use of appropriate personal protective equipment (surgical mask always required, apron, gown, gloves, and protective eyewear as appropriate)
- Patient placement
- Minimising patient transfer or transport.

Use of appropriate personal protective equipment for droplet precautions

Surgical masks that meet [Australian Standards](#) should be worn when entering the patient care area of a patient who requires droplet precautions. A surgical mask and protective eyewear should also be worn to minimise the risk of contamination of mucous membranes when near the patient.

When moving between patients, personal protective equipment must always be changed, and hand hygiene must always be performed.

Patient placement for droplet precautions

Placing patients on droplet precautions in a single room reduces the risk of patient-to-patient transmission. If single rooms are in short supply:

- Prioritise patients who have excessive cough and sputum production
- Consider the patient's ability to perform hand hygiene and use respiratory hygiene and cough etiquette
- Placing masks on coughing patients can also prevent infected patients from dispersing respiratory secretions into the air
- Place patients who are infected with the same pathogen in the same room (cohort).

If it is necessary to place a patient who requires droplet precautions in a room with a patient who is not infected with the same infectious agent:

- Ensure patients are physically separated by at least 1.5 metres and draw privacy screens
- Avoid atomisation procedures/treatment, such as nebulisers, and induced sputum collection
- Avoid placing patients on droplet precautions in the same room with patients who may have increased risk of adverse outcomes from infection or may facilitate transmission (e.g. immunocompromised, prolonged lengths of stay, cystic fibrosis, cardiac conditions, or muscular dystrophy)

Important: There is a high risk for infection in patients cohorted together with non-identical strains of disease.

Patient transfer for droplet precautions

Limiting the transfer of a patient on droplet precautions reduces the risk of transmission.

If transfer within, or between health service organisations is necessary, the patient should wear a surgical mask and use respiratory etiquette during the transfer. Both the transferring and receiving organisations must be made aware of the precautions required before the transfer.

Airborne precautions

Airborne precautions prevent transmission of infectious agents that are disseminated through airborne droplet nuclei and remain infective over time and distance. These agents may be inhaled by individuals who have not had face-to-face contact with, or been in the same room as, the infectious individual. Airborne droplet nuclei can also be generated through aerosol-generating procedures (AGPs), such as intubation, suctioning, bronchoscopy, or the use of nebulisers.

Airborne precautions are based on evidence that shows that:

- The use of particulate filter respirators (PFR), such as P2 or N95, prevents the inhalation of small particles that may contain infectious agents transmitted via the airborne route
- The use of negative pressure rooms may reduce the transmission of infection
- The wearing of correctly fitted surgical masks by coughing patients prevents dispersal of respiratory secretions into the air.

Infectious agents for which airborne precautions are indicated include:

- Rubella (measles),
- Varicella zoster (chickenpox)
- Active pulmonary *Mycobacterium tuberculosis* (TB)
- Disseminated Herpes zoster (shingles).

The key elements of applying airborne precautions are:

- Use of appropriate personal protective equipment, particularly correctly fitted particulate filter respirators (PFRs), such as P2 and N95
- Patient placement (e.g. use of negative pressure rooms)
- Minimising patient movement.

Specialist procedural areas also should refer to their discipline-specific guidelines for details advice on applying airborne precautions relevant to the field of practice.

Use of appropriate personal protective equipment for airborne precautions

A particulate filter respirator should be worn to prevent airborne transmission. Healthcare workers should be trained in the correct use of particulate filter respirators and follow manufacturer's instructions when putting on and removing the particulate filter respirator.

The filtration efficiency of particulate filter respirators protects the wearer from inhaling small respiratory particles, but to be effective the respirator must fit so that inhaled air only travels through the filter medium. Table 7 provide information on the characteristics of P2 and N95 respirators.

When moving between patients, personal protective equipment must always be changed, and hand hygiene must always be performed.

Fit testing

The purpose of fit testing is to identify which size and style of particulate filter respirator is suitable for an individual, and to ensure that it is worn correctly. Fit testing should be undertaken based on relevant state/territory jurisdictional requirements, in conjunction with a risk assessment with relevance to the healthcare setting. Fit testing programs may be considered:

- At the beginning of employment for healthcare workers who will be working in clinical areas where there is a significant risk of exposure to infectious agents transmitted via the airborne route
- When there is a significant change in the wearer's facial characteristics that could alter the facial seal of the respirator
- At regular intervals (Standard AS/NZS 1715: 2009 recommends annual fit testing). [Standard AS/NZS 1715: 2009](#) outlines the method by which fit testing is conducted.

Table 1.7: Characteristics of P2 and N95 respirators*

	P2 respirator	N95 respirator
Characteristics	<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 • Designed to provide a good facial fit to minimise aerosol contamination of the mucous membranes of the nose and mouth <p>P2 particulate filtering respirators/masks must have a filter efficiency of at least 94% when tested with NaCl aerosol at a flow rate of 95 L/min.</p> <p>Under the EN system, aerosol testing is similar to Standard AS/NZS 1716: 2012, but have additional filter efficiency testing with paraffin oil aerosol that must also meet the minimum 94% filter efficiency to be classified as P2. The particle size of this aerosol has a mass median diameter of 0.3 to 0.6 microns with a range of particles in the 0.02 to 2-micron size range.</p>	<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 • Designed to provide a good facial fit to minimise aerosol contamination of the mucous membranes of the nose and mouth <p>NIOSH classified N95 particulate filtering respirators/masks must have a filter efficiency of at least 95% when tested with NaCl aerosol at a flow rate of 85 L/min.</p> <p>N95 respirator masks can only be used for oil free aerosols. The particle size of this aerosol ~0.3micron.</p>

* Adapted from: [Australian Guidelines for the Prevention and Control of Infection in Healthcare, \(2021\)](#)

Fit checking

Health service organisations should provide healthcare workers with information and training on how to perform a fit check, and the manufacturer's instructions for fit checking of individual brands and types of particulate filter respirators should be referred to at all times

Healthcare workers must perform fit checks every time they put on a particulate filter respirator.

The procedure for fit checking includes the following steps:

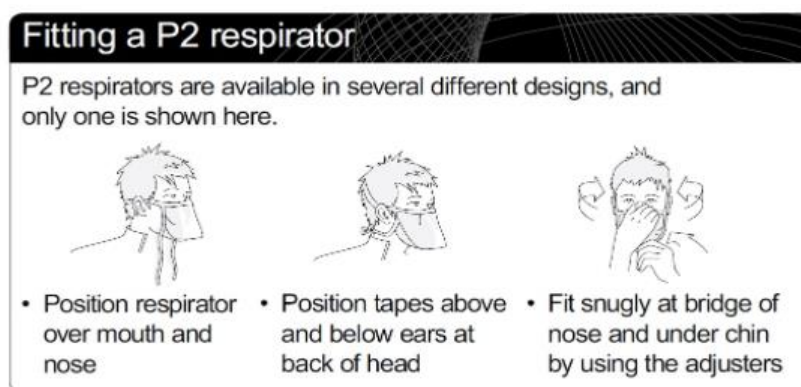
1. Place the particulate filter respirator on the face
2. Place the headband or ties over the head and at the base of the neck
3. Compress the particulate filter respirators to ensure a seal across the face, cheeks, and bridge of the nose
4. To check the particulate filter respirators for a positive pressure seal, gently exhale. If air escapes from around the edges of the particulate filter respirator, the mask needs to be adjusted
5. To check for a negative pressure seal, gently inhale. If the mask is not drawn in towards the face or air leaks around the face seal, readjust the particulate filter respirator
6. After adjusting the particulate filter respirator to ensure there is a good seal around the face, repeat steps 5 and 6. If necessary, change to a different style that fits the wearers face.

HCWs who have facial hair (including a 1–2 day beard growth) must be aware that an adequate seal cannot be guaranteed between the particulate filter respirators and the wearer's face.

Figures 1.3 and 1.4 show the correct way for fit checking and removing a particulate filter respirator.

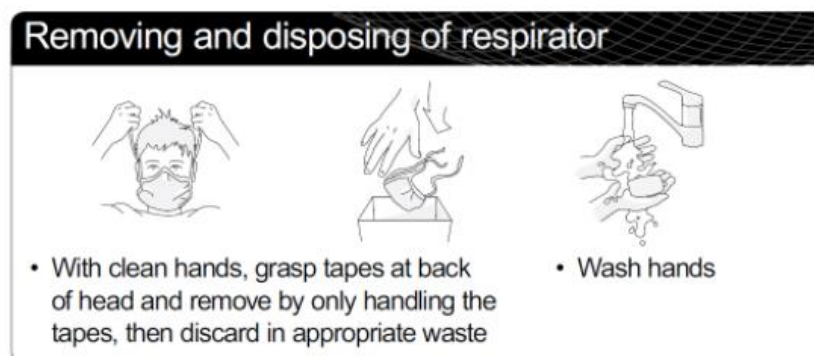
Additional information on suitable masks for airborne precautions and fit testing and checking can be found in [The Australian Guidelines for the Prevention and Control of Infection in Healthcare](#).

Figure 1.3: Fitting a particulate filter respirator



Source: Section 3.3 (2021) [Australian guidelines for the prevention and control of infection in healthcare](#)

Figure 1.4: Removing and disposing of a particulate filter respirator



Section 3.3 (2021) [Australian guidelines for the prevention and control of infection in healthcare](#)

Patient placement for airborne precautions

It is good practice to place patients on airborne precautions in a negative pressure room (Class N/Type 5) with bathroom facilities or in a room from which air does not circulate to other areas. If a negative pressure room is unavailable, the patient should be managed in a single room, or cohorted with patients with the same infectious agent. The door to the room must remain closed if patient care requires airborne precautions.

When moving between patients, personal protective equipment must always be changed, and hand hygiene must always be performed.

Minimising patient movement for airborne precautions

Limiting movement of a patient on airborne precautions reduces the risk of transmission.

If transfer of the patient is necessary, the patient should wear a correctly fitted surgical mask and follow respiratory hygiene and cough etiquette, as well as covering any skin lesions associated with the condition (e.g. chickenpox [varicella]). If the patient is a child, their oxygen saturation should be monitored while they are wearing a surgical mask.

Both the transferring and receiving organisations must be made aware of the precautions required before the transfer.

Other strategies used for infection prevention and control

Invasive medical devices

Invasive medical devices are a common source of healthcare-associated infections and provide a route for infectious agents to enter the body. Invasive medical devices include:

- Catheters inserted for drainage (e.g. urinary catheters)
- Catheters for intravascular access (e.g. peripheral intravenous catheters, peripherally inserted central venous catheters, central venous catheters)
- Devices for mechanical ventilation (e.g. intubation)
- Devices for feeding (e.g. enteral feeding tubes).

Key concepts for managing invasive devices

Health service organisation should have processes in place for:

- The appropriate use, management and removal of invasive medical devices
- The appropriate training for healthcare workers to use, management and remove invasive medical devices
- Monitoring device-related infection rates.

Before inserting any invasive medical device, patients should always be assessed to determine:

- Whether their condition can be managed without the insertion of an invasive medical device
- The most appropriate invasive device, if required
- How long the device will be required
- What plan is in place to ensure timely removal of the device.

All invasive medical devices should be inserted using aseptic technique. The healthcare worker inserting the invasive medical device should be adequately trained and competent in the skills required for safe insertion, maintenance, and removal.

Strategies that can be used to minimise the risk of device-related infection during insertion and maintenance procedures include:

- Training and education in the insertion, maintenance and removal of invasive medical devices
- The use of sterile equipment
- The use of appropriate skin preparation solutions (e.g. normal saline, chlorhexidine)
- Adherence to the 5 Moments for Hand Hygiene
- The use of appropriate personal protective equipment (e.g. the use of sterile or non-sterile gloves and gowns).

The patient should be provided education on the infection risk associated with the device and the importance of self-care, hygiene, and proper device maintenance.

When the device is *in situ*, the patient should be regularly monitored, including observations of the insertion site and the invasive device for signs and symptoms of infection.

There should be clear documentation of the insertion, maintenance, and plan for the removal of the device, as well as daily review of the ongoing need for the device. The dwell time for an invasive medical device should be as short as possible. The longer the time the invasive medical device is in place, the greater the risk of infection or other complications developing related to the device. To minimise the dwell time of an invasive medical device:

- Health service organisations should consider including advice on the maximum dwell time for invasive medical devices in local policies or procedures based on best clinical evidence
- Clinicians who have ordered the insertions of an invasive medical device should include instructions for the removal for the device in the patient's care plan or clinical notes
- The ongoing need for an invasive medical device should be reviewed routinely as part of the patient's clinical care
- The insertion site should be reviewed at least daily and details about the site condition should be documented in the patient's clinical care notes
- If the patient develops signs of infection (temperature, swelling or redness at the insertion site) or other indications of complications related to the invasive medical device, the patient's care provider (treating medical team, general practitioner, nurse) should be notified immediately and consider removing the device if safe to do so
- Remove the device as soon as it is no longer necessary.

Information on the management of sharps injuries is covered in full detail in the [Prevention and management of occupational exposures](#) module of this workbook.

The Commission's [Management of Peripheral Intravenous Catheters Clinical Care Standard](#) contains 10 quality statements and 13 indicators to guide quality care for the management of cannulas, and is accompanied by supporting resources.

Antimicrobial resistance

Antimicrobial resistance (AMR) is recognised as a significant global health priority. Resistance to antimicrobials is commonly found in Australian hospitals and increasingly so in the community. This resistance can have a significant impact on morbidity, mortality, and treatment costs.

A significant driver of antimicrobial resistance is the unnecessary or inappropriate use of antimicrobials. Around one third of all antimicrobial use in healthcare is unnecessary or inappropriately prescribed, as shown through the [National Antimicrobial Prescribing Survey](#).

The additional costs of infections caused by resistant organisms include:

- The need for more expensive and broader spectrum antimicrobials to treat infections
- The need to isolate patients colonised with resistant organisms to minimise cross-infection
- The need for additional requirements such as personal protective equipment, single room accommodation, single use patient equipment, and additional cleaning resource
- Extended length of hospital admission, invasive treatments, further antimicrobial use, and potentially long-term health complications for the patient.

Infection prevention and control practices are recognised as a key part of an effective response to antimicrobial resistance. Preventing infection reduces the need for antimicrobials and the opportunity for organisms to develop resistance.

In the Australian healthcare setting, antimicrobial resistance is most associated with resistant bacterial strains, such as methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant *enterococci* (VRE), and multidrug-resistant gram-negative bacteria (MRGN). These are commonly referred to as multidrug-resistant organisms (MROs). However, antimicrobial resistance occurs in fungi (*Candida auris*) and viruses (e.g. some strains of influenza) as well.

A risk management approach should be used to prevent and control multidrug-resistant organisms (MROs) in all health service organisations. This should include:

- Standard precautions for all patient care always
- The use of transmission-based precautions where a patient is known or suspected to be colonised with a multidrug-resistant organism.

Additional strategies that may be required to control multidrug-resistant organisms could also include:

- Identifying high risk settings and patients for multidrug-resistant organism acquisition (e.g. intensive care or haematology/oncology units)
- Targeted screening for early identification and management of colonised and high-risk patients
- Strategies to communicate information about positive multidrug-resistant organisms results
- Decolonisation programs, such as whole-body washes (using chlorhexidine) or topically applied antimicrobial agents and/or orally administered antimicrobials
- Multidrug-resistant organism surveillance programs may be appropriate to monitor the effect of interventions designed to control these organisms. Surveillance information should be fed back to healthcare workers and facility management promptly.

Antimicrobial stewardship

Antimicrobial stewardship (AMS) is a suite of coordinated activities which promote the appropriate prescribing and use of antimicrobials. Antimicrobial stewardship is conducted at all levels of the healthcare system, from local hospitals and general practices to national programs, with the intent of improving the safety and appropriateness of use; maximising the benefit of antimicrobials; reducing patient harm; and preventing and containing antimicrobial resistance in Australia.

Actions 3.18 and 3.19 of the [National Safety and Quality Health Service Preventing and Controlling Infections Standard](#) require all health service organisations to have systems in place for the safe and appropriate prescribing and use of antimicrobials, and describes the elements necessary to support an effective AMS program.

Antimicrobial stewardship programs should include:

- Local antimicrobial stewardship policies and procedures which implement clinical guidelines consistent with [Therapeutic Guidelines: Antibiotic](#)
- Establishing a multidisciplinary AMS team that includes, at least, a lead doctor and pharmacist
- Antimicrobial formulary restrictions and approval processes that limit the use of broad-spectrum and later-generation antimicrobials to patients in whom their use is clinically indicated.
- A clinical microbiology service, which can provide guidance and support for optimal specimen collection, reporting of clinically meaningful pathogens and their susceptibilities
- Ongoing education and training for prescribers, pharmacists, nurses, midwives, and consumers about antimicrobial resistance, antimicrobial stewardship and optimal antimicrobial use
- Processes for reviewing antimicrobial prescribing, with intervention and direct feedback to the prescriber
- Implementing point-of-care interventions (including directed therapy, intravenous to-oral switching, and dose optimisation).

Some key point healthcare workers should consider when prescribing and administering antimicrobials include:

- Is this the right antimicrobial/ dose for this patient's condition?
- Should this patient receive this antimicrobial medication as an oral or intravenous medication?
- How frequently should this patient receive this antimicrobial medication?
- How long will this patient require this antimicrobial medication?
- Are there other patient factors that may affect the choice of antimicrobial medication? (such as age, weight, renal function, allergies, other medicines prescribed and other health conditions)
- Is this antimicrobial being prescribed for surgical or other prophylaxis? How many doses have been charted? Will this prescription be required for greater than 24 hours?

The Commission has produced a range of resources to support health service organisations implement antimicrobial stewardship program. These resources can be found on the Antimicrobial Stewardship web page, including:

- [Antimicrobial Stewardship in Australian Health Care](#) (the AMS Book) which provides a comprehensive range of advice to guide AMS in different settings.
- [Antimicrobial stewardship clinical care standard](#) which supports quality improvement programs to reduce antimicrobial resistance
- [Antimicrobial stewardship in primary care](#)- which focuses implementing AMS programs in the primary care setting
- [Antimicrobial stewardship in aged care](#)- which focuses implementing AMS programs in the age care setting
- [Surgical antimicrobial prophylaxis](#)- which provides information on the use of antimicrobials for surgical prophylaxis

Module 2: Risk management for infectious agents and diseases

This Workbook is designed to complement the learning module you are undertaking.

Module 2 has been developed to provide you with an understanding of how to use risk management systems to help minimise the risk of transmission of infectious agents in health service organisations. Many of the infectious agents covered in this module are classified as notifiable diseases. You should refer to your local state or territory guidelines for more information on these specific diseases.

After completing this module, you should:

- Understand risk management and the use of the hierarchy of controls in infection prevention and control
- Be able to apply risk management strategies to assist in reducing the transmission of infectious diseases
- Understand how the means of transmission of an infectious agent relates to standard and transmission-based precautions, and other infection prevention and control strategies, which can be used to limit the spread of infection.

Health service organisations that are required to be assessed against the [National Safety and Quality Health Service \(NSQHS\) Standards \(second edition\)](#) should refer to the Preventing and Controlling Infections Standard, which sets the framework for infection prevention and control in health service organisations.

Further information on risk assessment can be found in the [Australian Guidelines for the Prevention and Control of Infection in Healthcare](#).

Risk management and the hierarchy of controls

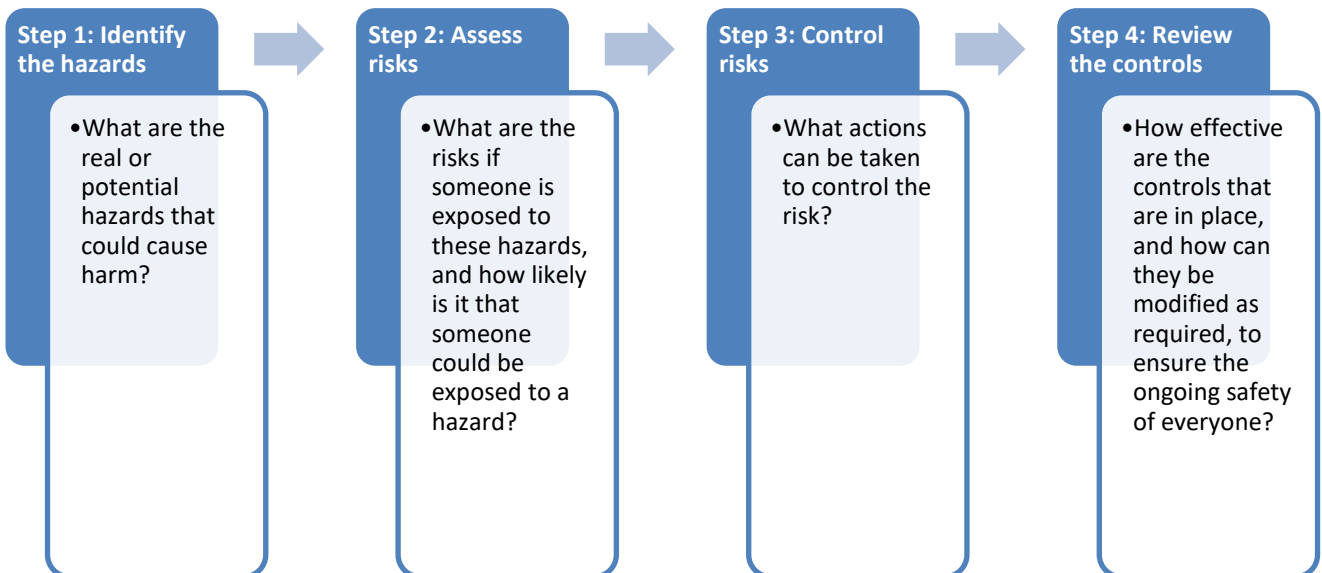
What is risk management?

Risk assessment and management are ongoing and proactive process aimed at identifying and responding to risks which impact on infection prevention and control. The [Work Health and Safety Act](#) requires employers to have systems and processes to identify hazards, and assess and control the risks for patients, visitors and members of the workforce, so far as is reasonably practicable (i.e. what can be done and what is possible in the circumstances, for ensuring health and safety, and continuity of health service delivery).

The following are key concepts used in risk management:

- **Hazard** - A situation or thing that has the potential to harm a person.
- **Risk** – The possibility that harm (death, injury, illness) might occur when exposed to a hazard. Risk assessments should be undertaken to determine what could happen if someone is exposed to a hazard, and the likelihood of this occurring. A risk assessment can help determine:
 - The severity of the risk
 - The effectiveness of current control measures
 - What action is required to control the risk
 - How urgently action should be taken.
- **Risk control** – Taking action to eliminate or control the risks, so far as is reasonably practical. Controls should be constantly reviewed and measured to evaluate their effectiveness.

Risk management is a four-step process:



Risk management and infection prevention and control

In the context of infection prevention and control:

- The microorganisms that may colonise or infect patients, healthcare workers or visitors are the **hazards**
- Healthcare-associated infections (HAIs), occupational exposures and sharps injuries are examples of the **risks**.
- The elements of standard and transmission-based precautions are the **controls**.

Risk management is the basis for preventing and reducing harm arising from healthcare-associated infection. A successful approach to risk management occurs on many levels within a healthcare facility, such as:

- Facility wide - Providing support for effective risk management through an organisational risk-management policy, educating staff, following up outcomes, monitoring and reporting
- Ward or department based - Embedding risk management into all local policies to ensure risks are considered in every setting
- Individual - Considering the risks involved in carrying out specific procedures, assessing the necessity of a procedure as part of clinical decision-making, and attending education sessions (e.g. hand hygiene or respirator fit testing).

All health service organisations need to be able to determine the risks in their own context and select the appropriate course of action. Therefore, it is necessary for health service organisations to regularly conduct infection prevention risk assessments and ensure that all staff understand their responsibility in managing these risks.

The hierarchy of controls

Actions 3.02a and 3.07b of the [NSQHS Standards](#), require all health service organisations to establish multidisciplinary teams to identify and manage risks associated with infections, using the hierarchy of controls, in conjunction with infection prevention and control systems.

The hierarchy of controls (Figure 1) is a model used in work health and safety management. It is a step-by-step approach to controlling risk, ranking controls from most to least effective.

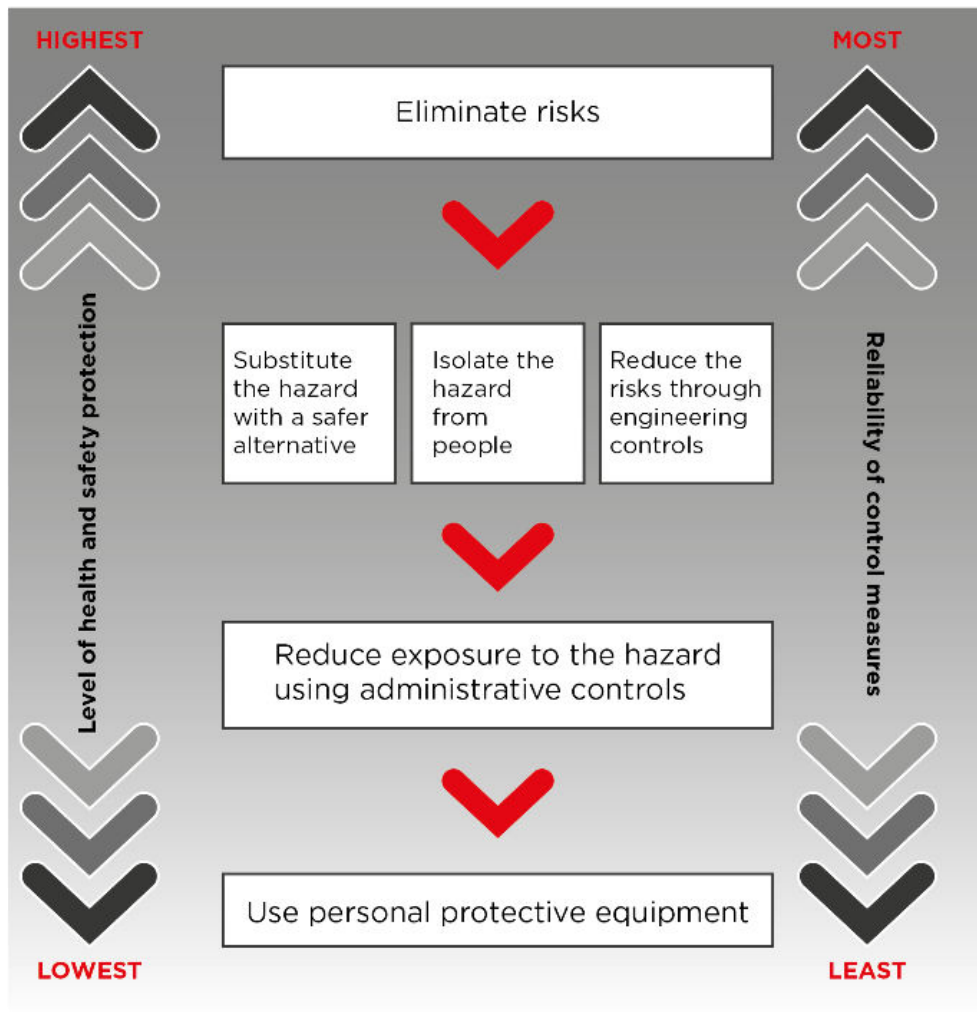
The hierarchy of controls, used in conjunction with infection prevention and control systems, supports the design of infection prevention and control programs and strategies to prevent and control the risk of transmission of infection.

The most effective control measure involves eliminating the hazard and associated risk. If it is not reasonably practicable to eliminate the hazards and risks, then risks must be minimised using one or a combination of controls, such as:

- Substitution
- Isolation
- Engineering controls
- Administrative controls
- Personal protective equipment.

The ways of controlling risk are ranked from the highest level of protection and reliability to the lowest. Administrative controls and personal protective equipment are the least effective, as they do not control the hazard at the source, but rather rely on human behaviour and supervision.

Figure 2 1: The Hierarchy of controls



Source: Safe Work Australia. How to manage work health and safety risks: code of practice. Canberra: SWA; 2018:19, 'Hierarchy of control measures' licensed under CC BY-NC 4.0.

Applying the hierarchy of controls

Some examples relevant to each of the controls for infection prevention and control programs are provided below. More information is available in the Commission's fact sheet [Use of the hierarchy of controls in infection prevention and control](#).

Specific guidance has also been developed for [COVID-19](#).

Eliminate risks

Elimination is used to remove the infection risk entirely. Examples include:

- Prompt management of spills to eliminate the risk of exposure to clinical and biological waste
- Immediate disposal of sharps after use to prevent sharps injury
- The use of telehealth to eliminate exposure to potentially infectious patients
- Restricting entry of potentially infectious healthcare workers and visitors to the health service organisation.

Substitute the hazard with a safer alternative

Substitution is often used to minimise infection risks. Examples include:

- Replacement of reusable medical devices that are difficult to clean, such as cannulated or channelled devices, with single-use equipment
- Introduction of safety-engineered devices for cannulation and injections to prevent sharps injury
- Administration of aerosolised medicines with spacers instead of nebulisers, to prevent exposure to aerosols.

Isolate the hazard from people

Isolation involves physically separating people from the infection hazard. Examples include:

- Placement strategies, such as cohorting or single rooms, for patients with infections transmitted by droplet or airborne transmission
- Increasing the distance between beds
- Physical barriers such as privacy screens, for infections transmitted by the droplet route.

Reduce the risks through engineering controls

Engineering controls for infection hazards involve the use of a physical or mechanical process. Examples include:

- Optimisation of ventilation and air quality including air exchange rates, air flow and air filtration systems, temperature, and ambient humidity
- Redesign of work areas to limit the number of workers at workstations
- Maintenance of airflow direction away from staff workstations and towards patient care areas where possible.

Reduce exposure to the hazard using administrative controls

Administrative controls are practices and policies that reduce or prevent exposure to hazards. Examples include:

- Designation of an organisational lead who is responsible for implementing infection prevention and control strategies
- Organisational compliance with the current version of the [Australian Guidelines for the Prevention and Control of Infection](#).
- Provision of training in infection prevention and control practices to all healthcare workers
- Provision of a risk-based workforce vaccine-preventable diseases screening and immunisation program, consistent with the current edition of the [Australian Immunisation Handbook](#) and current jurisdictional requirements. Further information is also provided in the Commission's document [NSQHS Standards Workforce Immunisation Risk Matrix](#).

Use personal protective equipment (PPE)

The effectiveness of personal protective equipment in reducing the risk of infection depends on access to appropriate personal protective equipment, correct use, and complementary substitution, administrative and engineering controls. The use of personal protective equipment includes:

- Access to a sufficient supply of a range of sizes and types of personal protective equipment relevant to the infection risks in the healthcare setting
- Training programs about correct use of personal protective equipment (such as putting on, removal and disposal), and competency assessment
- Fit checking and fit testing protocols for particulate filter respirators (e.g. P2/N95).

Risk management in infection prevention and control programs

The [NSQHS Standards](#) require health service organisations to use evidence-based systems to mitigate the risk of infection. Infection prevention and control programs are an important element of these systems to ensure:

- A safe environment for patients, visitors and healthcare workers
- Good health outcomes for patients
- Minimisation of the development of resistant organisms.

Each infection prevention and control program need to address risk management in relation to the following.

Patients

Every patient that presents to a health service organisation should be considered as potentially at risk of acquiring an infection, and an infection risk to others. Opportunities for the transmission of infections occur because patients:

- Are often located closely to one another
- Are unwell, often with co-morbidities
- May undergo invasive procedures
- May have invasive medical devices inserted
- May receive antimicrobials and immunosuppressive therapies.

Points to consider when assessing infection risk in relation to a patient include:

- The patient's history, including underlying health conditions (e.g. recent surgery, overseas travel, immunosuppression)?
- Checking if the patient has symptoms that suggest they may have an infection
- Are other patients, healthcare workers or visitors at risk of infection (e.g. immunosuppressed patients, pregnant women, young children, the elderly)?
- Is the patient likely to undergo an invasive procedure and where will this occur (operating theatre, interventional suite)?
- Processes for communicating relevant details of a patients' infectious status if care is transferred between clinicians or health service organisations, or with family and carers?

The clinical environment

The level of infection risk posed by the clinical environment varies according to the purpose for which it is used, the design and structure, the ease with which the space can be cleaned, the volume of patient care activity and the type of equipment used for patient care.

Points to consider when assessing infection risk in relation to the clinical environment:

- What policies and guidelines are available to guide maintenance, repair and upgrade of building, equipment, furnishings, and fittings?
- What processes are in place to evaluate and respond to infection risks for new and existing equipment, devices, and products?
- Who is responsible for cleaning the environment?

- Are healthcare workers trained in environmental and equipment cleaning, use of personal protective equipment, and infection prevention and control?
- What environmental cleaning solutions are available?
- Are there local issues that might increase the risk of infection such as building renovations or outbreaks?

The [Australasian Health Facility Guidelines](#) (AusHFG) provide information to assist health service organisations plan the design of health facilities.

The Commission has developed [environmental cleaning resources](#) that provide more information on risk management for the clinical environment.

Further information on risk management of the clinical environment is covered in full detail in the [Clean and safe healthcare environment](#) and the Renovation, repairs and redevelopment risk management modules in this workbook.

Healthcare workers

Healthcare workers can become exposed to infectious agents in several ways, including through contact with an infectious patient or because of a sharps injury. Healthcare workers may also put patients at risk of infection if they have an infectious condition.

Points to consider when assessing infection risk in relation to healthcare workers:

- Does the organisation have a vaccine-preventable diseases screening and immunisation policy and program? Are healthcare workers assessed for their individual risk of exposure to vaccine-preventable diseases or other infection, during their work? Further information is provided in the Commission's document [NSQHS Standards Workforce Immunisation Risk Matrix](#)
- Does the organisation have appropriate training in place?
- Is a range of personal protective equipment available and easily accessible?
- Does the organisation provide suitable personal protective equipment for different tasks and different roles (e.g. clinical care, cleaning, engineering)?

Healthcare workers living with a bloodborne virus (BBV), including hepatitis B, hepatitis C and human immunodeficiency virus (HIV), must be managed by the [Australian National Guidelines for the Management of Health Care Workers known to be infected with blood-borne viruses 2018](#) and/or relevant state or territory policy.

Delivery of health care



While delivering care, healthcare workers should assess for risks and decide how activities can be performed safely. Some activities carry a higher risk of infection transmission than others. The use of standard and transmission-based precautions will mitigate most infection risks. However, other factors should also be considered when assessing for infection risk in the delivery of health care.

Points to consider when assessing infection risk in relation to delivery of health care:

- What type of activity is being performed (e.g. invasive procedure, wound dressing, personal care)?
- Where is the care being delivered (e.g. clinical setting, patient's home)?
- Is the patient known to be colonised or infected with a particular microorganism?
- Are cognitive or behavioural factors present that may increase the risk of the patient transmitting an infection?
- What other activities are happening in the clinical area (e.g. cleaning, emergency responses)?
- What resources are available for the activity (e.g. appropriate PPE, condition of the equipment)?
- What actions can be taken to reduce the risk of infection transmission during the activity (e.g. aseptic technique, patient placement, transmission-based precautions).

The Commission has developed several resources to assist with risk assessment in the delivery of health care, including:

- [Aseptic technique](#)
- [NSQHS Standards workforce immunisation risk matrix](#)
- [Ensuring appropriate patient placement](#)
- [Environmental cleaning.](#)

Clinical equipment

All new and existing equipment used for patient care and procedures should be routinely assessed for potential infection risks.

The variety of, and options for, equipment used in patient care is constantly evolving. New materials and technology used for the development of equipment and medical devices can improve patient care and procedures and create new challenges.



Cleaning solutions used within a health service organisation may not be appropriate for new devices. Some technologies require specialised servicing and maintenance, while others require staff to undergo specialised training and accreditation to use the device to perform a procedure. Existing equipment and medical devices may also become damaged over time or be difficult to clean. These factors can potentially increase the risk of infection transmission, if not managed or planned for.

Points to consider when assessing infection risk in relation to clinical equipment include:

- Does the organisation have a process for assessing new products and equipment?
- Does the organisation have an equipment maintenance program for cleaning, servicing, repairing and replacement?
- Are reusable devices reprocessed on site or by an external contractor?
- Are staff trained to reprocess medical and patient care equipment?
- How are equipment, stock and reusable medical devices stored?
- Do current reprocessing practices comply with Australian Standards AS/NZS 4187: 2014 and AS/NZS 4815 for reprocessing?

Visitors and carers

Visitors and carers can also be at risk of infection as well as a potential infection risk to others.

Visitors and carers may be involved in patient care and should be informed about basic infection prevention and control practices. Identifying and managing gaps in information and resources for visitors and carers will help to reduce the risk of infection, both in the organisation and at home.

Points to consider when assessing infection risk in relation to visitors and carers include:

- Is information available for visitors and carers about current infection risks or infectious diseases?
- Are restrictions on visiting clinical areas needed to reduce infection risks?
- If carers are involved in direct patient care, are they provided with information, training, and support to deliver that care safely?
- Is infection prevention and control related information available in locally used languages, other than English?
- Are visitors and carers aware that they should not visit patients when they themselves are unwell?

Risk management for specific infectious agents and diseases

This section provides guidance in relation to risk management, infection prevention and control precautions, and patient placement for a series of infectious agents, that align with the content in the module.

Patient placement is an important element of infection prevention and control precautions, along with the use of dedicated equipment, the use of appropriate PPE, and effective environmental cleaning.

The Commission has developed [Ensuring Appropriate Patient Placement](#) as a guide to support healthcare workers in the appropriate bed allocation, particularly in circumstances when infection prevention and control advice is not readily available.

Standardised infection control signage (posters) complements appropriate patient placement by increasing the awareness of healthcare workers, patients and visitors to the precautions required to minimise the risk of transmission of infectious agents. Signage is available on the Commission's [website](#). Some states and territories have also developed this type of signage which can be accessed by visiting state and territory health department websites.

The content of the following tables has been collated from:

- [The Australian Guidelines for the Prevention and Control of Infection in Healthcare \(current edition\)](#)
- [Australian Government Department of Health](#)
- [Centers for Disease Control and Prevention](#)

Communicable Diseases Network Australia (CDNA) has developed the [Series of National Guidelines \(SoNGs\)](#) to provide nationally consistent advice and guidance to public health units, in responding to a notifiable disease event.

Clostridioides difficile

Disease or infectious agent	Symptoms, diagnosis, and treatment	Means of transmission	infection prevention and control precautions on clinical suspicion	Other strategies
<p><i>Clostridioides difficile</i> is a toxin and spore forming bacteria, that causes severe gastrointestinal infection and pseudomembranous colitis. About 20% of patients with an initial infection will have at least one recurrent episode of symptomatic infection, usually within 21 days of the initial episode.</p> <p><i>Clostridioides difficile</i> infection (CDI) is commonly associated with prolonged and unnecessary use of broad-spectrum antimicrobials, hospitalisation, advanced age, and underlying morbidity. Emergence of a hyper-virulent strain has been identified. Infants can carry without having disease.</p>	<p>Symptoms include:</p> <ul style="list-style-type: none"> • Diarrhoea- Two or more loose/watery stools more than what is normal for a patient in a 24-hour period • Fever • Ileus, toxic megacolon or pseudomembranous colitis (identified by colonoscopy). <p>Diagnosis is made by:</p> <ul style="list-style-type: none"> • Faecal, rectal swab or intestinal contents testing. <p>Treatment consists of:</p> <ul style="list-style-type: none"> • Appropriate antimicrobial therapy. 	<p>Direct contact with contaminated surfaces and equipment. Transmitted in faeces.</p>	<p>Standard and contact precautions, including isolation in single room with dedicated ensuite, where available.</p> <p>Contact precautions for a minimum of 48 hours after the resolution of symptoms</p>	<p>Transmission can be further reduced by:</p> <ul style="list-style-type: none"> • Using soap and water to perform hand hygiene, rather than alcohol-based hand rub • Early testing of patients who have diarrhoea, and intervention to prevent outbreaks • Regular cleaning of all equipment and environmental surfaces • An effective antimicrobial stewardship program to ensure appropriate antimicrobial use, and potentially reduce the risk of patients developing CDI • Routine surveillance • Patient and carer education on how to reduce transmission. <p>Further information on the Commission's work on <i>Clostridioides difficile</i> can be found here.</p>

Creutzfeldt-Jacob Disease (CJD)

Disease or infectious agent	Symptoms, diagnosis, and treatment	Means of transmission	Infection prevention and control precautions on clinical suspicion	Other strategies
<p>Caused by protein-based, transmissible agents known as prions, that accumulate in brain and neural cells. Causes rare chronic encephalopathy and associated dementia leading to death.</p> <p>Prions cannot be cultured and do not trigger an immune response. Resistant to heat, chemicals, and irradiation.</p> <p>Long incubation period of many years. Once signs appear, deterioration is progressive and rapid.</p>	<p>Symptoms include:</p> <ul style="list-style-type: none"> • Personality changes • Memory loss • Impaired thinking • Blurred vision or blindness • Insomnia • Incoordination • Difficulty speaking • Dysphagia • Myoclonus. <p>Diagnosis is made by:</p> <ul style="list-style-type: none"> • Medical and personal history • Neurological exam • Certain diagnostic tests such as, CSF testing for protein markers • Brain biopsy. <p>No treatment available. Death usually occurs within 1 year of onset of symptoms.</p>	<p>May develop as:</p> <ul style="list-style-type: none"> • Sporadic - occurs for no obvious cause • Genetic or familial - inherited • Medically acquired - from contaminated instruments used during brain or cornea surgery, from transplants of diseased human growth hormone or tissue, or from blood transfusions • Variant - caused by eating meat from cattle that had mad cow disease (vCJD). 	<p>Standard precautions</p>	<p>Transmission can be further reduced by:</p> <ul style="list-style-type: none"> • Exclusive use of man-made human growth hormone, rather than the kind derived from human pituitary glands • Destruction of surgical instruments used on the brain or nervous tissue of someone with known or suspected CJD • Single-use kits for spinal taps (lumbar punctures). • Risk assessment of all patients undergoing identified higher risk procedures.

Gastroenteritis

Disease or infectious agent	Symptoms, diagnosis, and treatment	Means of transmission	Infection prevention and control precautions on clinical suspicion	Other strategies
Gastroenteritis (viral) Rotavirus, norovirus, adenovirus.	<p>Symptoms include:</p> <ul style="list-style-type: none"> • Diarrhoea • Nausea and vomiting • Abdominal pain. <p>Diagnosis requires either:</p> <ul style="list-style-type: none"> • Two or more loose/watery stools more than what is normal for a patient in a 24-hour period • Two or more episodes of vomiting in a 24-hour period • A stool positive for an infectious agent PLUS at least one symptom of nausea, vomiting, abdominal pain, diarrhoea. <p>Treatment consists of:</p> <ul style="list-style-type: none"> • Appropriate antimicrobial therapy for bacterial and protozoan infections • No specific treatment for viral infections. 	<p>Faecal-oral route from contaminated food, fluid or hands, and contaminated surfaces</p> <p>Transmission can also occur through aerosolisation of droplets of vomit or diarrhoea.</p>	<p>Contact precautions for duration of illness in most infections.</p> <p>Contact precautions until 24 hours after symptoms have ceased for <i>Salmonella</i> spp., Campylobacter, Shigella, Cholera.</p> <p>Contact precautions for a minimum of 48 hours after the resolution of symptoms or to control institutional outbreaks for norovirus.</p> <p>In some situations, such as during an outbreak, droplet precautions are also required.</p>	<p>Transmission can be further reduced by:</p> <ul style="list-style-type: none"> • Early diagnosis to reduce the risk of outbreaks • Effective hand hygiene with soap and water • Prioritising patients with vomiting and diarrhoea for a single room with a dedicated ensuite • Patient and carer education on how to reduce transmission.
Gastroenteritis (bacterial) <i>Salmonella</i> spp., Campylobacter, Shigella, Cholera.				
Gastroenteritis (protozoa) <i>Giardia lamblia</i> , <i>Entamoeba histolytica</i> , <i>Cryptosporidium parvum</i> .				
Incubation period is usually 1-4 days, but can be as short as several hours, or as long as several weeks after exposure.				

Group A beta-haemolytic *streptococcus* (GAS)

Disease or infectious agent	Symptoms, diagnosis, and treatment	Means of transmission	Infection prevention and control precautions on clinical suspicion	Other strategies
<p>Group A beta-haemolytic <i>streptococcus</i> (GAS or group A strep) are bacteria that cause infections that range from minor to very severe, and include:</p> <ul style="list-style-type: none"> • Strep throat • Skin infections, such as impetigo (school sores) • Scarlet fever • Cellulitis • Toxic shock syndrome • Rheumatic fever • Necrotising fasciitis • Post-streptococcal glomerulonephritis. <p>Puerperal and neonatal infections require immediate antibiotic treatment.</p> <p>GAS can also lead to sepsis, which needs to be identified early and requires immediate treatment. Sepsis is a medical emergency.</p>	<p>Symptoms vary depending on the site of infection but may include:</p> <ul style="list-style-type: none"> • Fever and chills • Tender, swollen lymph nodes • Sore throat, inflamed and exudative tonsils (strep throat) • Rash on the torso (scarlet fever) • Blisters on the face and/or limbs (impetigo). <p>Diagnosis is made by:</p> <ul style="list-style-type: none"> • Throat swab • Swab of fluid in blisters • Blood culture. <p>Treatment consists of:</p> <ul style="list-style-type: none"> • Appropriate antimicrobial therapy. 	<p>Person to person by contact and droplet transmission (saliva and respiratory secretions).</p>	<p>Contact and droplet precautions until the first 24 hours of antimicrobial therapy is complete.</p> <p>Standard precautions thereafter.</p>	<p>Transmission can be further reduced by:</p> <ul style="list-style-type: none"> • Covering affected wounds with appropriate occlusive dressings • Patient and carer education on how to reduce transmission and the importance of taking the antimicrobial therapy as prescribed, to minimise the incidence of complications.

Hepatitis A

Disease or infectious agent	Symptoms, diagnosis, and treatment	Means of transmission	Infection prevention and control precautions on clinical suspicion	Other strategies
<p>Hepatitis A virus is a non-enveloped RNA virus classified as apicornavirus. Highly contagious and causes acute liver inflammation.</p> <p>Usually, a short-term infection and does not become chronic. In rare cases, can cause liver failure and death.</p> <p>Occurs where there is incidence of the disease, combined with poor food handling or sanitation.</p> <p>Often associated with community outbreaks, e.g. childcare centres, refugee camps.</p> <p>Infection is usually self-limiting, but can last for several weeks, and confers life-long immunity to further infection.</p> <p>Long incubation period (15-50 days) so determining the source of infection is often difficult.</p>	<p>May be asymptomatic. Symptoms may include:</p> <ul style="list-style-type: none"> • Jaundice and yellowing of the sclera • Loss of appetite • Abdominal pain • Nausea and vomiting • Fever • Dark urine or pale stools • Diarrhoea • Joint pain • Lethargy. <p>Diagnosis is made by:</p> <ul style="list-style-type: none"> • Medical history • Blood test. <p>No specific treatment. Treatment consists of:</p> <ul style="list-style-type: none"> • Rest • Adequate nutrition • Fluids. 	<p>Faecal-oral route, either by person-to-person contact or ingestion of contaminated food/water.</p>	<p>Standard precautions Addition of contact precautions, for incontinent persons for the duration of illness.</p>	<p>Transmission can be further reduced by:</p> <ul style="list-style-type: none"> • Immunisation of high-risk individuals • Provision of hepatitis A vaccine or normal human immunoglobulin (NHIG) post exposure as recommended • Education on safe food handling and sanitation. <p>See Hepatitis A - CDNA National Guidelines for Public Health Units</p>

Hepatitis B

Disease or infectious agent	Symptoms, diagnosis, and treatment	Means of transmission	Infection prevention and control precautions on clinical suspicion	Other strategies
<p>Hepatitis B virus is an enveloped DNA virus belonging to the family Hepadnaviridae.</p> <p>Causes liver inflammation which can be acute or become chronic. Complications include cirrhosis of liver, hepatocellular carcinoma and death.</p> <p>Chronic hepatitis B infection occurs more commonly in some communities, including:</p> <ul style="list-style-type: none"> • Aboriginal and Torres Strait Islander communities. • In people from parts of the world where hepatitis B is more common. <p>Long incubation period (40-180 days) and is often insidious and asymptomatic in clinical presentation.</p>	<p>May be asymptomatic or cause with mild flu-like symptoms. Symptoms in more serious cases may include:</p> <ul style="list-style-type: none"> • Jaundice and yellowing of the sclera • Loss of appetite • Abdominal pain • Nausea and vomiting • Fever • Dark urine or clay-coloured stools • Joint pain • Fatigue. <p>Diagnosis is made by:</p> <ul style="list-style-type: none"> • Medical history • Blood test. <p>No specific treatment. Management consists of:</p> <ul style="list-style-type: none"> • Rest • Adequate nutrition • Fluids • Antiviral medication in some instances. 	<p>Parenteral exposure to blood or body fluids of an infected person, or contaminated equipment.</p> <p>Occupational transmission can occur by percutaneous injuries, or mucosal exposure to blood or body fluids from an infected person.</p> <p>Transmission can also occur perinatally.</p> <p>International reports of transmission via contaminated blood products or organ donation.</p>	<p>Standard precautions</p>	<p>Transmission can be further reduced by:</p> <ul style="list-style-type: none"> • Screening and vaccination for all healthcare workers and laboratory staff • An effective occupational exposure protocol for bloodborne viruses • Regular review of activities that provide an infection risk • Use of safety-engineered devices and equipment wherever possible • Safe sharps management, handling and disposal • Effective spills management protocols • Cleaning, disinfection and sterilisation protocols for instrumentation and equipment that meet relevant national or jurisdictional requirements • Patient and carer education on how to reduce transmission. <p>See Hepatitis B – CDNA National Guidelines for Public Health Units.</p>

Hepatitis C

Disease or infectious agent	Symptoms, diagnosis, and treatment	Means of transmission	Infection prevention and control precautions on clinical suspicion	Other strategies
<p>Hepatitis C virus is a small, enveloped RNA virus belonging to the family Flaviviridae.</p> <p>Causes liver inflammation which can be acute or become chronic.</p> <p>Complications include cirrhosis of liver, hepatocellular carcinoma and death.</p> <p>Incubation period 2–12 weeks (range: 2–26 weeks) and is often insidious and asymptomatic in clinical presentation.</p> <p>Around 30% of people who have been infected may clear the virus from their blood naturally, with no treatment, within 6 months.</p>	<p>May be asymptomatic or cause with mild flu-like symptoms. Symptoms in more serious cases may include:</p> <ul style="list-style-type: none"> • Jaundice and yellowing of the sclera • Loss of appetite • Abdominal pain • Nausea and vomiting • Fever • Dark urine or clay-coloured stools • Joint pain • Fatigue • Skin rash. <p>Diagnosis is made by:</p> <ul style="list-style-type: none"> • Medical history • Blood test. <p>Treatment consists of:</p> <ul style="list-style-type: none"> • Appropriate antiviral therapy. 	<p>Parenteral exposure to blood or body fluids of an infected person, or contaminated equipment.</p> <p>Occupational transmission can occur by percutaneous injury, or mucosal exposure to blood or body fluids of an infected person.</p> <p>Can occur perinatally.</p> <p>Can occur in people who have substantial or repeated percutaneous exposures to blood (e.g. injecting drug users, persons with haemophilia).</p> <p>International reports of transmission via contaminated blood products.</p>	<p>Standard precautions</p>	<p>Transmission can be further reduced by:</p> <ul style="list-style-type: none"> • Screening and vaccination for healthcare workers and laboratory staff • An effective occupational exposure protocol for bloodborne viruses • Regular review of activities that provide an infection risk • Use of safety-engineered devices and equipment • Safe sharps management, handling and disposal • Effective spills management protocols • Cleaning, disinfection and sterilisation protocols for instrumentation and equipment • Patient and carer education on how to reduce transmission. • Risk assessment management of infected healthcare workers with regard to exposure-prone procedures (EPPs). <p>See Hepatitis C - CDNA National Guidelines for Public Health Units.</p>

Impetigo

Disease or infectious agent	Symptoms, diagnosis, and treatment	Means of transmission	Infection prevention and control precautions on clinical suspicion	Other strategies
<p>Highly infectious bacterial skin infection caused by <i>Staphylococcus</i> or <i>Streptococcus</i> bacteria. Common in school-aged children.</p>	<p>Symptoms include:</p> <ul style="list-style-type: none"> • Red, itchy patches of skin that form blisters, particularly around the nose and mouth • Blisters burst and weep yellow, sticky fluid • Area develops a raised, wet-looking crust. <p>If large areas of the skin are affected, symptoms may also include:</p> <ul style="list-style-type: none"> • Fever • Swollen lymph glands • Malaise. <p>Diagnosis is made by:</p> <ul style="list-style-type: none"> • Clinical appearance • Culture of fluid in blisters. <p>Treatment consists of:</p> <ul style="list-style-type: none"> • Appropriate antimicrobial therapy. 	<p>Direct contact with the fluid from the blisters or sores</p>	<p>Contact precautions are required until the first 24 hours of antimicrobial therapy is completed Standard precautions are required thereafter.</p>	<p>Transmission can be further reduced by:</p> <ul style="list-style-type: none"> • Covering the blisters or sores with an occlusive dressing • Excluding children with impetigo from school or day care until 24 hours of antimicrobial therapy is complete • Performing hand hygiene with soap and water • Good personal hygiene • Avoiding the sharing of personal items such as towels and face washers • Patient and carer education on how to reduce transmission.

Influenza (seasonal)

Disease or infectious agent	Symptoms, diagnosis, and treatment	Means of transmission	Infection prevention and control precautions on clinical suspicion	Other strategies
<p>Respiratory tract infection caused by single-stranded RNA orthomyxoviruses, classified as types A, B, C or D.</p> <p>Generally, only influenza A and B cause severe disease in humans. Novel and pandemic strains require outbreak and disaster risk planning. Refer to national/State/Territory guidelines for further information. Incubation period 1-4 days with symptomatic disease lasting 2-5 days.</p> <p>Virus changes antigenic makeup frequently (often annually). Complications include:</p> <ul style="list-style-type: none"> • Pneumonia • Otitis media • Encephalitis • Death. 	<p>Symptoms include:</p> <ul style="list-style-type: none"> • Fever • Malaise • Headache • Cough • Sore throat • Myalgia • Vomiting and diarrhoea in children. <p>Diagnosis made by:</p> <ul style="list-style-type: none"> • Nose and/or throat swab. <p>Treatment consists of:</p> <ul style="list-style-type: none"> • Anti-viral medications should be considered for treatment if identified early. 	<p>Direct and indirect contact and droplet transmission.</p>	<p>Contact and droplet precautions until after 72 hours of receiving anti-influenza medication or 5 days have elapsed since the onset of respiratory symptoms. May be longer for young children, immunosuppressed or patients in intensive care. Standard precautions thereafter.</p>	<p>Transmission can be further reduced by:</p> <ul style="list-style-type: none"> • Early diagnosis and treatment to reduce the risk of outbreak • Minimising aerosol-generating procedures • Annual vaccination in line with national, state or territory requirements • Patient and carer education on how to reduce transmission. <p>See Seasonal Influenza Infection - CDNA National Guidelines for Public Health Units.</p>

Legionnaires' disease

Disease or infectious agent	Symptoms, diagnosis, and treatment	Means of transmission	Infection prevention and control precautions on clinical suspicion	Other strategies
<p>Severe bacterial lung infection caused by either <i>Legionella pneumophila</i> or <i>Legionella longbeachae</i>.</p> <p><i>Legionella pneumophila</i> most often associated with water from water supply (hot, warm or cold) or from cooling towers for air-conditioning units.</p> <p><i>Legionella longbeachae</i> most often associated with potting mixes or soil.</p>	<p>Symptoms include:</p> <ul style="list-style-type: none"> • Headache (often severe) • Fever • Myalgia • Dry cough and shortness of breath. <p>In some cases, other systems in the body are affected causing:</p> <ul style="list-style-type: none"> • Diarrhoea • Mental confusion • Renal failure. <p>Diagnosis is made by:</p> <ul style="list-style-type: none"> • History of possible exposure • Culture of blood, urine and/or sputum. <p>Treatment consists of:</p> <ul style="list-style-type: none"> • Appropriate antimicrobial therapy. 	<p>Not transmitted from person-to-person.</p> <p>Infection caused by inhaling bacteria from soil or water.</p>	<p>Standard precautions for the duration of admission.</p>	<p>Transmission can be further reduced by:</p> <ul style="list-style-type: none"> • Developing a Legionella risk management plan based on risk assessment • Investigating potential outbreaks associated with the organisation, to identify and test the possible source of infection and likely reservoirs for contamination • Reviewing preventive maintenance procedures and monitoring programs for cooling towers, water systems, birthing and hydrotherapy pools, thermal mixing valves etc. • Avoiding the use of tap water in respiratory therapy devices, such as nebulisers. <p>See Legionellosis - CDNA National Guidelines for Public Health Units.</p>

Measles (rubeola)

Disease or infectious agent	Symptoms, diagnosis, and treatment	Means of transmission	Infection prevention and control precautions on clinical suspicion	Other strategies
<p>Measles is caused by an enveloped, single stranded RNA virus called paramyxovirus from the genus Morbillivirus.</p> <p>Highly transmissible. Non- immune individuals are at high-risk of contracting if exposed.</p> <p>Usually presents as a mild disease however, complications including otitis media, pneumonia and encephalitis. Rarely, subacute sclerosing panencephalitis (SSPE) can occur and can lead to death.</p>	<p>Symptoms include:</p> <ul style="list-style-type: none"> • Prodrome of malaise, cough, coryza, and conjunctivitis • Maculopapular rash that spreads from the head, to the trunk, to the lower extremities • Fever. <p>Diagnosis made by:</p> <ul style="list-style-type: none"> • Clinical symptomology • Throat swab • Urine test • Blood test. <p>No specific treatment. Management consists of:</p> <ul style="list-style-type: none"> • Rest • Adequate nutrition • Fluids. <p>Appropriate antimicrobial therapy may be required if otitis media or bacterial pneumonia develop.</p>	<p>Airborne transmission (saliva and respiratory secretions).</p>	<p>Airborne precautions, including placement in a negative pressure room if available, for 4 days after rash appears, and for the duration of illness in immunocompromised patients</p> <p>Standard precautions thereafter.</p>	<p>Transmission can be further reduced by:</p> <ul style="list-style-type: none"> • Preventing susceptible healthcare workers from caring for patients • Screening and vaccination in line with national, state or territory requirements • Post-exposure prophylaxis for susceptible healthcare workers • Minimising aerosol-generating procedures • Patient and carer education on how to reduce transmission. <p>See Measles - CDNA National guidelines for Public Health Units.</p>

Meningococcal disease

Disease or infectious agent	Symptoms, diagnosis, and treatment	Means of transmission	Infection prevention and control precautions on clinical suspicion	Other strategies
<p>Rare but significant disease caused by a bacterium known as <i>Neisseria meningitides</i>.</p> <p>Can cause inflammation of the brain and spinal cord, and septicaemia. Often difficult to diagnose and can cause significant morbidity and mortality if not identified and managed early.</p> <p>Occurs throughout the year, although most significant in Australia during autumn and winter.</p> <p>Can be carried asymptotically in the throat of healthy individuals and be transmitted to others.</p> <p>Can also cause:</p> <ul style="list-style-type: none"> • Bacteraemia • Septic arthritis (especially weight bearing joints) • Conjunctivitis. 	<p>Symptoms include:</p> <ul style="list-style-type: none"> • Sudden onset of fever • Altered state of consciousness • Neck stiffness • Headache • Haemorrhagic, non-blanching rash. <p>Young children may have fewer specific symptoms. Which may include:</p> <ul style="list-style-type: none"> • Irritability • Difficulty waking • High-pitched crying • Refusal to eat. <p>Absence of a rash should not delay treatment if meningococcal disease is suspected.</p> <p>Diagnosis made by:</p> <ul style="list-style-type: none"> • Clinical symptomology • Culturing of blood or cerebral spinal fluid. <p>Treatment consists of:</p> <ul style="list-style-type: none"> • Urgent appropriate antimicrobial therapy. 	<p>Droplet transmission (saliva and respiratory secretions).</p>	<p>Droplet precautions until the first 24 hours of antimicrobial therapy is complete.</p> <p>Standard precautions thereafter.</p>	<p>Transmission can be further reduced by:</p> <ul style="list-style-type: none"> • Healthcare worker education about the identification of disease • Vaccination • Contact tracing and prophylaxis for close contacts • Patient and carer education. <p>Immunisation considered with some healthcare worker groups e.g. laboratory staff. More commonly used during outbreaks.</p> <p>Immunisation does not cover all possible serotypes.</p> <p>Post-exposure prophylaxis for staff who have had significant contact with patient's naso/oropharyngeal secretions before droplet precautions being implemented.</p> <p>Colonised individuals usually not treated with antibiotics.</p> <p>See Invasive Meningococcal Disease - CDNA National Guidelines for Public Health Units.</p>

Mumps

Disease or infectious agent	Symptoms, diagnosis, and treatment	Means of transmission	Infection prevention and control precautions on clinical suspicion	Other strategies
<p>Acute viral infection caused by an enveloped virus which is a member of the Paramyxovirus family.</p> <p>Incubation period is usually 12-25 days. Generally mild, and self-limiting in children, but may lead to severe complications, such as:</p> <ul style="list-style-type: none"> • Encephalitis • Meningitis • Myocarditis. <p>Complications in post pubertal individuals include:</p> <ul style="list-style-type: none"> • Epididymo-orchitis (males) • Mastitis and/or oophoritis (females) • Miscarriage in first 3 months of pregnancy. <p>Rare in Australia due to vaccination. Unimmunised people have the highest risk.</p>	<p>Symptoms include:</p> <ul style="list-style-type: none"> • Fever • Swelling of the parotid glands (usually unilateral) • Headache • Fatigue • Myalgia • Loss of appetite • Pain on chewing or swallowing. <p>Diagnosis made by:</p> <ul style="list-style-type: none"> • Clinical symptomology • Throat swab • Urine test • Blood test. <p>No specific treatment. Management consists of:</p> <ul style="list-style-type: none"> • Rest • Adequate nutrition • Fluids. 	<p>Contact and droplet (respiratory secretions)</p>	<p>Standard and droplet precautions until 5 days after onset of parotid gland swelling.</p> <p>Exposed non-immune people should be considered infectious from 12th-25th day after exposure, with or without symptoms.</p>	<p>Transmission can be further reduced by:</p> <ul style="list-style-type: none"> • Preventing susceptible healthcare workers from caring for patients • Screening and vaccination in line with national, state or territory requirements • Patient and carer education on how to reduce transmission.

Novel respiratory viruses

Disease or infectious agent	Symptoms, diagnosis, and treatment	Means of transmission	Infection prevention and control precautions on clinical suspicion	Other strategies
<p>Novel respiratory viruses are new virus subtypes that emerge when an animal virus begins to spread among humans.</p> <p>Include:</p> <ul style="list-style-type: none"> • Novel influenza viruses • Coronaviruses, such as Middle East Respiratory Syndrome Coronavirus (MERS-CoV), Severe Acute Respiratory Syndrome (SARS) and Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2/COVID-19). <p>Often have pandemic potential.</p>	<p>Early symptoms include:</p> <ul style="list-style-type: none"> • Runny nose • Low-grade fever (generally minimal throughout the course of the disease) • Mild, occasional cough • Apnoea in infants. <p>Diagnosis made by:</p> <ul style="list-style-type: none"> • Clinical symptomology • Physical examination • Throat swab culture • Blood test. <p>Treatment consists of:</p> <ul style="list-style-type: none"> • Antiviral treatment • Symptom support/ hydration, respiratory support 	<p>Contact, droplet and airborne transmission.</p>	<p>Combined contact and airborne precautions, noting that these precautions in combination, provide adequate protection against droplet transmission.</p>	<p>Transmission can be further reduced by:</p> <ul style="list-style-type: none"> • Early diagnosis to reduce the risk of outbreaks • Preventing non-immune healthcare workers from caring for patients (in the case of SARS-CoV-2/COVID-19) • Screening and vaccination of healthcare workers in line with national, state or territory requirements (in the case of SARS-CoV-2/COVID-19) • Minimising aerosol-generating procedures • Patient and carer education on how to reduce transmission, including vaccination (in the case of SARS-CoV-2/COVID-19). <p>See Coronavirus Disease 2019 (COVID-19) - CDNA National Guidelines for Public Health Units.</p>

Pertussis (whooping cough)

Disease or infectious agent	Symptoms, diagnosis, and treatment	Means of transmission	Infection prevention and control precautions on clinical suspicion	Other strategies
<p>Highly infectious respiratory tract infection caused by the bacterium <i>Bordetella pertussis</i>.</p> <p>Most at risk population is infants < 6months of age who are not fully vaccinated. In this population death can result from pertussis or its complications.</p> <p>Any age group can contract this infection and transmit it to others if exposed to a case and not protected by vaccination, or if immunity has waned.</p>	<p>Early symptoms include:</p> <ul style="list-style-type: none"> • Runny nose • Low-grade fever (generally minimal throughout the course of the disease) • Mild, occasional cough • Apnoea in infants. <p>As the disease progresses, symptoms may include:</p> <ul style="list-style-type: none"> • Paroxysmal coughing, followed by a high-pitched “whoop” sound • Vomiting during or after coughing fits • Exhaustion following coughing paroxysms. <p>Diagnosis made by:</p> <ul style="list-style-type: none"> • Clinical symptomology • Physical examination • Throat swab culture • Blood test. <p>Treatment consists of:</p> <ul style="list-style-type: none"> • Appropriate antimicrobial therapy. 	<p>Droplet transmission (saliva and respiratory secretions).</p>	<p>Droplet precautions until at least 5 days after starting appropriate antimicrobial therapy, or for 21 days after the onset of symptoms if not receiving antimicrobial treatment, or for 14 days after the onset of paroxysmal cough (if the onset is known)</p> <p>Standard precautions thereafter.</p>	<p>Transmission can be further reduced by:</p> <ul style="list-style-type: none"> • Preventing susceptible healthcare workers from caring for patients • Early diagnosis and treatment to reduce the risk of outbreaks • Identification and follow up of high-risk contacts (children under 5 years of age and pregnant women) • Minimising aerosol-generating procedures • Pertussis booster/vaccination and post-exposure prophylaxis for healthcare workers in late pregnancy and high-risk areas • Patient and carer education on how to reduce transmission. <p>See Pertussis CDNA National Guidelines for Public Health Units.</p>

Respiratory syncytial virus (RSV), parainfluenza and adenovirus

Disease or infectious agent	Symptoms, diagnosis, and treatment	Means of transmission	Infection prevention and control precautions on clinical suspicion	Other strategies
<p>Respiratory syncytial virus (RSV), parainfluenza and adenoviruses are a group of respiratory viruses that are common among children and can also affect adults.</p> <p>Highly infectious and can cause acute respiratory distress.</p> <p>Often associated with seasonal outbreaks which can impact upon healthcare services with an influx of admissions.</p> <p>Complications include:</p> <ul style="list-style-type: none"> • Pneumonia • Bronchiolitis • Conjunctivitis • Croup. 	<p>Early symptoms include:</p> <ul style="list-style-type: none"> • Runny nose • Fever • Decreased appetite • Cough • Sneezing • Wheezing • Dyspnoea. <p>Diagnosis made by:</p> <ul style="list-style-type: none"> • Nasal aspirate. <p>No specific treatment.</p> <p>Management consists of:</p> <ul style="list-style-type: none"> • Rest • Adequate nutrition • Fluids. 	<p>Direct and indirect contact and droplet transmission.</p>	<p>Contact and droplet precautions, including placement in a single room if available for the duration of illness.</p>	<p>Transmission can be further reduced by:</p> <ul style="list-style-type: none"> • Early diagnosis to reduce the risk of outbreaks • Minimising aerosol-generating procedures • Patient and carer education on how to reduce transmission.

Rubella (German measles)

Disease or infectious agent	Symptoms, diagnosis, and treatment	Means of transmission	Infection prevention and control precautions on clinical suspicion	Other strategies
<p>Rubella is caused by an enveloped, positive stranded RNA classified as a Rubivirus in the Matonaviridae family. Usually a mild, and self-limiting and may be subclinical.</p> <p>Average incubation period of rubella virus is 17 days, with a range of 12 to 23 days.</p> <p>Complications include:</p> <ul style="list-style-type: none"> • Arthralgia or arthritis • thrombocytopenic purpura • encephalitis. <p>Can cause significant birth defects in foetus if contracted during early pregnancy</p>	<p>Symptoms include:</p> <ul style="list-style-type: none"> • Lymphadenopathy • Maculopapular rash that spreads from the head to the trunk, to the lower extremities • Fever. <p>Diagnosis made by:</p> <ul style="list-style-type: none"> • Clinical symptomology • Throat swab • Urine test • Blood test. <p>No specific treatment. Management consists of:</p> <ul style="list-style-type: none"> • Rest • Adequate nutrition • Fluids. 	<p>Contact and droplet transmission (saliva and respiratory secretions).</p>	<p>Contact and droplet precautions for the duration of illness in immunocompromised patients</p> <p>Standard precautions thereafter.</p>	<p>Transmission can be further reduced by:</p> <ul style="list-style-type: none"> • Preventing susceptible healthcare workers from caring for patients (e.g. pregnant women) • Screening and vaccination in line with national, state or territory requirements • Patient and carer education on how to reduce transmission.

Tuberculosis (TB)

Disease or infectious agent	Symptoms, diagnosis, and treatment	Means of transmission	Infection prevention and control precautions on clinical suspicion	Other strategies
<p>Bacterial infection caused by an acid-fast bacillus (AFB) known as <i>Mycobacterium tuberculosis</i>.</p> <p>Most commonly affects the lungs, causing pulmonary TB, but can also affect parts of the body (such as the brain, kidneys or bone) and is known as extra-pulmonary TB.</p> <p>Most people infected with TB do not have any symptoms (latent TB). Latent TB can develop into active TB disease.</p>	<p>Symptoms depend on which part of the body is affected. Symptoms of active pulmonary TB include:</p> <ul style="list-style-type: none"> • Persistent cough • Haemoptysis • Lethargy • Weight loss • Fever • Night sweats. <p>Latent TB infection is asymptomatic and is not transmissible to others.</p> <p>Diagnosis made by:</p> <ul style="list-style-type: none"> • Medical history and potential risk of exposure • Chest x-ray for evidence of pulmonary infection • Blood and sputum cultures. <p>Treatment consists of:</p> <ul style="list-style-type: none"> • Combined multi-drug therapy, usually a combination of four agents administered con over a prolonged period (usually at least six months). 	<p>Active pulmonary TB can spread from person to person through airborne transmission (respiratory secretions).</p> <p>Latent and extra-pulmonary TB is not spread easily from person to person.</p>	<p>Airborne precautions until diagnosis confirmed, for all cases of active pulmonary TB and during all aerosol generating procedures (such as induced sputum collection).</p> <p>Standard precautions for all cases of latent and extra-pulmonary TB.</p>	<p>Transmission can be further reduced by:</p> <ul style="list-style-type: none"> • Patient education about the disease and the application of airborne precautions for themselves and others. <p>See CDNA National Guidelines for Public Health Units - Management of TB.</p>

Varicella (chickenpox)

Disease or infectious agent	Symptoms, diagnosis, and treatment	Means of transmission	Infection prevention and control precautions on clinical suspicion	Other strategies
<p>Highly contagious infection caused by an enveloped virus known as varicella-zoster virus (VZV), which is a member of the herpes virus family.</p> <p>Highly contagious and can cause severe disease in adults, particularly in pregnant women and those who are immunocompromised.</p> <p>Average incubation period 14 to 16 days after exposure, with a range of 10 to 21 days.</p> <p>Complications include:</p> <ul style="list-style-type: none"> • Cerebellar ataxia • Encephalitis • Viral pneumonia • Haemorrhagic conditions • Septicaemia • Toxic shock syndrome • Necrotising fasciitis • Osteomyelitis • Bacterial pneumonia • Septic arthritis. <p>Shingles can occur in some individuals who have had previous infection with VZV.</p>	<p>Symptoms include:</p> <ul style="list-style-type: none"> • Fever • Headache • Malaise • Vesicular rash. <p>Diagnosis made by:</p> <ul style="list-style-type: none"> • Clinical symptomology • Blood test • Culture of fluid from lesion. <p>Management consists of:</p> <ul style="list-style-type: none"> • Antiviral therapy in some cases • Rest • Adequate nutrition • Fluids. 	<p>Airborne transmission, as well as via direct contact with fluid from lesions and nasopharyngeal secretions.</p>	<p>Airborne and contact precautions, including placement in a negative pressure room if available, until all lesions are dry and crusted</p> <p>Standard precautions thereafter.</p>	<p>Transmission can be further reduced by:</p> <ul style="list-style-type: none"> • Preventing susceptible healthcare workers from caring for patients • Pre-employment screening and vaccination of healthcare workers in line with national, state or territory requirements • Post exposure prophylaxis for susceptible healthcare workers • Minimising aerosol-generating procedures • Patient and carer education on how to reduce transmission.

Module 3: Basic microbiology and multidrug-resistant organisms

Module 3 has been developed to provide you with an understanding of basic microbiology and the key multidrug-resistant organisms (MROs) that may be present in acute and non-acute health service organisations, and in the community. Your local state or territory health department may also have more specific MRO guidance available. Information on the management of MROs can also be found in the [Australian Guidelines for the Prevention and Control of Infection in Healthcare](#).

After completing this module, you should be able to:

- Describe normal flora and where it is found
- Show an understanding of environmental microorganisms
- Show an understanding of different types of microorganisms
- Show knowledge of multidrug-resistant organisms
- Show an understanding of antimicrobial resistance.

Health service organisations that are required to be assessed against the [National Safety and Quality Health Service \(NSQHS\) Standards \(second edition\)](#) should refer to the Preventing and Controlling Infections Standard, which sets the framework for infection prevention and control in health service organisations.

Basic microbiology

In the context of human health, microbiology is the study of microorganisms that make up normal flora and transient flora, as well as infectious agents, and how these microorganisms impact on the health and safety of humans.

As part of their role in producing comprehensive and integrated care, it is important for health service organisations to develop and maintain formal links with pathology providers, microbiologists, laboratories, and infectious disease specialists, who can:

- Identify microorganisms
- Detect resistance patterns
- Support management or treatment of patients.

Normal flora

Normal flora (also known as commensal flora) refers to a collection of microorganisms found in all individuals that do not usually cause any harm. These microorganisms are acquired soon after birth and change continuously throughout life.

Normal flora is primarily made up of colonising species that are beneficial to the host. Different parts of the body have different normal flora (see Figure 3.1).

Under certain conditions, normal flora may become opportunistic pathogens. An opportunistic pathogen is a microorganism that usually does not harm its host, but can cause infection:

- When the host's resistance is low (such as in the elderly, pregnant women, neonates, or those with weakened immune systems)
- When a protective barrier (such as the skin or mucous membranes) is damaged or penetrated.

For example, opportunistic pathogens are a common cause of infections acquired from surgical procedures. *Clostridioides difficile* infection, and infections caused by *Candida* species (spp.) may also be opportunistic, as they may occur due to disruption of the normal flora in the body, caused by antimicrobial therapy.

People can also be infected by transient flora that briefly colonise the body, or from microorganisms directly acquired from an external source, such as other people, medical devices, equipment, or the environment.

Environmental microorganisms

Our environment is filled with microorganisms. Microorganisms can be found in:

- Water
- Soil
- In, and, on, animals
- Buildings and air-conditioning units
- Vegetation
- Food
- On equipment and other hard surfaces.

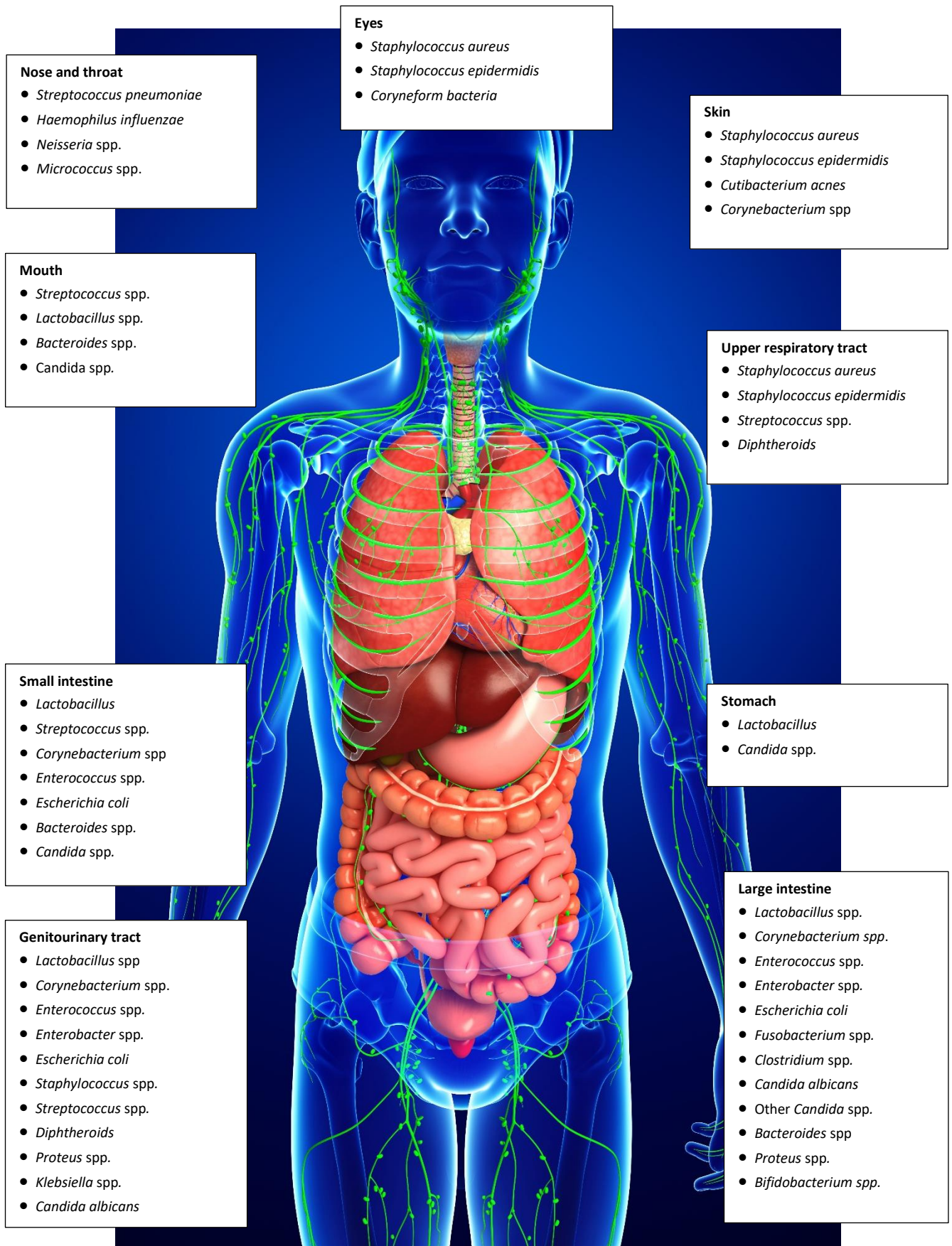
Areas in a health service organisation where there is a risk of contamination by environmental microorganisms include:

- Food preparation areas
- Air handling systems
- Water and plumbing systems
- Inanimate surfaces and objects, such as curtains, shelving, or storage units
- Equipment, such as ventilators and humidicribs
- Wet areas.

Examples of common environmental microorganisms that can become pathogens include *Pseudomonas aeruginosa*, *Legionella longbeachae*, *Legionella pneumophila*, *Listeria monocytogenes*, and *Aspergillus fumigatus*.

Humans also shed their normal flora into their immediate environment. If an individual's normal flora has potential to cause disease in other people, the environment can act as a reservoir for these microorganisms to multiply and be transmitted, directly or indirectly. Examples of normal flora that can contaminate the environment and be transmitted to others include *Staphylococcus aureus* and *Enterococcus* spp.

Figure 3.1: Normal flora and the human body



Types of microorganisms

Bacteria

Bacteria are single-celled microorganisms. Their cell structure is simpler than that of other organisms, as there is no nucleus or membrane-bound organelles. Instead, their genetic information is contained in a single loop of deoxyribonucleic acid (DNA).

When conditions are favourable (correct temperature and available nutrients), bacteria can multiply rapidly. This can occur inside a host, or on culture media in a laboratory.

Bacteria cause many of the infections that are associated with health care and are therefore the primary focus of infection prevention and control programs and surveillance activities.

Nomenclature

Bacterial names consist of two words written in italics. The genus is the first word, and the species is the second word, often abbreviated to “spp.” For example, *Escherichia* spp. The genus is written with an initial capital letter; the species is all lower case.

Identifying bacteria

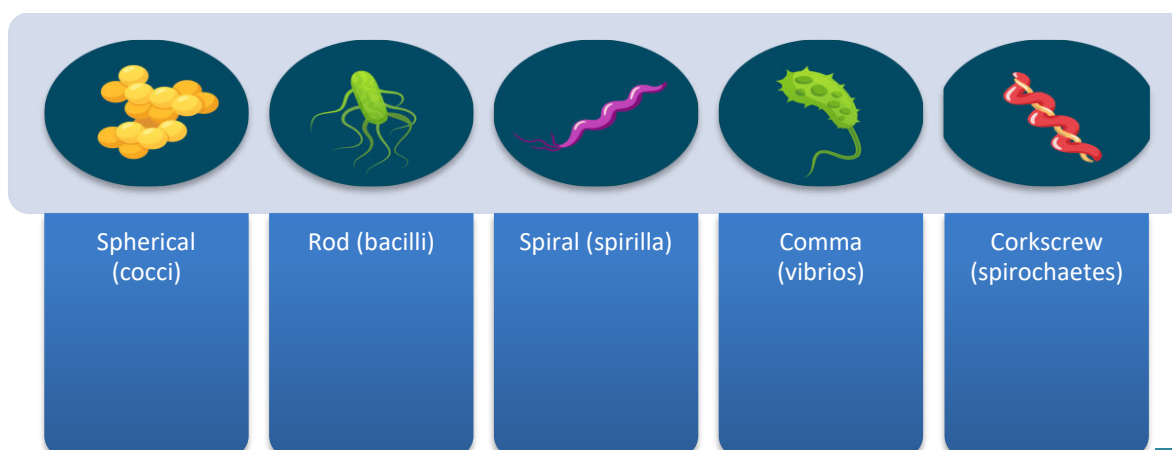
Tools for identification of bacteria include:

- Microscopy
- Gram staining
- Culture
- Biochemical, molecular, or proteomic methods, such as immunoassay, polymerase chain reaction (PCR), or matrix-assisted laser desorption ionisation-time of flight (MALDI-TOF) mass spectrometry.

Microscopy

Bacteria can be seen under a microscope and classified into five groups according to their basic shapes (see Figure 3.2). Bacteria can exist as single cells, in pairs, chains or clusters.

Figure 3.2: Classification of bacteria by shape



Gram staining

Gram staining is a common technique used to differentiate two large groups of bacteria by the chemical and physical properties of their cell walls. A slide, containing a heat-fixed smear of bacterial cells, is treated with crystal-violet stain (a basic dye), during which the cells turn blue. The slide is then flushed with an iodine solution, followed by an organic solvent (such as alcohol or acetone). In the final step, a counterstain, such as safranin, is added and stains the gram-negative cells red.

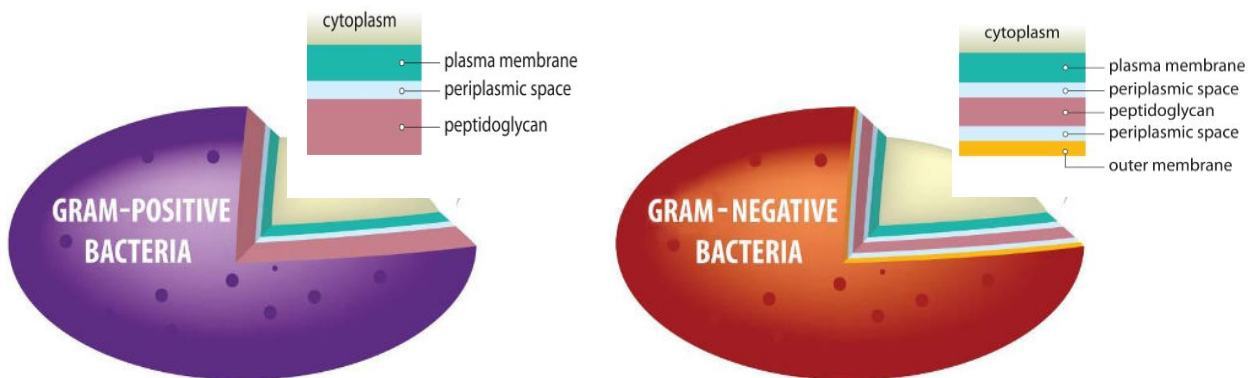
Gram staining divides bacterial species into two large groups:

- Gram-positive bacteria
- Gram-negative bacteria (see Figure 3.3).

Gram-positive bacteria are characterised by having a thick cell wall made of peptidoglycan (a substance consisting of sugars and amino acids) which retains the blue stain when challenged with the Gram stain technique. Examples of gram-positive bacteria include *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Enterococcus* spp., *Streptococcus pyogenes*, *Streptococcus pneumoniae*, *Clostridioides difficile*, *Lactobacillus* spp. and *Listeria* spp.

Gram-negative bacteria have a thinner peptidoglycan layer and an additional outer layer made up of lipids (fats) and polysaccharides (sugars). As a result, the second red stain is retained, and the blue stain is not. Examples of gram-negative organisms include *Neisseria meningitidis*, *Neisseria gonorrhoeae*, *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Acinetobacter* spp., *Serratia* spp. and *Bacteroides* spp.

Figure 3.3: Characteristics of gram-positive and gram-negative bacteria



The benefit of Gram staining is that it provides rapid preliminary guidance as to the type of bacteria causing infection. This means that appropriate antimicrobial therapy can be started while waiting for other test results, which can be used to refine the treatment regimen.

Other stains used for microorganism identification

Mycobacterium tuberculosis, which is the causative agent for pulmonary and extra-pulmonary tuberculosis (TB), is an important human pathogen for infection prevention and control programs. Due to a complex waxy component in the cell wall, mycobacteria do not take up Gram staining. Instead, a special stain called a Ziehl-Neelsen (ZN) is used, which stains the bacilli red. It is often preferable to use this staining technique to identify mycobacteria as mycobacteria grow relatively slowly and it can take several days to weeks before results of cultures are available.

Because of their resistance to acid-alcohol decolouration (i.e. Gram staining), mycobacteria are sometimes referred to as acid-fast bacilli (AFB).

Culture

An artificial nutrient-based culture medium is often used to grow bacterial and fungal cells for further testing. Different types of culture medium are designed to either inhibit or stimulate microorganism growth. Microorganism cells are applied to the culture medium and allowed to grow (incubate). Incubation can take days to weeks depending on the particular species of microorganism. Once colonies of cells are visible on the culture medium, these colonies are used for further pathological testing such as microscopy, Gram staining, antimicrobial sensitivity testing and biochemical testing.

Biochemical methods

Biochemical testing is used to identify different bacteria based on their biochemical behaviours in the presence of other chemicals. For example, the ability of a bacteria to metabolise carbohydrates. Antigen testing via immunoassay is a type of biochemical testing method, which detects the presence of proteins (antigens) that are produced as a result of the body's reaction to the presence of infection.

Other molecular testing

Molecular testing is used to detect the presence of DNA. A polymerase chain reaction (PCR) is an example of molecular testing, where a high number of copies of the bacterial cell's DNA are produced and used to identify the bacteria and/or specific genes in the bacteria. This method is often used to identify bacteria that are difficult to culture (e.g. those that are nutritionally fastidious or require extreme growing conditions).

Proteomic methods

The MALDI-TOF mass spectrometry is an example of a proteomic method that is used to identify and classify bacteria. A sample of microbes is added to a solution called a matrix, which is then dried. The sample is placed into the mass spectrometer and a laser is used to ionise the sample, with individual proteins producing a unique signal. Different bacteria are comprised of different proteins, so the time taken for the reaction (ionisation) to occur is unique to each bacterium and can be used to identify them. This method of testing is fast, sensitive and economical.

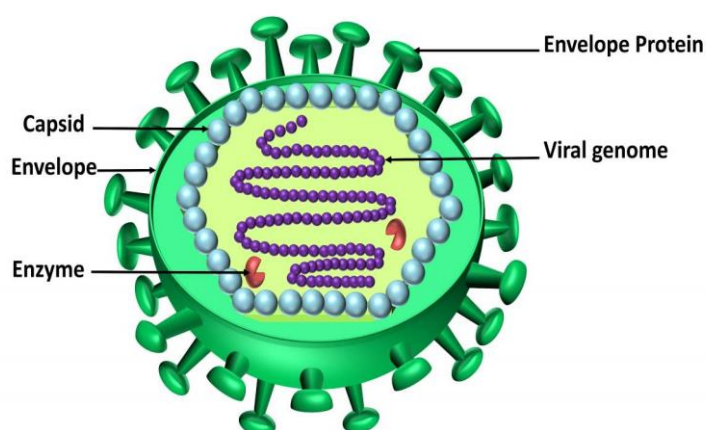
Viruses

Viruses are small microorganisms that are seen using an electron microscope and are usually detected by viral culture or molecular methods, such as PCR.

Viruses consist of a core of genetic material of either DNA or ribonucleic acid (RNA), and an outer protein coat called a capsid. Around the capsid, there may be a spiky covering known as an envelope (See Figure 3.4).

These spikes are proteins that enable viruses to bind to and enter host cells.

Figure 3.4: Structure of a virus



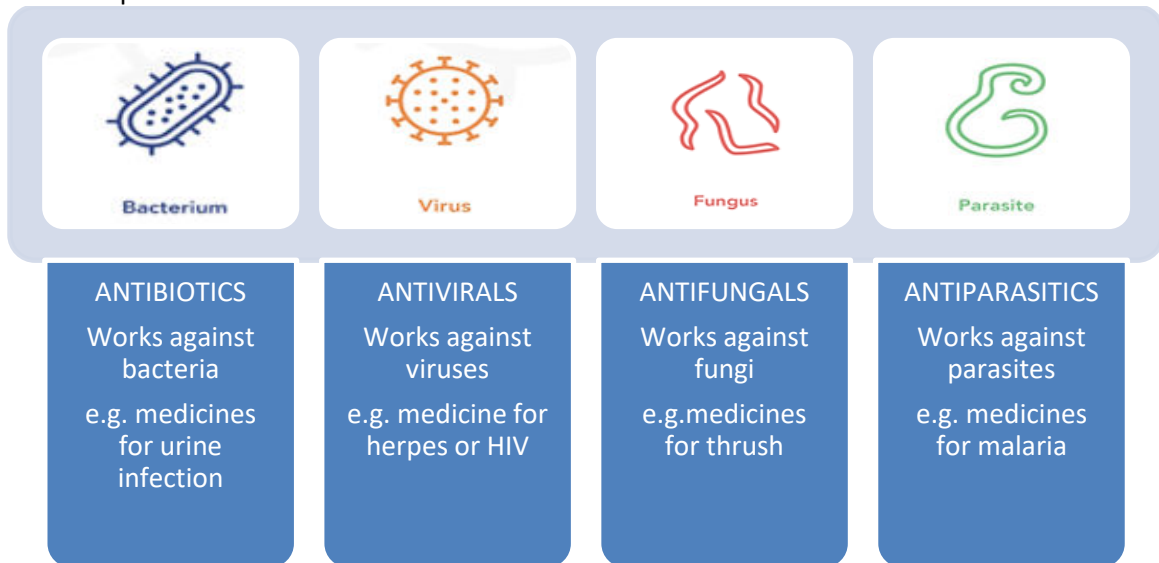
Unlike bacteria, viruses have no ability to live independently. Instead, viruses require a living host cell in which to grow and multiply. These may be the cells of bacteria, fungi, plants, and animals. After entering a host cell, a virus hijacks the host cell and uses the host's cellular machinery to make many copies of itself.

Examples of viruses include:

- Respiratory viruses, such as respiratory syncytial virus (RSV) and influenza
- Systemic viruses, such as measles, rubella, herpes, and varicella-zoster
- Gastrointestinal viruses, such as rotavirus and norovirus
- Bloodborne viruses, such as hepatitis and human immunodeficiency virus (HIV).

Viral infections cannot be treated with antibacterial antimicrobials (i.e. antibiotics). Figure 3.5 shows the appropriate antimicrobial treatments for each different type of microorganism.

Figure 3.5: The spectrum of antimicrobials



Fungi

Fungi are single-celled or multicellular organisms. Most fungi are microscopic and consist of a thread-like branching structures, named hyphae. These branching structures grow into a root-like structure called a mycelium, which absorbs nutrients from the environment. A wide variety of nutrient sources are used by fungi, from soil and water to decaying matter and other living organisms.

Parasitic fungi use specialised hyphal structures that allow them to penetrate host cells. The cell wall of fungi is composed largely of chitin, the same molecule used in the exoskeleton of crustaceans and insects.



Image: *Candida fungi*

Fungi are mostly found in the environment. Yeast, mildew, and mould are types of fungi.

Fungi commonly produce spores when they reproduce. Yeast, such as *Candida* spp., are classified as fungi. Yeasts, however, may be normal flora in certain parts of the body; they can also be invasive opportunistic pathogens.

Aspergillus is a common environmental fungus, which is not usually part of the normal flora of humans.

Most strains of this fungus are harmless, but a few can cause serious illness when people with weakened immune systems, underlying lung disease, or asthma, inhale *Aspergillus* spores. For this reason, dust from construction and renovation work, near or around susceptible hospitalised patients, needs to be contained and monitored.

Prions

Prions are abnormal proteins that replicate in host cells. Prions are not microorganisms but are of significant concern for human and animal health, as they are transmissible, and can cause disease that is rapidly progressive, invariably incurable, and fatal. Prions induce abnormal folding of specific normal cellular proteins (called prion proteins or PrPC), found most abundantly in the brain. This leads to:

- Brain damage
- Chronic encephalopathy
- Associated dementia.

The abnormal proteins of prions are mostly transmitted in healthcare settings via contaminated instruments used during neurosurgery, or other procedures involving contact with neural tissue, such as dentistry. Prions have a long incubation period and are resistant to heat, chemicals, and irradiation. They cannot be cultured and do not trigger an immune response. Human prion diseases are classified as Transmissible Spongiform Encephalopathies and include:

- Classic Creutzfeldt-Jakob Disease (CJD)
- Variant Creutzfeldt-Jakob Disease (vCJD) (mad cow disease).

Other prions are also known to affect animals. There are a number of rare transmissible spongiform encephalopathies (TSEs) which have been found in sheep, goats, cows, deer, cats and some zoo animals. These diseases are not directly transmissible from animal to animal or from human to animal. Bovine Spongiform Encephalopathy (BSE) is fatal neurological disorder which affects cattle and is linked to vCJD in humans. In cattle, BSE is spread through the ingestion of feed stock contaminated with infected meat and bone meal (such as brain and spinal cord). People who have eaten beef or beef products from BSE-infected cattle are at risk of developing vCJD. In Australia, there are not cases cattle infected with BSE.

The Communicable Diseases Network Australia ([CDNA](#)) has developed infection prevention and control guidance on CJD.

Multidrug-resistant organisms

MROs are microorganisms that have developed resistance to the action of multiple antimicrobials (see Table 3.1). Almost all resistance mechanisms are encoded by resistance genes. These can develop because of mutations, or through acquiring plasmids and other mobile genetic elements. Mobile genetic elements, like plasmids, are small pieces of DNA that carry genetic instructions from one bacterium to another.

Table 3.1: Resistance mechanisms of multidrug-resistant organisms

Resistance mechanism (Defence strategy)	Description
Restrict access of the antimicrobial	Restrict access by changing the entryways or limiting the number of entryways. Example: gram-negative bacteria have an outer layer (membrane) that protects them from their environment. These bacteria can use this membrane to selectively keep some antimicrobials from entering into the bacterial cell.
Removal of the antimicrobial	Uses pumps (called efflux pumps) in their cell walls to remove antimicrobials that have enter the cell. Example: some <i>Pseudomonas aeruginosa</i> bacteria can produce pumps to get rid of several different antimicrobials, including fluoroquinolones, beta-lactams, chloramphenicol, and trimethoprim.
Change or destroy the antimicrobial	Change or destroy the antimicrobial with enzymes or proteins that break down the antimicrobial. Example: <i>Klebsiella pneumoniae</i> produce enzymes called carbapenemases, which break down carbapenem and most other beta-lactams.
Bypass the effects of the antimicrobial	Develop new cell processes that avoid using the antimicrobial's target. Example: methicillin-resistant <i>Staphylococcus aureus</i> bacteria can bypass the effects beta-lactams by acquiring a gene that codes for a protein that is not affected by the antimicrobial agent.
Change the targets for the antimicrobial	Many antimicrobials are designed to single out and destroy specific parts (or targets) of bacteria. The bacteria may have genes that change the target so the antimicrobial can no longer fit and do its job. Example: <i>Escherichia coli</i> bacteria with the <i>mcr-1</i> gene can add a compound to the outside of the cell wall so that the antimicrobial colistin cannot latch onto it.

Adapted from: <https://www.cdc.gov/drugresistance/about/how-resistance-happens.html>

Risk factors and treatment

Risk factors for acquiring an infection caused by a MRO include:

- Hospitalisation or recent health care, especially if the patient received antimicrobials
- Living in residential aged care and other communal environments
- Having a developing, waning or compromised immunity (e.g. neonates, the elderly, neutropenic patients, those undergoing organ transplant).

The risk of infection is increased by:

- The presence of indwelling devices
- Long-term antimicrobial use
- Surgical procedures
- Prolonged hospitalisation
- Haemodialysis.

The treatment of an infection caused by an MRO is dependent on the resistance and susceptibility patterns of the microorganism. Often, complex treatment or treatment with greater side effects is required if an infection is caused by an MRO.

Clinical management should involve consultation with an infectious diseases physician, a microbiologist, the infection prevention and control team, and the antimicrobial stewardship team (depending on availability of all these specialists). These specialists will be aware of local [antibiograms](#), which are reports that display the organisms present in clinical specimens and their susceptibility to various antimicrobials.

The Commission has developed a [Specification for a Hospital Cumulative Antibiogram](#), which provides a guide for health service organisations to develop local cumulative antibiograms. The use of cumulative antibiograms is intended to aid antimicrobial stewardship (AMS) programs in the development of local antimicrobial prescribing guidelines and formulary management.

The Commission's [Australian Passive AMR Surveillance \(APAS\)](#) system collects, analyses and reports on AMR data from hospitals and private pathology services across Australia. Participation in APAS also allows laboratories to produce their own local cumulative antibiogram. Where local resistance data are not available, national surveillance data provide a broader picture of antimicrobial resistance in Australia.

Infection prevention and control interventions

Understanding the means of transmission of an infectious agent and knowing how and when to apply the basic principles of infection prevention and control, is critical to preventing and controlling the spread of all infections, including those caused by MROs.

Standard precautions are work practices that provide a first-line approach to infection prevention and control in the healthcare environment and should be adopted by all healthcare workers when caring for all patients, regardless of suspected or confirmed infection status. Standard precautions are used to reduce or prevent the transmission of infectious agents and to render and maintain objects and healthcare settings as free as possible from infectious agents.

Standard precautions include:

- Hand hygiene, consistent with the [5 Moments for Hand Hygiene](#)
- The use of appropriate personal protective equipment
- The safe use and disposal of sharps
- [Environmental cleaning](#)
- Respiratory hygiene and cough etiquette
- [Aseptic technique](#)
- Reprocessing of reusable medical equipment and instruments
- Waste management
- Appropriate handling of linen.

Transmission-based precautions are precautions, used in addition to standard precautions, that interrupt the specific means of transmission of a particular infectious agent. Understanding the means of transmission of an infectious agent is important for deciding the most appropriate transmission-based precautions to use.

There are three categories of transmission-based precautions:

- **Contact precautions** are used when there is a known or suspected risk of transmission of infectious agents by direct or indirect contact
- **Droplet precautions** are used when there is a known or suspected risk of transmission of infectious agents by respiratory droplets
- **Airborne precautions** are used when there is a known or suspected risk of transmission of infectious agents by the airborne route.

For some infectious agents, a combination of precautions may be required (for example, seasonal influenza requires both contact and droplet precautions).

Multidrug-resistant gram-positive organisms

Any organism has the potential to develop resistance to common antimicrobial treatments. However, in the healthcare setting there are several commonly recognised MROs. These include:

- Healthcare-associated methicillin-resistant *Staphylococcus aureus* (HA-MRSA)
- Community-associated methicillin-resistant *Staphylococcus aureus* (CA-MRSA)
- Vancomycin-resistant *enterococcus* (VRE)
- *Clostridioides difficile*.

Staphylococcus aureus

Staphylococcus aureus is a gram-positive coccus that is found readily on the skin and in the upper respiratory tract of healthy humans. At any point in time, one third of humans carry *S. aureus* in their normal flora.

S. aureus is also able to survive in dry conditions in the healthcare environment, such as on bench tops, linen, or bed rails. Transmission is usually person-to-person by direct contact with contaminated hands, or indirectly by contact with contaminated equipment or the environment.

S. aureus can cause a wide range of localised or systemic infections, such as:

- Boils
- Cellulitis
- Endocarditis
- Pneumonia
- Severe sepsis
- Post-operative, catheter-associated and bloodstream infections.

S. aureus has developed many resistance mechanisms, including enzyme production, cell structure changes, and production of toxins, such as haemolysin and exotoxins. The preferred agent for 'susceptible' strains is flucloxacillin (or dicloxacillin), which can be replaced with first-generation cephalosporins, such as cefazolin or cefalexin in penicillin-allergic patients. Treatment depends on the susceptibility pattern of the microorganism to antimicrobial treatment.

Further information on the Commission's work on *S. aureus* can be found [here](#).

Healthcare-associated methicillin-resistant S. aureus

Transmission of HA-MRSA is usually person-to-person by direct contact with contaminated hands, or indirectly, by contact with contaminated equipment, or the environment.

HA-MRSA strains are resistant to beta-lactam antibiotics, such as penicillin, amoxicillin, flucloxacillin and cephalosporins. HA-MRSA strains are often also resistant to erythromycin, clindamycin, aminoglycosides, and fluoroquinolones. When needed, vancomycin is the usual treatment.

Community-associated methicillin-resistant S. aureus

CA-MRSA strains are found in people in both healthcare and community environments. Transmission is usually person-to-person by direct contact, or indirectly from contact with the environment.

CA-MRSA strains are resistant to methicillin but remain susceptible to many other commonly used antimicrobials, as well as vancomycin.

Vancomycin-intermediate/resistant S. aureus

Vancomycin-intermediate/resistant *S. aureus* (VISA/VRSA) is sometimes referred to as glycopeptide-intermediate *S. aureus* (GISA).

VISA/VRSA is usually found in hospitalised patients who have had serious MRSA infections (such as bacteraemia) and required long-term treatment before development of resistance.

Vancomycin-resistant Enterococcus species

Enterococcus spp. are gram-positive cocci found in normal bowel flora. *Enterococcus* spp. are opportunistic pathogens that cause a variety of infections in vulnerable people, such as the very elderly, the immunosuppressed, and those whose physical barriers, are compromised through surgery or invasive devices.

These infections include:

- Urinary tract infections
- Endocarditis
- Bacteraemia
- Wound infections
- Intra-abdominal infections.

Enterococci are naturally resistant to several common antimicrobial classes, including anti-staphylococcal penicillins, cephalosporins, macrolides and lincosamides. More serious infections require treatment with intravenous ampicillin or amoxicillin. Vancomycin is used, instead of ampicillin/amoxicillin, for serious infections in patients who are allergic to penicillins.

Ampicillin resistance has emerged worldwide which has led to increased use of vancomycin. More recently, vancomycin-resistant enterococci (VRE) have also emerged, most notably in:

- *Enterococcus faecium*, and to a lesser extent
- *Enterococcus faecalis*.

There are two main gene complexes that contribute to vancomycin resistance and are transferable to other bacteria:

- *vanA*, which causes resistance to both vancomycin and teicoplanin
- *vanB*, which causes low-level resistance to vancomycin but is susceptible to teicoplanin.

Colonisation with VRE is common. People who are colonised will often show no signs of infection but can transmit the organism to others. Transmission is usually person-to-person by direct contact with contaminated hands, or indirectly by contact with contaminated equipment or the environment.

VRE are often implicated in healthcare-associated outbreaks in intensive care units, transplant units and renal therapy units.

Further information on the Commission's work on VRE can be found [here](#).

Clostridioides difficile

Clostridioides difficile is an anaerobic, spore-forming, gram-positive bacillus often found as part of the normal flora, especially in children younger than two years old. In adults it can be the cause of *C. difficile* infection (CDI), which is a severe, antibiotic-associated, gastrointestinal disease.

The bacterium is ubiquitous in its spore form in natural and built environments. *C. difficile* spores can survive for long periods in the environment and are resistant to heat, desiccation, and chemicals.

C. difficile is not a multidrug-resistant organism, however due to the tough structure of its cell wall, *C. difficile* is known to be naturally resistant to cephalosporins, acquires clindamycin resistance readily and, more recently, has developed resistance to fluoroquinolones. As such, contact precautions, in addition to standard precautions are often used to manage a hospital patient who has a CDI to prevent cross-infection.

Transmission of *C. difficile* occurs by ingestion of spores through person-to-person contact, animal-to-person contact or environment-to-person contact.

The transmission of *C. difficile* can be further reduced by using soap and water to perform hand hygiene, rather than alcohol-based hand rub.

C. difficile multiplies after the normal gut flora are inhibited, due to exposure to medications or procedures that disrupt the normal flora of a person's gastrointestinal system (e.g. certain antimicrobials or protein pump inhibitors, gastrointestinal surgery, endoscopy, or the presence of enteral feeding tubes).

The bacteria damage the gut wall using two main exotoxins:

- Toxin A - an enterotoxin that acts on intestinal mucosa
- Toxin B - a cytotoxin which kills cells.

Clinical manifestations associated with CDI include diarrhoea and pseudomembranous colitis. However, these presentations are generally only observed in individuals infected with toxin-producing strains of *C. difficile*. Non-toxigenic strains of *C. difficile* are sometimes associated with extra-intestinal illness.

Epidemics in Canada, the United States and the United Kingdom have involved outbreaks of hyper-virulent strains of *C. difficile*, that are resistant to fluoroquinolones, and capable of excessive toxin production.

Further information on the Commission's work on *C. difficile* can be found [here](#).

Multidrug-resistant gram-negative organisms

In this section, we'll look at some multidrug-resistant gram-negative organisms, including:

- Aminoglycoside-resistant gram-negative bacteria (ARGN)
- Extended-spectrum beta-lactamases (ESBLs)
- Carbapenemase-producing *Enterobacterales* (CPE).

Aminoglycoside-resistant gram-negative bacteria

Aminoglycoside-resistant gram-negative bacteria (ARGN) are resistant to aminoglycoside antimicrobials, such as gentamicin, tobramycin, and amikacin. The gene for aminoglycoside resistance can be passed from one bacterium to another via mobile genetic elements.

Some of these bacteria are part of normal flora, and some are widespread in moist areas of the environment. Infection by an ARGN is usually caused by an internal (endogenous) source or by contact transmission.

Examples of ARGNs include:

- *Acinetobacter* spp.
- *Escherichia coli*
- *Proteus mirabilis*
- *Klebsiella* spp.
- *Serratia* spp.
- *Enterobacter* spp.
- *Burkholderia* spp.

The most common ARGN is *Pseudomonas aeruginosa*, which is an opportunistic pathogen that primarily affects hospitalised or immunocompromised patients. *P. aeruginosa* is commonly found in moist environments, and is naturally resistant to many chemicals, including most common antimicrobials and some antiseptics. As a result, *P. aeruginosa* frequently causes infections in patients who are receiving antimicrobial treatments for other purposes.

P. aeruginosa can cause urinary tract infection in patients with catheters or structural abnormalities of the urinary tract. It is commonly associated with burn and other wound infections and has a strong propensity to cause chronic persistent airway infection in patients with cystic fibrosis. *P. aeruginosa* also causes septicæmia, especially in neutropenic patients.

Extended-spectrum beta-lactamase (ESBL)-producing bacteria

Beta-lactamases are enzymes produced by gram-negative bacteria that destroy certain beta-lactam antimicrobials (Table 3.2). Some beta-lactamases are encoded on mobile genetic elements (e.g. plasmids), while others are encoded on chromosomes. The genes encoding these enzymes are widespread in hospitals and the community. Extended-spectrum refers to the enzyme's ability to break down the newer third-generation cephalosporins, besides penicillins and earlier generations of cephalosporins.

Table 3.2: Beta-lactam antimicrobials

Beta lactam groups	Examples
Penicillins	<ul style="list-style-type: none"> • <i>Penicillinase sensitive</i>: penicillin G (procaine benzylpenicillin), penicillin • <i>Penicillinase resistant</i>: methicillin, flucloxacillin, dicloxacillin • ampicillin, amoxicillin • ticarcillin • piperacillin
Cephalosporins	<ul style="list-style-type: none"> • <i>First generation</i>: cefazolin, cefalothin, cefalexin • <i>Second generation</i>: cefaclor, cefotetan, cefoxitin • <i>Third generation</i>: cefotaxime, ceftriaxone, ceftazidime • <i>Fourth generation</i>: cefepime • <i>Fifth generation</i>: ceftaroline
Carbapenems	<ul style="list-style-type: none"> • imipenem, meropenem, ertapenem
Monobactams	<ul style="list-style-type: none"> • aztreonam

Examples of ESBL-producing include:

- *E. coli*
- *E. cloacae*
- *K. pneumoniae*.

These microorganisms have great capacity to become multidrug-resistant. Few antimicrobials are available for treatment of highly multidrug-resistant strains, and all are more toxic than the beta-lactamases. When treatment is required, a carbapenem is often used.

ESBLs cause a variety of infections in the healthcare setting and are often associated with poor outcomes. Infection is usually caused by an endogenous source or acquired by contact transmission. Patients colonised with an ESBL can serve as a reservoir for further transmission.

Carbapenemase-producing *Enterobacterales*

Enterobacterales are the largest family of gram-negative bacteria causing human infection. This family includes common pathogens such as:

- *E. coli*
- *K. pneumoniae*
- *Enterobacter cloacae*
- *Proteus* spp.

Enterobacterales colonise the normal human gastrointestinal tract, generally without causing disease. However, they can also cause common infections, including urinary tract infection, abdominal infection, and bloodstream infection. *Enterobacterales* are important human pathogens and vehicles for the dissemination of AMR because:

- Some are normal flora of the gastrointestinal tract
- Most have the potential to colonise people and are highly transmissible (i.e. they are easily spread between individuals)

- Antimicrobial resistance genes can easily spread between different species and strains within the *Enterobacterales* family
- They are the most common gram-negative bacteria to cause human infections in the community and in healthcare settings.

Carbapenemase-producing *Enterobacterales* (CPE) are members of the *Enterobacterales* that are resistant to carbapenems. Carbapenems are the 'last resort' beta-lactam antimicrobials for treating serious infections, and include imipenem, meropenem and ertapenem. The most common way that *Enterobacterales* become resistant to carbapenems is by producing enzymes called a carbapenemase.

CPE are an ongoing threat to public health. Vulnerable patients with comorbidities are at increased risk of developing an infection and consequently dying.

A number of strategies have been shown to reduce transmission CPE. These include the use of standard and transmission-based precautions (including hand hygiene, appropriate patient placement and use of personal protective equipment), increased patient screening, and environmental cleaning and disinfection. Environmental controls, including facility redesign where possible, also minimise the risks associated with environmental reservoirs of CPE.

Further information on the Commission's work on CPE can be found [here](#).

Carbapenemase-producing *Enterobacterales* are one of the critical antimicrobial resistances (CARs) monitored and reported on via the Commission's [National Alert System for Critical Antimicrobial Resistances \(CARAlert\)](#).

Antimicrobial resistance and stewardship

Antimicrobial resistance

Antimicrobial resistance (AMR) is recognised as a significant global health priority. Resistance to antimicrobials is commonly found in Australian hospitals and some resistances are increasing in the community.

Antimicrobial resistance can have a significant impact on:

- Morbidity
- Mortality
- Treatment costs.

The personal and financial costs of AMR include:

- The psychosocial and clinical impact associated with the isolation of patients with MROs
- The need for complex treatments that have a risk of serious side-effects
- The need for additional resources, such as personal protective equipment, special accommodation, and dedicated care equipment, to provide care to the patient and protects the broader patient population and workforce

A significant contributor to AMR is the unnecessary or inappropriate use of antimicrobials. Around one third of all antimicrobial use in health care is unnecessary, or inappropriately prescribed, as shown by the [National Antimicrobial Prescribing Survey](#).

The Commission's [Antimicrobial Use and Resistance in Australia \(AURA\) Surveillance System](#), captures data on antimicrobial use and AMR in human health, to provide a valuable data source to inform clinical practice change, and support policy development for prevention and control of AMR.

Antimicrobial stewardship

Antimicrobial stewardship (AMS) is a suite of coordinated activities which together promote the appropriate prescribing and use of antimicrobials. Antimicrobial stewardship is important at all levels of the healthcare system, to improve the safety and appropriateness of antimicrobial use.

The intention of AMS is to:

- Maximise the benefit of antimicrobials
- Reduce patient harm
- Prevent and contain AMR.

Actions 3.18 and 3.19 of the National Safety and Quality Health Service [Preventing and Controlling Infections Standard](#) describe the elements necessary to support an effective AMS program, and require all health service organisations to have systems in place for the safe and appropriate prescribing and use of antimicrobials.

In addition, this Standard requires health service organisations to act on the results of antimicrobial use and appropriateness audits, to promote continuous quality improvement.

The Commission's [AMS webpage](#) and [Antimicrobial Stewardship in Australian Health Care](#) (the AMS Book) provides more information on AMS in different healthcare settings.

Module 4: Clean and safe healthcare environment

This module has been developed to provide you with an understanding of the basic principles for maintaining a clean and safe healthcare environment. You should refer to your local state or territory guidelines for any local environmental cleaning requirements.

After completing this module, you will understand:

- The role of environmental cleaning in reducing the transmission of infectious agents
- The role of risk assessment in environmental cleaning
- Environmental cleaning processes and product selection
- Safe linen and waste management
- Cleaning programs and cleaning schedules
- The role of auditing in environmental cleaning.

Environmental cleaning is a fundamental element of standard and transmission-based precautions and should be incorporated in the infection prevention and control program of every health service organisation.

A safe and clean healthcare environment can be influenced by factors, such as:

- Air and water quality
- Intact and cleanable surfaces
- Cleaning programs and the provision of cleaning equipment
- Waste and linen management programs
- Cleaning, storage, and maintenance of shared patient care equipment
- Provision of personal protective equipment (PPE)
- Provision of hand hygiene products and hand washing sinks
- General decluttering of workspaces.

Every member of the health workforce has a responsibility to maintain a clean and safe environment. For example:

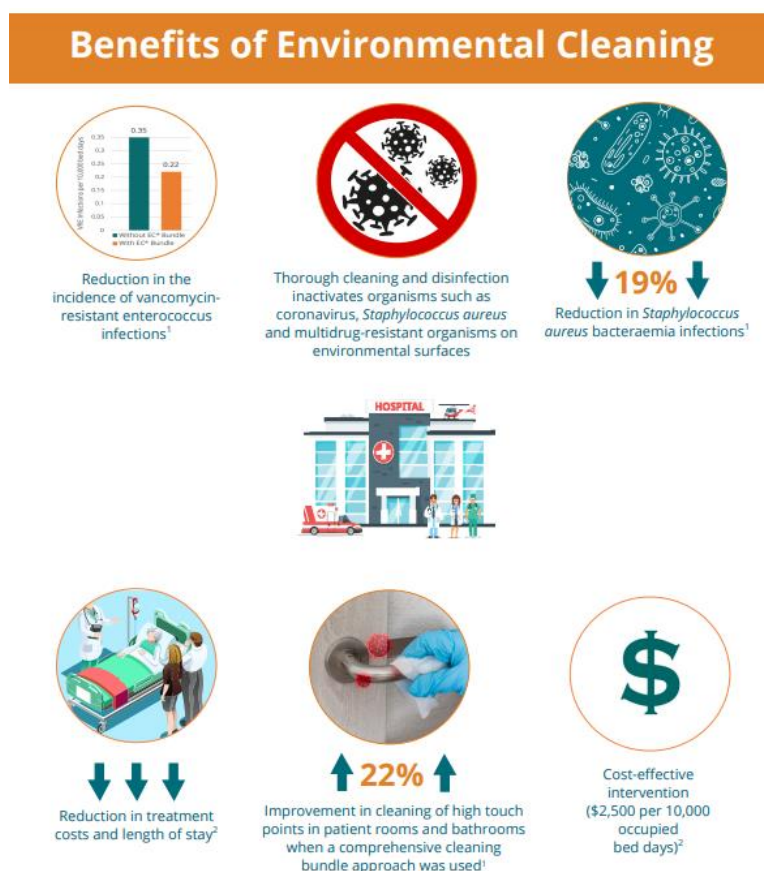
- Clinical staff (e.g. medical, allied health, nursing, and midwifery staff) should know how to clean shared patient care equipment and how to respond to biological spills
- Cleaning staff have a dedicated role in ensuring that the healthcare environment is clean and safe
- Other members of the health workforce may be required to clean their own work environment (e.g. desks, work benches, computers, and phones).

The benefits of a clean and safe healthcare environment include:

- A reduction in infections and transmission of communicable diseases
- A reduction in the financial and personal costs associated with the treatment of infections and length of stay for patients
- Improved patient and healthcare worker safety.

The benefits of environmental cleaning are highlighted in Figure 4.1.

Figure 4.1: Benefits of environmental cleaning



Source: <https://www.safetyandquality.gov.au/publications-and-resources/resource-library/benefits-environmental-cleaning-infographic>

The [National Safety and Quality Health Service \(NSQHS\) Standards](#) (Action 3.13 of the [Preventing and Controlling Infections Standard](#)) require health service organisations to have processes in place to maintain a clean and hygienic environment, in line with the current edition of the [Australian Guidelines for the Prevention and Control of the Infection in Healthcare](#), and jurisdictional requirements, that:

- Respond to environmental risks, including novel infections
- Require cleaning and disinfection using products listed on the [Australian Register of Therapeutic Goods](#) (ARTG) consistent with manufacturers' instructions for use and recommended frequencies
- Provide access to training on cleaning processes for routine and outbreak situations, and novel infections
- Audit the effectiveness of cleaning practice and compliance with its environmental cleaning policy
- Use the results of audits to improve environmental cleaning processes and compliance with policy.

In addition, Action 3.14 of the NSQHS Standards require health service organisations to have processes to evaluate and respond to infection risks for:

- New and existing equipment, devices and products used in the organisation
- Clinical and non-clinical areas, and workplace amenity areas
- Maintenance, repair and upgrade of buildings, equipment, furnishings, and fittings
- Handling, transporting, and storing linen
- Novel infections, and risks identified as part of a public health response or pandemic planning.

Environmental cleaning in the healthcare environment

Why is environmental cleaning important?

There are two main reasons why environmental cleaning is important for all health service organisations.

Firstly, environmental cleaning is one of the most effective ways to interrupt the transmission of infectious agents, to prevent infection and outbreaks of infectious diseases. As described earlier in this Workbook, microorganisms can be transferred from environmental surfaces and equipment on the hands of healthcare workers. These microorganisms potentially can be transmitted to a patient or another individual or may contaminate other surfaces touched by the healthcare worker and may cause subsequent infection.

Many microorganisms will survive on environmental surfaces for long periods of time if left undisturbed. For example:

- Viruses, such as Hepatitis B and C, are known to survive in dried blood on environmental surfaces and equipment surfaces; and influenza can be transmitted by contact with contaminated surfaces
- Bacteria, such as methicillin-resistant *Staphylococcus aureus* (MRSA) and the spores of *Clostridioides difficile*, can be present in dirt and dust that has settled on surfaces
- Fungi, such as *Candida* and *Aspergillus*, occur naturally in the environment in soil and vegetation, but can also be present on indoor environmental surfaces and in wet areas, such as bathrooms and kitchens. Renovations and construction work can also release fungal spores into the air.

Contaminated environmental surfaces and equipment have been linked to outbreaks of infectious diseases in healthcare settings.

For more information on the risk of transmission of specific microorganisms and infectious agents, refer to module 2: [Risk management for infectious agents and diseases](#) of this workbook.

Secondly, healthcare consumers and healthcare workers expect health service organisations to provide facilities that are clean and hygienic. A visually clean and hygienic environment that is well maintained, free of clutter and unnecessary items, supports a health consumer's right to access safe and high-quality care in an environment that makes them feel safe.

What is the healthcare environment?

The environment in a healthcare setting includes:

- Floors, walls, and the ceiling
- Furnishings, such as curtains, bedside lockers, beds, and chairs
- Fittings, such as taps, sinks, light switches, and door handles
- Patient care equipment, e.g. shower chairs, walkers, wheelchairs.

Health service organisations should refer to the [Australasian Healthcare Facility Guidelines](#) for guidance on facility design, including furnishings and fittings. These guidelines provide information on the recommended elements for facility design that are consistent with infection prevention and control requirements.

What is environmental cleaning?

Environmental cleaning includes the cleaning of the physical environment and patient care equipment to remove dirt and microorganisms from surfaces, so that the environment and equipment is clean and hygienic for both healthcare consumers and healthcare workers.

How often is environmental cleaning required?

A risk assessment should be carried out for each department of a health service organisation to identify infection risks and the frequency of cleaning to minimise the infection risks to patients, visitors, and all members of the health workforce. The principles of risk assessment for environmental cleaning are discussed in [Module 2 Risk management for infectious agents and diseases](#) of this workbook.

Health service organisations should refer to their local or jurisdiction for guidance on how frequently to clean different functional areas within a facility. Areas identified as high risk for infection will need more frequent cleaning, such as twice daily or more often, and areas with a low risk for infection may need less frequent cleaning, such as daily or less often. Determining [risk ratings](#) for different areas will be discussed in detail later in this module.

The frequency with which environmental surfaces and equipment should be cleaned is usually determined by how frequently an area or item of equipment is used, and the types of patients or services that use the area or item of equipment. Environmental and equipment cleaning can be prioritised as follows:

1. Environmental surfaces and equipment must always be cleaned if they are visibly dirty
2. Surfaces that are soiled with blood or body fluids must always be cleaned and disinfected immediately to avoid blood and body fluid exposure to members of the health workforce and patients
3. Shared patient equipment and patient rooms must always be cleaned between patient use (e.g., before and after patient use, before returning equipment to storage and after a patient is discharged)
4. Frequently touched surfaces (such as light switches, handrails, door handles), high traffic zones (such as corridors, ambulance bays, waiting rooms), clinical departments/wards, procedural units, bathrooms, and toilets should be cleaned at least daily or more frequently
5. Other surfaces (such as minimally touched surfaces like floors, walls, ceilings, windows, and blinds) and environments (such as non-clinical areas) may require less frequent cleaning
6. Workstations on wheels and shared computer stations should be cleaned between use by different operators
7. Reception desks and write up areas should be kept free of clutter to facilitate daily cleaning.

Figure 4.2 highlights the frequently touched areas in a patient zone. These areas are usually heavily contaminated with microorganisms and require more attention when cleaning.

Figure 4.2: Image of the patient zone with frequently touched surfaces highlighted in yellow



Other factors that influence how frequently an area may need to be cleaned include:

- The type of activity that occurs in an area and the potential for contamination with blood, body fluids, dust, or dirt
- The number of people who use the area
- The type of environmental surfaces/equipment in an area, particularly the ability of these surfaces to support the growth of infectious agents (e.g., porous material, fluid-repellant surfaces)
- Moisture, temperature, and light levels, which can influence the growth and survival of infectious agents on environmental surfaces.

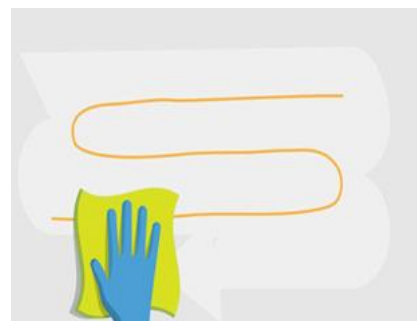
Cleaning techniques and cleaning frequency may need to be adjusted depending on these factors.

Each health service organisation should develop a cleaning schedule and program based on the local level of infection risk. The cleaning schedule and program will provide guidance on the type of cleaning required, and the frequency of cleaning in each area of the health service organisation. [Cleaning schedules](#) will be covered in more detail later in this module.

Cleaning methods

How is environmental cleaning performed?

Cleaning of environmental surfaces and patient care equipment involves the physical removal of dirt and microorganisms from all surfaces, so that the environment and equipment is clean and hygienic for both healthcare consumers and healthcare workers. This is done by wiping over surfaces with a cloth, using a neutral detergent and water, using an S-shaped motion.



Tip: Using an **S-shaped motion** stops dirt and infectious agents from being spread back over the area that has just been cleaned.

Steps used for cleaning surfaces and equipment:

1. Wipe the surface with a neutral detergent solution, using an S-shaped motion
2. Allow the neutral detergent to remain on the environmental surface for the recommended contact time advised by the detergent manufacturer
3. Allow the surface to completely dry.

Disinfection may be required if the environmental surface and or shared patient care equipment is contaminated with blood or a body fluid or a resistant infectious agent. There are two processes that are commonly used for cleaning with a disinfectant in the healthcare setting: a two-step process or a two-in-one process.

Two-step process

Step 1: All environmental surfaces are cleaned first with a neutral detergent and water to remove dirt, dust, and organic matter (such as, blood and body fluids). The neutral detergent is allowed to remain on the environmental surface for the recommended contact time advised by the detergent manufacturer, then the surface is allowed to completely dry.

Step 2: If the environmental surface has been contaminated with blood, body fluids or an infectious agent, a disinfectant solution is applied to the surface after initial cleaning with a neutral detergent. The disinfectant is allowed to remain on the environmental surface for the recommended contact time advised by the disinfectant manufacturer, to kill or inactivate infectious agents, then the surface is allowed to completely dry again.

Two-in-One-step process

A cleaning solution that contains both a neutral detergent and a disinfectant is used to clean and disinfect environmental surfaces. The solution is allowed to remain on the environmental surface for the recommended contact time advised by the product manufacturer, then the surface is allowed to completely dry.

Cleaning products and equipment

[Action 3.13](#) (Clean and safe environment) of the NSQHS Standards, requires that health service organisations use products for environmental cleaning that are listed on the [Australian Register of Therapeutic Goods](#) (ARTG). This recommendation applies to all areas of a healthcare facility including clinical and non-clinical areas.

The recommendation to use ARTG-listed cleaning products ensures that health service organisations are using safe and effective cleaning products that meet their local needs. The Therapeutic Goods Administration's testing methods ensure that the products listed on the ARTG as a hospital-grade disinfectant meets the manufacturer's claims for antimicrobial action against infectious agents.

There are two main types of products used for environmental cleaning in the healthcare setting - neutral detergents and disinfectants.

Neutral detergents

A neutral detergent is a solution that contains a surfactant. A surfactant is a chemical that facilitates the removal of dirt and organic matter. Most hard surfaces can be adequately cleaned with warm water and a neutral detergent as per the manufacturer's instructions.

Disinfectants

A disinfectant is a chemical agent that rapidly kills or inactivates most infectious agents. Disinfectants must not be used instead of detergents. Disinfectants should only be used if required, and only after cleaning with a neutral detergent, or in a combination cleaning agent (detergent/disinfectant). When assessing and selecting a disinfectant in the healthcare setting, product factors, such as kill claims, wet contact time, compatibility, safety, ease of use and value for money, should be considered. Table 4.1 provides a list of questions to consider when selecting a disinfectant for cleaning in a healthcare facility.

Table 4.1: Questions to ask when selecting disinfectants for healthcare facilities

Factors to consider	Questions to ask
Kill claims	Does the product: <ul style="list-style-type: none"> • Kill pathogens that cause most healthcare -associated infections, outbreaks, and are a major issue in our facility? • Have sustained activity once used on surface? • Work in the presence of organic matter (blood, sputum, faeces)? • Testing match real life scenarios? • Kills pathogens quickly?
Wet contact times	<ul style="list-style-type: none"> • Is it fast acting? • Does it keep surfaces wet for enough time to kill pathogens? • How long before the disinfectant evaporates? • Is the product inactivated by organic material?
Compatibility	<ul style="list-style-type: none"> • Is it compatible with the surfaces in our facility? • Is it compatible with other products in use? • Is it compatible with medical equipment?
Safety	<ul style="list-style-type: none"> • What is the toxicity rating? (consider exposure of staff, visitors, and patients) • Is it approved by a relevant regulatory body? • What personal protective equipment will be required?
Ease of use	<ul style="list-style-type: none"> • Does it come in the forms that our facility needs (wipes, sprays, liquids)? • Are the instructions clear? • Does it need dilution or is it a ready-made solution? • Is it a two-in-one or one step product? • How much training will be required and who will provide this training? • Can the product help you to standardised practices in your facility?
Value for money	<ul style="list-style-type: none"> • Is it the most cost-effective option? (consider product capabilities, efficiencies through improvements in cleaning compliance/ standardisation and potential transmission avoided)

Source: <https://www.safetyandquality.gov.au/publications-and-resources/resource-library/fact-sheet-principles-environmental-cleaning-product-selection>

Cleaning with a disinfectant is only necessary when:

- Cleaning surfaces (including floors) suspected, or known, to have been contaminated by a multidrug-resistant organism (MRO), an infectious agent with outbreak potential, and/or, other potentially infectious material, including blood and body fluids
- Cleaning in high or extreme risk settings, according to local risk assessment
- Undertaking discharge cleaning for a patient with an infection or a colonisation caused by an MRO or another infectious agent.

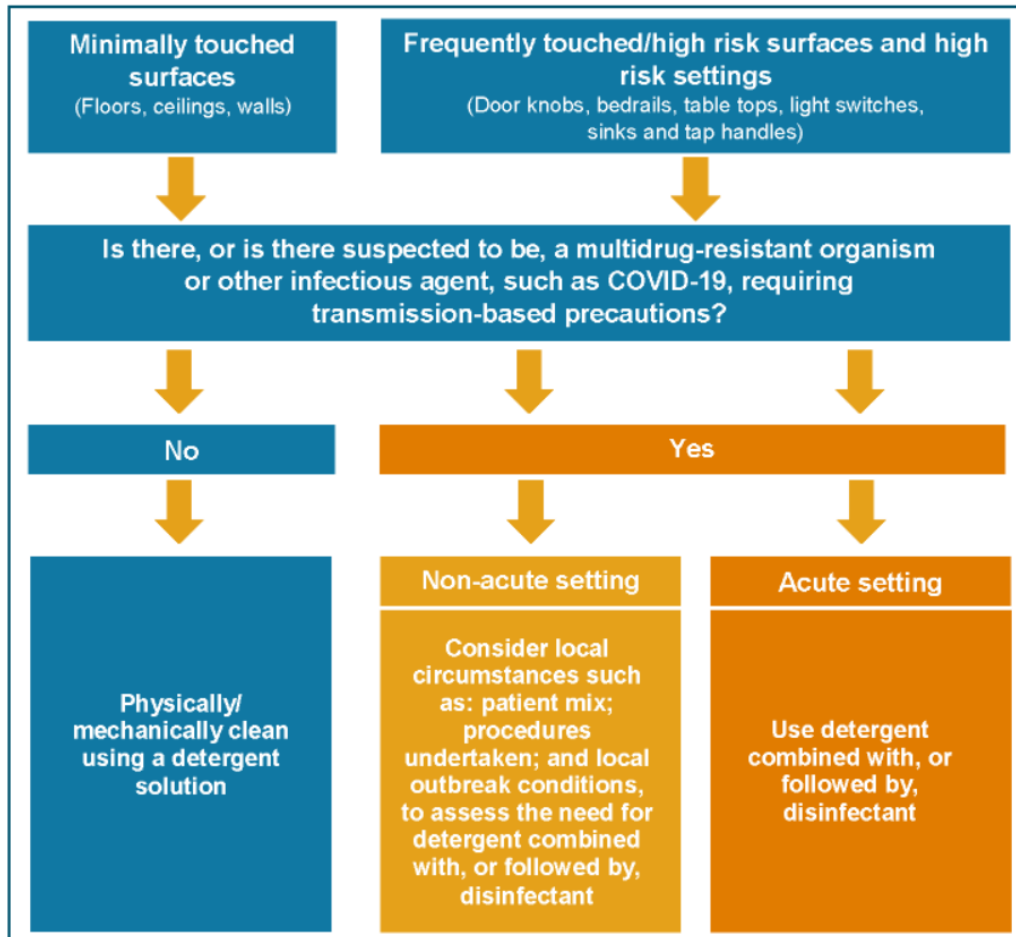
For a disinfectant to work effectively (i.e. kill the infectious agents on a surface), the disinfectant must:

- Have enough contact time with the surface to kill the infectious agent
- Be used at the correct concentration
- Be applied to a clean, dry surface
- Be effective against the specific infectious agent.

All cleaning products should be prepared daily, or as needed, and replaced with fresh solution frequently or when the solution becomes contaminated. Once a solution has been prepared, it should be dated and discarded after 24 hours. Figure 4.3 provides guidance on when to use a disinfectant in addition to a neutral detergent for environmental cleaning.

Tip: If using contact precautions, in addition to standard precautions, when caring for a particular patient, you will most likely need to clean the patient zone and equipment using both a detergent and a disinfectant.

Figure 4.3: When to use a disinfectant in routine cleaning



Source: <https://www.safetyandquality.gov.au/publications-and-resources/resource-library/flowchart-process-and-product-selection-routine-environmental-cleaning>

Cleaning equipment

It is essential that cleaning products and equipment selected for use in a health service organisation are specifically labelled and intended for the purpose of cleaning. Staff should only use cleaning products and equipment supplied and approved by the health service organisation that are in good condition and working order. This includes mops, buckets, appropriate personal protective equipment, cleaning cloths and cleaning solutions. These products should be used as per the manufacturers' instructions.

Staff who undertake environmental cleaning should have access to an appropriate water supplies, sink/floor drainage and suitable facilities for equipment and chemical storage.

All cleaning equipment should be cleaned and dried between uses. Mop heads should be laundered daily after use on a patient's environment and after contamination with an infectious agent. If a cleaning cart is used, there should be separation between clean and soiled items and the cart should be thoroughly cleaned at the end of the day. Reusable cleaning equipment can be colour-coded to restrict the use of specific items, such as mops and clothes, to designated areas, such as bathrooms, kitchens, or isolation rooms only.

Cleaning equipment that is designated for single use only should be appropriately disposed of immediately after use. In the interest of environmental sustainability, reusable items should be used in preference to single-use items wherever it is safe to do so.

Cleaning patient care equipment

Equipment used for patient care should be cleaned frequently, and before and after each use. Patient care equipment includes medication trolleys, mobile workstations, IV poles, pumps, physiotherapy equipment, wheelchairs, or beds. Shared patient care equipment can act as a reservoir for microorganisms and enable microorganisms to be transferred between patients.

Most patient care equipment can be cleaned with a neutral detergent; however, it is important to first refer to the manufacturer's instructions for how to clean each piece of equipment and which cleaning products are suitable to use. Some items may require special servicing to clean them.

Health service organisations should develop processes for the cleaning of patient care equipment which includes instructions on the use of suitable cleaning products, the removal of stains, sticky marks and dust from surfaces, and appropriate storage of cleaned patient care equipment.

Tip: Only use cleaning solutions recommended by the equipment's manufacturer. Some cleaning solutions may not be compatible with all materials used in the manufacturing of patient equipment and may degrade or damage these materials over time. Damaged equipment may become an infection control and patient safety risk.
The manufacturer's warranty may also be void if the manufacturer's instructions for use are not followed.

The TGA regularly publishes information on products that may not be compatible or suitable for use in the healthcare setting. This information can be found at the [Australian Register of Therapeutic Goods website](#).

Management of biological spills

Biological spills are spillages of blood and body fluids, such as urine, faeces, vomit, and sputum. The prompt removal of all spots and spills of blood and body fluids ensures a safe and hygienic environment, and meets infection prevention and control, and work health and safety requirements. All clinical staff should be provided with training on how to manage a biological spill and signage should be used to indicate where spill kits are stored and how to use them. Table 4.2 provides details on the process for managing biological spills in the healthcare environment.

Table 4.2: Management of biological spills

Volume of spill	Process
Spot cleaning	<ul style="list-style-type: none"> • Select and put on appropriate personal protective equipment (PPE) • Wipe the spot immediately with a damp cloth, tissue, or paper towel • Discard contaminated materials into an appropriate waste bin • Remove PPE in the correct sequence and perform hand hygiene
Small spills (up to 10cm diameter)	<ul style="list-style-type: none"> • Select and put on appropriate PPE • Wipe spill immediately with absorbent material • Place contaminated absorbent material into an impervious container or plastic bag for disposal – discard into an appropriate waste bin • Clean the area with warm detergent solution, using a disposable cloth or sponge • Remove PPE in the correct sequence and perform hand hygiene
Large spills (greater than 10cm diameter)	<ul style="list-style-type: none"> • Select and put on appropriate PPE • Cover the area of the spill with an absorbent clumping agent and allow to absorb • Use a disposable scraper and pan to scrape up absorbent material and any unabsorbed blood or body fluid • Place all contaminated items into an impervious container or plastic bag for disposal • Discard contaminated materials into an appropriate waste bin • Mop the area with a neutral detergent solution • Wipe the area with disinfectant and allow to dry • Remove PPE in the correct sequence and perform hand hygiene

Source: Table 6, Section 3.1. [Australian Guidelines for the Prevention and Control of Infection in Healthcare](#)

Each clinical area in a health service organisation should have a basic spill kit to manage biological spills. A spill kit should include the following equipment:

- A list of equipment and instructions for use
- A scoop and scraper
- Single-use personal protective equipment (PPE) including gloves, protective apron, surgical mask, and protective eyewear
- Absorbent agent to absorb liquids
- Clinical waste bags and ties.

Detergent and disinfectant should be supplied by the health service organisation.

Managing chemical and other spills in the healthcare setting

Besides spill kits for the management of biological spills, some health service organisations may have specialised spill kits to manage spills of hazardous chemicals and materials, such as cytotoxic or radiological material, or other hazardous chemicals used for medical treatments. Many hazardous chemicals and materials also carry a risk of fire, explosion, injury, poison or damage to person or property, and may be incompatible with other chemicals (such as cleaning solutions). [SafeWork Australia](#) provides recommendations for the safe handling and storage of these types of hazardous chemical and materials. The health service organisation should provide staff responsible for handling and using hazardous chemicals and materials with instruction, training, and equipment for storing, handling, and managing hazardous chemicals and materials. Signage should be used to indicate where chemical spill kits are stored and how to use them.

The management of hazardous chemical and material spills requires specialised training and equipment, and is not covered by this Workbook or module: Clean and safe healthcare environment

Linen management

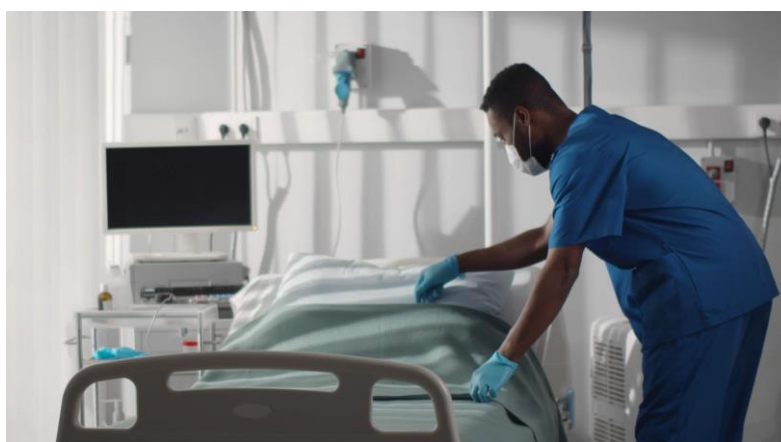
All clean linen used in the health service organisation should be stored in a dedicated space for clean linen only. This space should be separate to storage space for dirty/used linen and should be designed to protect the clean linen from contamination by aerosols, dust, moisture, and vermin. Linen stored on trolleys can be covered with clean covers or stored in clean cupboards with the doors closed to protect clean linen from contamination.

Used linen should be stored in a separate area, away from clean linen and the clinical area. Used linen should be handled carefully. Staff should always use standard precautions when handling used linen. For example, hand hygiene must be performed after all contact with used linen, regardless of whether the linen is visibly soiled. In some circumstances, staff may need to use transmission-based precautions and standard precautions if there is a risk that the linen is contaminated with a highly infectious agent.

When changing used linen, staff should take a linen bag to where they are working to avoid carrying the used linen through the clinical area. This reduces the risk of exposure to infectious agents to healthcare workers and the clinical area. If the used linen is soiled with a body fluid, it should be placed into a leakproof bag and sealed to prevent spills. Clean linen that has been removed from a clean linen stock trolley and decanted to a small trolley (for bed making) must not be returned to the stock of clean linen, but should be discarded into a linen bag to prevent contamination of the clean stock of linen for that department.

To prevent injury to the person handling the linen bag and spillage, linen bags should not be over $\frac{3}{4}$ full. Linen transport trolleys used to transport linen to and from clinical areas should be cleaned after use and, separate trolleys should be used to be used for clean and dirty linen transport.

Health service organisations should refer to [AS/NZ 4146:2000 Laundry Practice](#) for guidance on the storage, handling and laundering of linen used in the healthcare facility.



Waste management

All waste that is generated in the clinical area must be handled with care. All staff should be trained on how to segregate waste and to always use standard precautions when handling waste. For example, staff should wear PPE, such as gloves and an apron, to protect themselves from contamination with infectious agents and perform hand hygiene after contact with all waste. In some circumstances, staff may need to use transmission-based precautions, and standard precautions, if there is a risk of exposure to highly infectious material in the waste.

Where practical, all waste should be disposed of at the point of generation to prevent contamination of the broader healthcare environment and disposed of into the appropriate waste receptacle. Waste bins should be leakproof containers and have lids that close to prevent spillage.

All waste must be stored and transported safely. Large transport waste bins should have lids to prevent spillage. Waste storage areas should have lockable doors, and be located away from public spaces, clinical and food preparation areas. Ideally, health service organisations should have processes for transporting waste through the organisation that avoid transporting the waste through patient and public areas, clean clinical spaces, and food preparation areas. This may involve the use of dedicated lifts or corridors for waste transportation. Health service organisations should also have processes in place, including the engagement of licensed services, for the regular removal of all types of waste.

Waste should be disposed of according to local waste management plans and jurisdictional requirements. Health service organisations should also refer to Standard AS/NZS 3816: 2018. Guides and other resources produced by the [Waste Management and Resource Recovery Association of Australia](#), including the [Industry Code of Practice: Managing Biohazardous Waste \(Including Clinical and Related Wastes\)](#) may also be useful for health service organisations.

A number of different categories of waste are generated by health service organisations. These categories include:

- **General waste** is the most frequently generated waste, and includes most items used in the clinical and non-clinical setting

- **Clinical waste** is any waste that can potentially cause injury, infection, or offence. Examples of clinical waste include:
 - Anatomical waste
 - Clinical waste/pathology waste
 - Radioactive waste
 - Cytotoxic waste
 - Pharmaceutical waste

- **Clinical sharps waste** includes any items such as hollow bore needles or catheters, and non-hollow bore items including glass vials, dental probes, scalpel blades, suture needles, retractors, skin or bone hooks, wires, electrosurgical tips. Sharps containers should be clearly labelled, puncture and leak proof, and conform to [Standards AS 4031: 1992 and Amendment 1: 1996, AS/NZS 4261: 1994 and Amendment 1: 1997](#) or relevant international standard e.g. [ISO 23907: 2019](#). Containers used for sharps waste should be located at the point of use or, if this is not possible, as close as practical to the area of use. Reusable sharps requiring transport to a reprocessing area must be placed in a puncture-resistant lidded container
- **Food waste** in the healthcare setting can include organic food material, oils, liquids, and food packaging. Like other forms of waste, the different waste material should be segregated and stored appropriately. Organic food waste must be stored in a manner to prevent attracting vermin and insects, and away from food storage and preparation areas.

Environmental sustainability and recycling

Action 3.03 of the [Preventing and Controlling Infections Standard](#) (Applying quality improvement systems), requires health service organisations to apply quality improvement systems that support and monitor the safe and sustainable use of infection prevention and control resources. Health services use immense amounts of resources and generate vast amounts of waste in delivering care to their patients. Improving the environmental sustainability of health services is an opportunity to improve the safety and quality of care, reduce low value care, unwarranted variation and reduce waste. To effectively mitigate and adapt to future sustainability, health services need to plan for the foreseeable effects of climatic events and take opportunities to deliver sustainable health care.

Sustainability can be defined:

1. The hazards that climatic change and environmental destabilisation pose to the delivery of future health services and the population's health, and
2. The effect that health service organisations pose to the climate and environment through emissions, waste production and supply chains when delivering care or when utilising low value models of care.

The environmental impact of the daily operations of a health service organisation should not be underestimated. Services, such as environmental cleaning and waste management, should assess and implement strategies that can deliver environmentally sustainable and adaptable services across all sectors of a health service organisation. Factors to consider should include, but are not limited to:

- Minimising the organisation's carbon footprint
- Water management, including minimising water utilisation and wastage, and identifying opportunities for water conservation
- Minimising the use of toxic cleaning products
- Options for reprocessing equipment.

Wastewater management

Health service organisations need to consider strategies for managing and reducing wastewater. In the healthcare setting, wastewater contamination can occur from procedures, such as dialysis, pharmaceutical compounding and disposal processes, and chemicals used for cleaning and disinfection. For example:

- **Renal dialysis** produces large volumes of wastewater. Reverse-osmosis reject water is generated before patient dialysis and is essentially clean water. Spent dialysis effluent is the wastewater produced during dialysis and contains blood cells. Both reverse-osmosis reject water and spent dialysis effluent are commonly discarded into the sewer system
- The disposal of **antimicrobial** and other clinical waste, such as faecal matter, into wastewater may also contribute to the proliferation of environmental MRO reservoirs, such as *carbapenemase-producing Enterobacteriales*, in the healthcare settings (see [AURA 2021 and the 2021 Recommendations for the control of carbapenemase-producing Enterobacteriales \(2021 CPE Guide\) for more information](#))
- **Cleaning chemicals** and **pharmaceuticals** can contain toxins that may be harmful to animals and the environment when discarded into sewage systems.

[Action 4.14](#) (Safe and secure storage and distribution of medicines) of the NSQHS Standards recommends that health service organisations comply with manufacturers' directions, legislation, and jurisdictional requirements for the disposal of unused, unwanted, or expired medicines. States and territories, as well as peak pharmaceutical advisory bodies, can provide guidance on the safe disposal of pharmaceuticals. Health service organisations should educate staff on the safe handling and disposal of pharmaceuticals and chemicals. Health service organisations should consider alternative uses for wastewater, alternative means of disposal of chemicals and options to recycle clean wastewater, such as reverse osmosis reject water, to reduce the environmental impact.

In some regions of Australia, there is a risk of water shortages. Health service organisations should be aware of options for reducing water wastage and implementing water re-use strategies in relation to storm water, grey water, and treated sewage, where feasible. For more information on safe water reuse, see the [Australian guidelines for water recycling](#).

Waste generation and management also should include consideration of environmental sustainability. Actions to consider for sustainability include:

- Minimising waste by selecting products with less packaging
- Using reusable items, where safe and clinically appropriate to do so
- Only using equipment if clinically indicated, such as reviewing if a patient really needs an intravenous line or urinary catheter
- Avoid overstocking linen trolleys to minimise amount of unused linen that needs to be re-laundered
- Minimising the use of toxic cleaning products
- The environmental sustainability of emerging cleaning technologies, such as micro-fibre cloths or steam cleaning technology
- Disposal of waste in appropriate containers and waste streams for disposal.

Recycling

Health service organisations can consider recycling programs to minimise waste and reduce the environmental impact of the waste production. General waste can be streamered into paper, glass, metals, and hard and soft plastics (such as peripheral venous catheter intravenous fluid bags and packaging) for recycling. Another option for recycling is retaining expired stock for education and training purposes. As with all other receptacles used to store waste, receptacles used to collect recycling should also be made of materials that can be cleaned.

The role of risk assessment in environmental cleaning

Risk assessment for environmental cleaning is an important element of the health service organisation's wider risk management program. Risk management is an ongoing and proactive activity, which involves systems and processes to identify hazards and assess and control the risks for patients, visitors, and members of the workforce, so far as is reasonably practicable.

Risk management is a four-step process. The steps are:

1. **Identify the hazards** – What are the real or potential hazards that could cause harm in the organisation?
2. **Assess risks** – What are the risks if someone is exposed to these hazards, and how likely is it that someone could be exposed to a hazard in the organisation?
3. **Control risks** – What actions can be taken to control the risk?
4. **Review the control measures** – How effective are the controls that are in place, and how can they be modified as required, to ensure the ongoing safety of everyone?

For more details on risk management refer to [Module 2 Risk Management for infectious agents and diseases](#).

In the context of environmental cleaning, unhygienic and poorly maintained healthcare environments and equipment may result in injury or illness, outbreaks of infectious agents, and damage to environmental surfaces and equipment, such as corrosion or rust. To mitigate these risks, a risk assessment is used to determine and allocate the *level of risk*. Factors which may affect the level of risk include:

- The treatments and services provided in the healthcare setting
- Whether the healthcare setting is a clinical or non-clinical environment
- Whether there are frequently touched/high touch surfaces or minimally touched/low touch surfaces
- Local infection risks, including outbreaks of infectious disease or a high burden of MROs, such as MRSA, vancomycin-resistant *enterococcus* (VRE) and carbapenemase-producing *Enterobacterales* (CPE)
- Whether standard or transmission-based precautions are in use.

The information from the risk assessment is then used to determine the type and frequency of cleaning required in a particular healthcare setting to protect patients, visitors and healthcare workers from risks associated with the specific hazards unique to that environment. Table 4.3 provides examples of risk levels assigned to specific healthcare settings, based on the outcomes of a risk assessment. For example, an operating theatre complex is assigned an infection risk level of *extreme* because of the high risk of infection to patients during surgery, and the high risk of equipment and environmental contamination with blood and body fluids. In comparison, the risk level in an administration area is low as there are no clinical activities performed in that setting.

Table 4.3: Examples of infection risk levels for healthcare settings

Risk level	Examples (includes connecting areas such as bathrooms, corridors, storerooms)
Extreme	<ul style="list-style-type: none">• Operating theatre complex• Intensive care units• Emergency departments• Labour and delivery wards• Clinical areas with immunosuppressed patients
High	<ul style="list-style-type: none">• General wards• Outpatient clinics with treatment/procedure rooms• Emergency ambulances and other rescue vehicles
Medium	<ul style="list-style-type: none">• Outpatient clinics including consulting rooms and ambulatory care• Residential accommodation• Offices in patient and clinical areas• Kitchenettes, pantry, and other food preparation and storage areas
Low	<ul style="list-style-type: none">• Office/ administration areas

Source: table adapted from: <https://www.safetyandquality.gov.au/publications-and-resources/resource-library/fact-sheet-principles-environmental-cleaning-auditing>

Environmental cleaning risk assessment should be a continual process, undertaken by staff who perform cleaning duties to adjust the type and frequency of cleaning required, based the level of risk. Cleaning frequencies may need to increase in response to emerging evidence, outbreaks of an infectious disease (e.g. gastroenteritis or COVID-19) or in response to internal building works (e.g. causing the generation of dust or fungal spores).

Cleaning schedules and cleaning programs

The information from a risk assessment should be used to inform the development of an organisation-wide or individual department's cleaning schedule.

Cleaning schedules describe the frequency of cleaning and the type of cleaning required to reduce risks and maintain a hygienic and safe healthcare environment. Cleaning schedules will differ, depending on the type of healthcare setting, the current risk level and the types of risk that have been identified. Cleaning schedules need to take into consideration:

- The infection risk level, e.g. which areas have a high or low risk of infection (see Table 4.3)
- Information on frequency of cleaning in different areas, based on the infection risk level
- Information on which cleaning products and techniques should be used in different settings and on different equipment
- Staffing training requirements for equipment, cleaning products, and personal protective equipment use.

Cleaning schedules should be available to all members of the workforce who are responsible for environmental cleaning. Table 4.4 provides an example of a cleaning schedule for a day procedure unit. This cleaning schedule includes the following information:

- Infection risk level for each area of the unit
- The type of cleaning required, including the recommended cleaning product
- The frequency of cleaning in each different area of the unit.

Table 4.4: Sample cleaning schedule for day only endoscopy unit

Frequency of cleaning	Cleaning solution	Area/ Type of activity	Infection risk level
Daily or more often	Neutral detergent, disinfectant for blood, body fluid and MROs	Sterilisation area	Extreme high risk
Daily or more often (e.g., between patient use)	Neutral detergent, disinfectant for blood, body fluid and MROs	Treatment/ procedure areas	High risk
Daily or more often	Neutral detergent, disinfectant for blood, body fluid and MROs	Bathrooms	High risk
Daily or weekly	Neutral detergent	Administration areas	Low risk
Daily or more often	Neutral detergent	Reception and patient waiting area	Low risk, but may increase if patient present with infectious conditions (e.g., MROs, COVID)
Daily or more often	Neutral detergent, disinfectant for blood, body fluid and MROs	Patient recovery area	High risk
Daily	Neutral detergent	Staff room	Medium risk

Source: <https://www.safetyandquality.gov.au/publications-and-resources/resource-library/environmental-cleaning-practices-small-health-service-organisations>

Staff training and safety for environmental cleaning

Health service organisations need to provide training and safe work practices to support members of the health workforce perform their roles. In relation to environmental cleaning and infection prevention and control, staff should be provided with:

- Education on basic infection prevention and control, specifically the use of [standard precautions](#) and [transmission-based precautions](#) and safe work practices that minimise the transmission of infectious agents
- Safe processes and systems of work, including manual handling techniques, safe handling and storage of chemicals and equipment, access to material safety data sheets and personal protective equipment use
- Education on how to clean biological and or chemical spills as appropriate to their role
- Workplaces that are functional and designed to minimise the transmission of infectious agents, for example designated areas for waste storage and disposal that is separate to other workspaces
- Access to reporting systems for compliance and identifying breaches of infection prevention and control protocols
- Training on cleaning processes and techniques
- Training on how to clean, use and maintain cleaning equipment.

Safe processes and systems of work

Developing safe processes and systems of work involves identifying all the factors that are involved with a task and designing interventions that protect workers for injury or harm associated with their work. This is a complex process that should involve managers/supervisors and staff who perform a particular task.

Developing safe processes and systems of work includes identifying:

- How work tasks are performed (the steps involved)
- The complexity of the task
- How frequently the task is performed
- The worker's ability to perform the task (training, skill level, limitations)
- The context/environment in which the task is performed and the resources that are available to perform the task.

For more information on safe systems and processes of work, refer to [Safe Work Australia: Principles of good work design](#)

Manual handling techniques

Manual handling techniques are one intervention that can be used to help reduce the risk of physical injury to workers associated with the duties they undertake in the course of their work. Environmental cleaning is a manual task, which involves lifting, pushing, pulling, carrying, potential exposure to hazardous chemicals, and sometimes operating heavy equipment.

It is important to identify hazardous tasks, and the potential risk for physical injury associated with them, and introduce interventions to minimise or eliminate those risks. For example, hanging clothe curtains using a ladder or moving heavy furniture to clean around. Manual handling techniques should be included as part of staff training for environmental cleaning, and specific training should be provided to staff who operate heavy equipment, such as floor polishers, or handle hazardous chemicals.

For more information on manual handling, see [Safe Work Australia: Model Code of Practice: Hazardous manual tasks](#)

Safe handling and storage of chemicals

All chemicals used for environmental cleaning have the potential to cause harm, illness or injury and must be stored and handled safely. Chemicals used in environmental cleaning can cause skin and respiratory sensitivity or reactions, and some chemicals may be carcinogenic or poisonous. Staff should be provided with:

- Training for handling and storing chemicals
- Appropriate PPE for handling and mixing cleaning chemicals
- Well ventilated environments to mix and store chemicals
- Assess to hazardous material spill kits
- Access to chemical safety data sheets for information on each chemical they use in the course of their work.

For more information on the chemical safety data sheets or specific chemicals used for environmental cleaning, see: [Safety data sheets | Safe Work Australia](#)

Personal protective equipment for cleaning

PPE should always be made available for all members of the workforce who undertake environmental and equipment cleaning.

In relation to environmental cleaning, staff need to have access to protective eyewear, face masks, face shields, aprons, gowns, and gloves (single use or utility gloves) to protect against exposure to infectious agents and chemical used in environmental and equipment cleaning.

Protective eyewear and face shields should always be worn handling or mixing chemicals for cleaning. Protective eyewear is required to protect the staff member for potential splashes from chemicals to the eyes and or face.

Face masks are used to protect a staff from inhaling vapors from cleaning chemicals.

Aprons or protective gowns are used to protect a person's clothing from contact with chemicals, and or infectious agents that maybe present on environmental surfaces and equipment during cleaning.

Gloves are used to protect the staff member's skin from exposure to cleaning chemical and infectious agents that may be present on environmental surfaces and equipment during cleaning. Staff may either use single use gloves, which are disposed of after each use, or reusable utility gloves which can be decontaminated for re-use. [Module 1, Principles of infection prevention and control](#) of this Workbook provides further information on the use of PPE in relation to standard and transmission-based precautions.

For further information on personal protective equipment used for environmental cleaning, see [Safe Work Australia](#)

Environmental cleaning audits

Auditing environmental cleaning checks that environmental cleaning is performed to a high standard to prevent the onset of healthcare-associated infections, thereby ensuring patient safety, and minimising the risk of adverse patient outcomes. Audit outcomes should be reported back to cleaning staff for discussion, and strategies can be developed to improve cleaning practices as required.

When undertaking environmental cleaning audits, the following points should be considered:

- **Who will be undertaking the audit?** This should be someone who has knowledge about environmental cleaning processes, is familiar with the health service organisation, and is trained in environmental cleaning auditing
- **When to audit?** Consider different times of the day to capture different cleaning activities. For example, in patient areas audit early in the morning to observe routine cleaning or later in the day to capture discharge cleaning
- **Where to audit?** A variety of areas should be sampled in each audit to provide a cross section of the cleaning process across an organisation. Each audit should include different locations, such as clinical and non-clinical staff and patient areas. However, if monitoring cleaning performance in a specific location, then that location should be included in each audit.
- **Frequency of audits?** The frequency or timing of environmental cleaning auditing should be based on the frequency of cleaning, as well as:
 - Local risks (for example, higher infection risk areas may require more frequent auditing in response to identified gaps in cleaning processes)
 - The commissioning of new cleaning processes or staff
 - Outbreak management
 - Special project cleaning.
- **What should be included in environmental cleaning audits?** Consider the different requirements and services provided by a health service organisation. Besides auditing cleaning processes of the different areas in a facility, audits may also include:
 - Compliance with linen storage and handling policies
 - Compliance with waste segregation, storage, and handling policies
 - Cleaning and storage of shared patient care equipment.

How to undertake environmental cleaning audits

Visual inspections measure the visual cleanliness that is apparent to patients and visitors and help to identify maintenance issues (e.g., surface degradation) that require rectification.

Objective methods, such as fluorescent gel markers and adenosine triphosphate (ATP) bioluminescence detection systems, can be used to measure the amount of organic material on a surface and the effectiveness of individual cleaning techniques.

Selecting surfaces to audit

A random sample of different surfaces and equipment in the health service organisation should be included in each environmental cleaning audit. For example, a mix of frequently and minimally touched surfaces such as light switches and handrails, bathrooms, patient equipment, kitchens, floors. If comparing audit results for an individual surface over time (e.g. the same tap handle in the same room in the same ward), it is important to record what specific sites have been audited at each audit.

What to do with audit results

Findings from audits should be fed back to all staff who are involved in environmental and equipment cleaning (clinical staff, non-clinical staff, support staff and managers). This information can then be used to modify cleaning processes as required; assess compliance with policies, procedures and protocols used in the organisation for environmental cleaning; identify and repair damaged equipment and surfaces; and improve stock and equipment storage systems.

Auditing environmental cleaning as part of an organisation's quality improvement program can be used to identify, and set priorities for, organisational strategies to prevent and control healthcare-associated infections and manage the risks. Health service organisations should have processes in place to escalate Rectification of damaged surfaces and equipment, which pose an infection and safety risk to patients and the health workforce.

For more information on auditing environmental cleaning, see the Commission's suite of environmental cleaning resources:

- [Principles of environmental cleaning factsheet](#)
- [Environmental cleaning practices for small health service organisations](#)
- [Environmental cleaning: information for cleaners](#)
- [Environmental cleaning: Emerging environmental cleaning technologies](#)
- [Principles of environmental cleaning: product selection](#)

Module 5: Basics of surveillance and quality improvement

This module provides an understanding of the basic principles of surveillance and quality improvement that should be used as part of an organisation's infection prevention and control program. By completing this module, you will understand:

- The importance of surveillance in infection prevention and control
- The essential components of an infection surveillance program
- The importance of data quality in infection surveillance
- The national systems for infection surveillance
- The purpose of quality improvement
- The elements of successful quality improvement systems
- The main components of a quality improvement system for infection prevention and control.

The [National Safety and Quality Health Service \(NSQHS\) Preventing and Controlling Infections Standard](#) (Action 3.05) requires health service organisations to have a surveillance strategy for infections, infection risk, and antimicrobial prescribing and use, that:

- a. Incorporates national and jurisdictional information in a timely manner
- b. Collects data on healthcare-associated and other infections relevant to the size and scope of the organisation
- c. Monitors, assesses, and uses surveillance data to reduce the risks associated with infections
- d. Reports surveillance data on infections to the workforce, the governing body, consumers and other relevant groups
- e. Collects data on the volume and appropriateness of antimicrobial use relevant to the size and scope of the organisation
- f. Monitors, assesses, and uses surveillance data to support appropriate antimicrobial prescribing
- g. Monitors responsiveness to risks identified through surveillance
- h. Reports surveillance data on the volume and appropriateness of antimicrobial use to the workforce, the governing body, consumers, and other relevant groups.

Staff responsible for the implementation of a health service organisation's infection prevention and control program should know:

- The different types of surveillance methods that can be used to monitor the risk or incidence of infection
- The basic statistical methods to interpret surveillance data
- How to report surveillance data
- How to use surveillance data to respond to changes in the risk or incidence of infection, using a quality improvement approach.

What is surveillance for infection prevention and control and why is it important?

Surveillance is an epidemiological practice by which the spread of disease and/or infection is monitored to establish patterns of progression. Appropriate surveillance to monitor the risk or incidence of infection can inform strategies to reduce the incidence of healthcare-associated infections (HAIs) and substantially reduce the morbidity and mortality associated with these infections. The scope of infection surveillance can be very broad. While this course focuses on the use of surveillance in the context of monitoring and responding to HAIs, there are other forms of surveillance that support infection prevention and control programs, such as environmental cleaning auditing, hand hygiene compliance auditing, or monitoring compliance with correct and appropriate use of personal protective equipment.

The surveillance of antimicrobial use as part of a health service organisation's antimicrobial stewardship (AMS) program is also relevant to infection prevention and control, particularly in the context of the management of multidrug-resistant organisms (MROs). Surveillance of antimicrobial use is not covered in this module. Information on AMS, and the surveillance of antimicrobial use, can be found [here](#) on the Commission's website.

The main purpose of infection surveillance is to improve the quality of care provided to patients to optimise their clinical outcomes and improve the patient experience. Surveillance data can be used to model, observe, and minimise the harm caused by infection. Surveillance data can also be used to evaluate the effectiveness of current infection prevention and control strategies and inform quality improvement action to prevent further transmission and disease.

Surveillance is an important infection prevention and control activity because it provides information on:

- Whether there is an infection problem
- The magnitude of the problem
- The factors that contribute to the onset of infection
- The impact of existing infection prevention and control strategies
- Where to target interventions to improve and minimise the risk of infection.

Health service organisations can use this information to develop strategies to minimise the risk of infection and improve patient safety. Timely feedback and reporting of surveillance data to stakeholders is critical to support effective change.

What are the components of an infection surveillance program?

It is important to ensure that infection surveillance data accurately reflects the clinical outcome or process that is of interest and can be compared with historical data or data from other organisations. Infection surveillance data should also be provided to and understood by relevant audiences, including a health service organisation's clinicians, executives, healthcare consumers and carers.

These goals can be achieved by using the most appropriate:

- Surveillance designs
- Data collection processes
- Statistical methods to analyse the data
- Methods to provide feedback and report findings.

Surveillance design

Surveillance design is the approach that is used to collect information about a particular disease or infection. When considering which surveillance design is most suitable, the following points should be considered:

- The purpose of the surveillance
- The duration of surveillance
- The target of the surveillance
- At what point data collection is required
- The resources available for surveillance in the short and long term
- The size, service complexity, and role delineation of the health service organisation
- The patient population and its risk factors for infection.

There are a number of different surveillance methods. Some methods address the duration of surveillance (e.g. continuous surveillance). Other methods may address the target of surveillance (e.g. process or outcome surveillance) or focus on the timing of data collection (e.g. prospective or retrospective surveillance). It is important to understand that certain surveillance methods can be used together in a complementary way in a surveillance design (e.g. continuous and process surveillance) because they address different and unrelated aspects of data collection.

Methods that address the same aspect however cannot be used together in a surveillance design - for example, it is not possible to use both a retrospective and prospective surveillance design. Table 5.1 provides a brief introduction to the different methods that are commonly used in infection surveillance.

Table 5.1: Different surveillance methods used in infection surveillance

Surveillance methods	Purpose	Advantages	Disadvantages
Continuous surveillance	<ul style="list-style-type: none"> • Can be used for ongoing surveillance. Examples include daily review of microbiology results. 	<ul style="list-style-type: none"> • Provides a historical and real time baseline rate, which contemporary data can be compared against to identify changes in the spread of an infection, such as the emergence of a local cluster or outbreak. 	<ul style="list-style-type: none"> • Can be resource intensive • Produces a large amount of information.
Targeted surveillance	<ul style="list-style-type: none"> • Can be used for the surveillance of specific processes or outcomes, such as specific infections, aspects of clinical care, populations, or locations within a health service. 	<ul style="list-style-type: none"> • Can be used for a short duration of time • Provides very specific information • Can be initiated in response to a change in infection rates or in response to an intervention. 	<ul style="list-style-type: none"> • Only provides information limited to the specific process, outcome or setting that is under surveillance.
Process surveillance	<ul style="list-style-type: none"> • Can be used to observe and measure compliance with a process in real time. For example, compliance with guidelines, policies and or procedures, including hand hygiene, aseptic technique, or personal protective equipment (PPE) use • Uses methods such as documentation review or observational auditing. 	<ul style="list-style-type: none"> • Easy surveillance method to use, for example can use auditing tools to monitor practices • Findings can be benchmarked against clinical indicators • Provides evidence of whether a process is occurring sub-optimally • Can be used to monitor practical activities, such as hand hygiene, PPE use, compliance with aseptic technique • Can be done alongside outcome surveillance. 	<ul style="list-style-type: none"> • Can be resource intensive • Cannot discriminate if a sub-optimal process has resulted in an infection.
Outcome surveillance	<ul style="list-style-type: none"> • Identifies if an infection has occurred • Involves reviewing multiply datasets • Can be used to record the burden of disease in a population, for example cases of Legionnaire’s disease. 	<ul style="list-style-type: none"> • Can be used to establish changes in disease epidemiology. 	<ul style="list-style-type: none"> • Can only collect data after the clinical outcome has occurred • Does not identify the clinical processes that may have contributed to the infection • Relies on accuracy of data collected at the time.
Passive surveillance	<ul style="list-style-type: none"> • Uses existing laboratory data that is collected as part of routine clinical investigation. 	<ul style="list-style-type: none"> • Less labour intensive than other forms of surveillance as information may be easily accessible from existing data sources, such as daily line lists or automated notifications, such as alerts on patient healthcare records. 	<ul style="list-style-type: none"> • May not capture all cases of infection as data collection is limited to what is captured by existing systems.

Surveillance methods	Purpose	Advantages	Disadvantages
Active (screening) surveillance	<ul style="list-style-type: none"> • Involves collecting information about colonisation and infection for the whole at-risk population. For example, admission/ pre-operative screening, COVID screening questions on admission. 	<ul style="list-style-type: none"> • Can provide information about the number of people in a population who: <ul style="list-style-type: none"> - have symptomatic disease - are asymptomatic carriers of infection - are not infected. 	<ul style="list-style-type: none"> • Is resource intensive and time-consuming.
Signal (sentinel) surveillance	<ul style="list-style-type: none"> • Is a specific type of outcome surveillance • Useful for monitoring of low numbers of infections, that are not sufficient for statistical analysis but may be a signal for further investigation of procedures or practices • Can be used to identify surgical site infections or catheter-associated urinary tract infections. 	<ul style="list-style-type: none"> • Does not require the collection of large amounts of information • Can be used as an early warning indicator of broader patient safety issues • Can be used for small health service organisations or where low numbers of infections are common. 	<ul style="list-style-type: none"> • Only provides information after the event has happened • Not useful for infections that occur in large numbers or have outbreak potential.
Prospective surveillance	<ul style="list-style-type: none"> • Requires data to be collected when the clinical outcome or clinical process occurs. Examples include daily review of microbiology results. 	<ul style="list-style-type: none"> • Provides real-time information and enables timely reporting of surveillance results • Identifies potential issues/ cases as they emerge • Allows for immediate interventions • Information can be verified against direct patient observation or clinical interview. 	<ul style="list-style-type: none"> • Is resource intensive and time-consuming.
Retrospective surveillance	<ul style="list-style-type: none"> • Data is collected after the clinical outcome has occurred or after the clinical process has been completed. 	<ul style="list-style-type: none"> • Data can be validated against documented evidence of infection, such as the patient healthcare record. 	<ul style="list-style-type: none"> • Surveillance can only be undertaken after the process or clinical outcome has occurred • May be difficult to provide timely feedback to individuals who were involved in the original event (e.g. staff move onto other roles, long time lag between the event occurring and identifying the infection during the surveillance) • Data may not be able to be verified against clinical observation or interview in real time • Is heavily reliant on accurate record keeping.

Standardised data collection processes

Case finding

A standardised surveillance definition is used to identify the cases of interest to be included in data collection. This process needs to be done thoroughly to enhance the reliability of surveillance data.

Examples of case finding methods include:

- Direct patient observation
- Clinical interviews
- Reviews of surgical lists
- Examination of laboratory results
- Review of pharmacy dispensing records
- Interrogation of the patient's observation chart, healthcare records and or clinical care plans
- Checking if the patient has been referred to other clinical services, such as infectious diseases clinics or wound clinics
- Review of infection flags/alerts on electronic patient healthcare records.

Health service organisations should aim to use multiple case finding methods to increase the robustness and reliability of data collection. In recognition of this issue, standardised surveillance definitions often require complementary use of multiple case finding methods, such as both laboratory results and clinical observations.

Case definition

In infection prevention and control surveillance, a surveillance definition describes the criteria used to determine whether a clinical outcome or clinical process can be attributed as an infection or infection risk. Surveillance definitions are specific to the clinical outcome or clinical process that is under surveillance.

A surveillance definition is made of two parts. The first part of the surveillance definition describes the parameters of the numerator. In simple terms the numerator represents the number of infections that have occurred, taking into consideration:

- **Patient specific risk factors** refer to risk factors such as the patient's age (e.g. paediatric or adult) and co-morbidities (e.g. diabetes/morbidly obese/anaesthesia risks/current infections)
- **The type of intervention/procedure** needs to be considered as there are different risks associated with different interventions/procedures (e.g. length of surgery/complexity of procedure)
- **The inclusion period** refers to the period of time in which the onset of infection must have occurred for it to be related to the intervention/procedure and/or the at-risk period
- **The acceptable markers of infection** describes the clinical signs, symptoms and other observations which are indicative of infection.

Other factors which may influence the risk for infection may also be included in the case definition, such as admission to intensive care units, the presence of indwelling devices, or specific procedures, such as surgery.

The second part of the definition describes the parameters of the denominator. The denominator represents the total number of patients who are potentially at risk of infection during the surveillance period. The denominator will also usually define the setting that is under surveillance and for what period.

Many infection surveillance programs around the world have adopted definitions from the United States Centres for Diseases Control [National Healthcare Safety Network \(NHSN\)](#). Using standardised definitions such as these allows for robust comparison of local data with data from other health services and organisations. The Commission has produced national standardised surveillance definitions for use in the Australian health system:

- [Staphylococcus aureus bloodstream infection](#)
- [Clostridioides difficile infection](#)
- [Central line-associated bloodstream infection](#).

Statistical methods

Staff who are responsible for infection surveillance should know how to calculate an infection rate, apply risk stratification, make statistically valid comparisons and be able to provide feedback and report on infection rates.

Infection rates

The amount of infection in a population is usually reported as the **incidence** or **prevalence** of infection.

Incidence: Only new cases of infection in a population

Prevalence: All cases (new and old) of an infection in a population

Infection rates are calculated using the following information:

- The **numerator**: represents the number of infections that occurred, as described by the surveillance definition
- The **denominator**: represents the number of individuals at risk of getting an infection (i.e. the at-risk population). The surveillance definition will inform who is included in the denominator. For example, the denominator may include all overnight admissions within a health service organisation (e.g. patient days) or the total population for a community
- The **constant**: is a multiple of 10, usually 100, which is used to obtain a percentage. The constant makes the resulting rate meaningful, as it is often difficult to understand the practical impact of an infection rate that is less than 1.

The formula for calculating the rate of infection is:

$$(\text{Numerator} / \text{Denominator}) \times \text{Constant} = \text{Infection rate}$$

Case study 1

Hospital A has a 200 bed capacity. Five patients were identified with *S. aureus* bloodstream infections from hospital A in a 30 day period. Hospital A had another 135 patients coming in and out of the hospital during these 30 days with a total of 12,000 patient-days of bed occupation in the hospital. What is the infection rate?

Using the formula:

(Numerator/ Denominator) X Constant = Infection rate

The numerator is the 5 cases of *S. aureus* bloodstream infection.

The denominator is the total 12,000 patient days of occupation in the hospital.

The constant is 10,000 - this multiplier has been chosen as it will result in a value greater than 1.

The calculation is:

$$= (5/12,000) \times 10,000$$

$$= (0.0004) \times 10,000$$

$$= 4 \text{ infections}$$

Therefore, the *S. aureus* infection rate is 4 per 10,000 patient-days.

Information on **patient-days of bed occupation** is usually available from the health service organisation administration services.

Case study 2

Ward A is an obstetric surgical ward. Each month they care for 150 women who have undergone a C/Section.

In April, 5 patients are readmitted with a wound infection. They had their surgery in March. What is the infection rate for this ward?

Using the formula: (Numerator/ Denominator) X Constant = Infection rate

The numerator is the 5 cases surgical site wound infection.

The denominator is the total 150 procedures.

The constant is 100 - this multiplier has been chosen as it will result in a value greater than 1.

The calculation is:

$$= (5/150) \times 100$$

$$= (0.033) \times 100$$

$$= 3.3$$

Therefore, the infection rate is 3.3 per 100 procedures.

Calculating infection rate using a standardised statistical method ensures that infection rates can be compared between similar wards and hospitals, and before and after the implementation of infection control strategies.

Risk stratification

Risk stratification is not used for all surveillance, for example, SAB surveillance. However, where risk stratification is applied, infection rates can be adjusted according to the level of infection risk for the at-risk population. Risk stratification uses standardised criteria and recognises that the level of infection risk can vary within the population. For example, people who have a long length of surgery or a higher ASA* physical status score may be at a higher risk of infection than people who have a short length of surgery and a low ASA score. Similarly, people who are immunocompromised may be more likely to acquire an infection than someone who is immunocompetent.

***ASA physical status score:** American Society of Anaesthesiology physical status score is used to assess a person's tolerance/risk for anaesthesia and surgery.

It is important to account for varying levels of infection risk within a population when analysing surveillance data. Failure to do so may result in:

- Missed opportunities to improve patient safety for high-risk patient groups and clinical settings
- Unnecessary costs associated with deploying unnecessary interventions in areas where the risk of infection is low.

It is also important to consider the impact of variations, such as infection risk, if a health service organisation wishes to benchmark their performance with others. The level of infection risk, and the comparability of infection surveillance data, can be affected by the differences between:

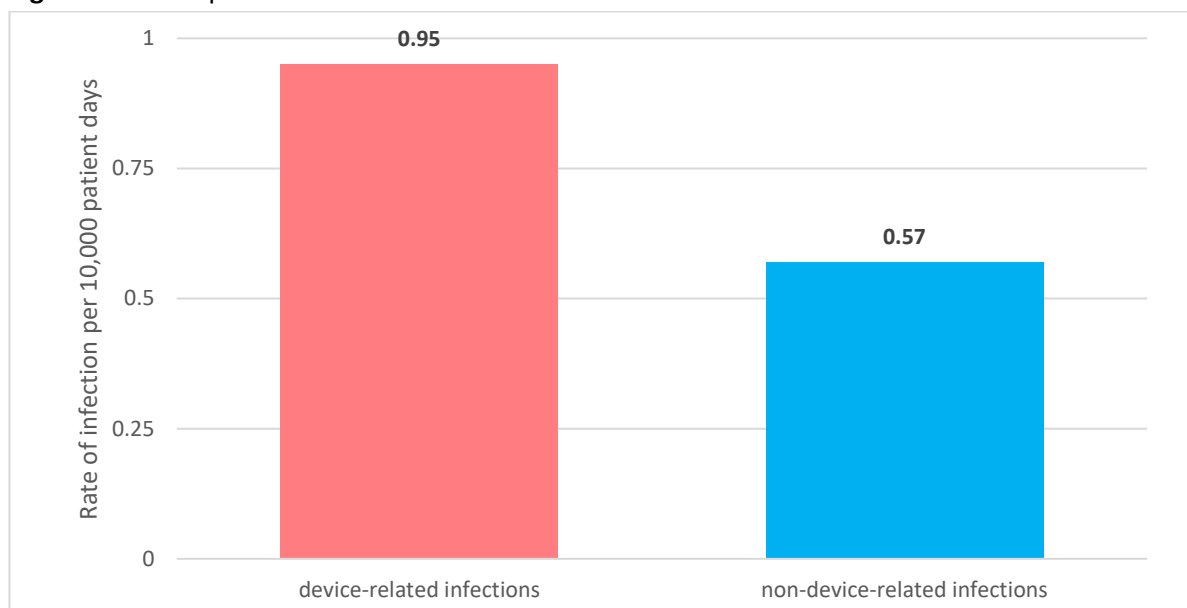
- Procedure type
- Facility type
- Patient case mix
- Role delineation (complexity of care).

Some simple ways to risk adjust infection surveillance data include:

- Comparing similarly aged patient populations (e.g. analyse healthcare-associated bloodstream infections in children separately to healthcare-associated bloodstream infections in adults)
- Analysing infections in high-risk patients and high-risk clinical settings separately to other patient groups and settings (e.g. analyse infections occurring in intensive care units or among haematology or oncology patients separately to infections presenting in general medical or surgical wards).

An example of risk stratification is comparing rates of infection between patients with invasive devices and patients without invasive devices within the same department, such as in intensive care units (ICU) – see Figure 5.1.

Figure 5.1: Example of rates of device-related infections in ICU



Another example of risk stratification is wound classification (see Table 5.2). Wound classification is used in surgical site infection (SSI) surveillance to identify which patients may have had a higher risk for SSI. Wound classification considers the degree of contamination of a surgical wound at the time of surgery. Stratifying SSIs by wound class ensures that surgical procedures with a high infection risk are not directly compared with surgical procedures where there is a much lower risk of infection.

Table 5.2 Wound classification

Wound Class	Description
Clean	An uninfected operative wound in which no inflammation is encountered and the respiratory, alimentary, genital, or uninfected urinary tracts are not entered. In addition, clean wounds are primarily closed and, if necessary, drained with closed drainage. Operative incisional wounds that follow non-penetrating (blunt) trauma should be included in this category if they meet the criteria.
Clean-contaminated	Operative wounds in which the respiratory, alimentary, genital, or urinary tracts are entered under controlled conditions and without unusual contamination. Specifically, operations involving the biliary tract, appendix, vagina, and oropharynx are included in this category, provided no evidence of infection or major break in technique is encountered.
Contaminated	Open, fresh, accidental wounds. In addition, operations with major breaks in sterile technique (e.g. open cardiac massage), or gross spillage from the gastrointestinal tract, and incisions in which acute, non-purulent inflammation is encountered, including necrotic tissue without evidence of purulent drainage (e.g. dry gangrene) are included in this category.
Dirty/infected	Includes old traumatic wounds with retained devitalised tissue and those that involve existing clinical infection or perforated viscera. This definition suggests that the organisms causing post-operative infection were present in the operative field before the operation.

Source: Approaches to surgical site infection surveillance (2017): <https://www.safetyandquality.gov.au/sites/default/files/2019-06/approaches-to-surgical-site-infection-surveillance.pdf>

Risk stratification improves comparability of different datasets collected in different sites or at different times and ensures that the findings are meaningful and relatable to the clinical context.

Comparisons

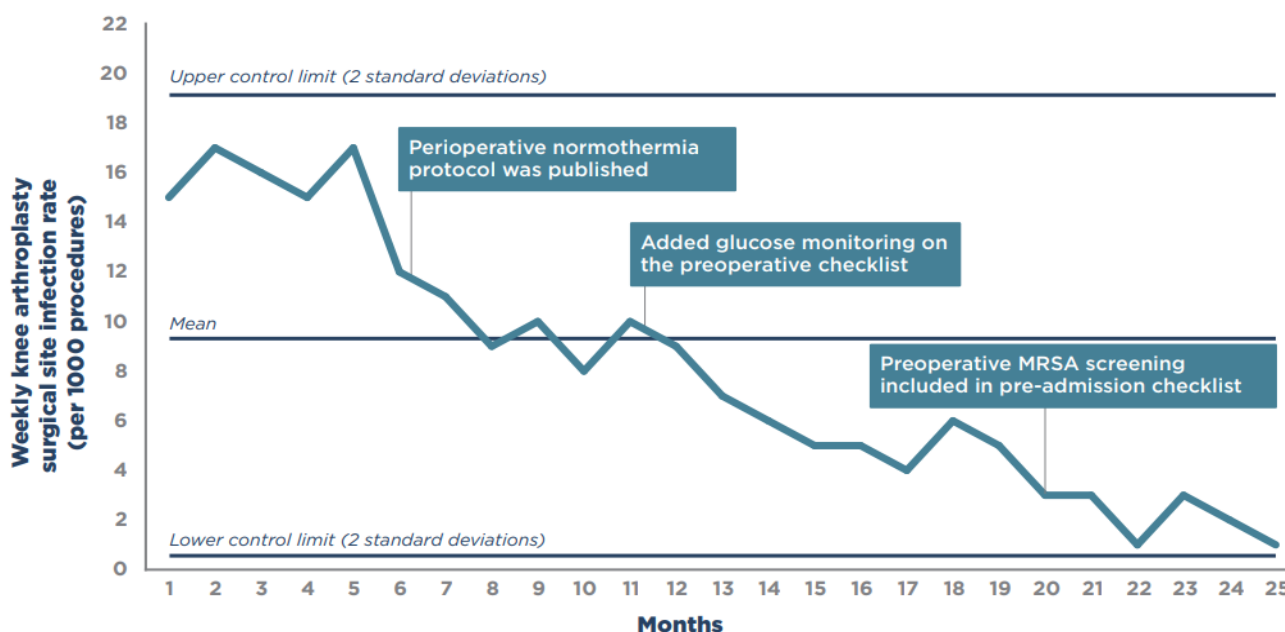
Besides risk stratification, valid data comparison relies on the use of consistent surveillance definitions and data collection methods. This consistent approach controls for variations due to differences in patient numbers, patient demographics, different hospitals or locations, different role delineations and different times periods.

To improve the comparability of infection surveillance data, findings are generally presented as either a:

- **Ratio**, which compares the number of individuals at risk of an infection or with an infection with the number of individuals who do not have the infection
- **Proportion**, which describes the number of individuals at risk of an infection or with an infection as a percentage or a fraction of the total at-risk population
- **Rate**, which describes the frequency at which infection occurs within a population within a particular setting.

Changes in rates over a period can be visualised by plotting rates on a statistical process control chart, also known as a run chart (see Figure 5.2). Data should be plotted at a regular frequency (such as daily, weekly, monthly) and changes in practice should be annotated on the chart alongside the time points when the change occurred. The run chart should include an upper and a lower control limit; often control limits of two or three standard deviations are used.

Figure 5.2: Example of a statistical process control chart for surgical site infection rates associated with total knee arthroplasty



Source: [Australian Commission on Safety and Quality in Health Care. Approaches to Surgical Site Infection Surveillance. Sydney: ACSQHC; 2017](#)

Comparing infection surveillance data helps to identify trends in the data, such as increases or decreases in infection rates over time, and can be used to inform strategies to improve clinical practice and patient safety and outcomes. For example:

- Comparing a hospital's infection rate to that of a hospital of similar size and complexity can provide an understanding of how a hospital is performing in relation to others. Successful strategies and interventions can be shared and implemented across groups of similar hospitals to promote changes in practice.
- Comparing current infection rates to previous reporting periods provides a basis for investigating reasons for increased rates, and for evaluating the effectiveness of interventions. Higher than average rates should prompt local action, such as staff training and education, policy compliance assessment, and review of policy and procedure, to improve clinical practice. Conversely, if the average rate is decreasing, any recent interventions and practice improvements can be identified, shared, and further embedded into routine clinical care.
- Examining infection rates by clinical setting can help to identify if there is a greater risk, or incidence, of infection in certain clinical areas, and allows for the implementation of specific strategies to address these risks. For example, an increased rate of healthcare-associated *S. aureus* bloodstream infection in a perioperative unit may prompt a hospital to consider reviewing its pre-surgical admission process for *S. aureus* screening, decolonisation and surgical antimicrobial prophylaxis. If infections are repeatedly related to one type of surgery, an outbreak investigation may also be required. The outcome of this review may also indicate, for example, a need to reinforce education on pre-operative screening, review of skin preparation or antimicrobial prophylaxis guidelines or introduce strategies to suppress *S. aureus* colonisation in patients undergoing high-risk surgical procedures.

Data quality in infection surveillance

Data quality refers to data that is accurate, fit for purpose, and fulfils the requirements of the relevant data dimensions. Data dimensions are the different elements of data that require assessment to establish the quality of the data. There are a number of different data dimensions that influence data quality, and one dimension can impact another. Table 5.3 describes the relevant data dimensions for infection prevention and control and infection surveillance. High quality data is achieved when there is a high level of confidence in a combination of these dimensions.

Table 5.3 A summary of the data dimensions in infection surveillance data

Data dimension	Definition
Completeness	A measure of how well the data contains the most important information required, without duplication and not missing information, according to the defined collection, data field and dataset criteria. This can usually be measured by checking against reference data.
Accuracy	The measure of how correct the data is at representing, estimating, or describing the purpose it was collected for. Accuracy can be checked internally by using expectations of relationships between data variables, for example date and time values, or externally by using reference data.
Consistency	The measure of how consistent and logical the data is when it is viewed in its entirety within the dataset (internal consistency), as well as with other datasets (external consistency).
Plausibility	The measure of the credibility of the data field, in light of another data field or knowledge about the data that is being measured. Plausibility can be determined by using expectations of relationships between variables.
Timeliness	Reflects the length of time between the events or phenomena described and the data becoming available. It is important data is recorded as close to an event as possible. This dimension of data is contextual and will differ depending on what data is being collected.
Relevance	The relatedness of the source of the data and how appropriate the data is for a data field or dataset. The timeliness of data can also impact the relevance of the data.

A critical part of infection surveillance is to ensure that surveillance data accurately reflects the true risk of infection in a specific setting or population. This is important because surveillance information is used to inform infection prevention and control policies and practices to improve both patient and healthcare worker safety and clinical outcomes.

Data validation

Data validation is a process that ensures collected data are accurate, classified correctly, fit for purpose and that there is minimal risk of bias. Robust data validation is an essential step required before, and during, the analysis of surveillance data to ensure high quality infection surveillance data. Data validation identifies errors and anomalies in data. If data are not validated, infection prevention and control interventions taken to respond to the data will be misinformed. In infection prevention and control, this may mean that inappropriate or less effective strategies are used; there may be misallocation of finite resources; and there may be increased patient or healthcare worker safety risk.

Data validation involves checking that all the information collected for infection surveillance is accurate and complete. As a minimum, this process should include:

- Checking that there are no blank data fields
- Checking that all the required data entry fields have been completed
- Removing duplicate data entries
- Checking that there are no errors from cutting and pasting practices
- Checking that data fields are within the expected or acceptable value ranges
- Checking for the consistent use of surveillance definitions
- Checking for other events that may affect validation in the findings, such as outbreaks of infectious agents or introduction of new equipment, process or procedure.

Feedback and reporting

Providing timely and relevant feedback to clinicians on clinical practice is known to have a positive effect on improving infection rates. Feedback will increase clinician:

- Awareness of infection prevention and control strategies
- Recognition of risk factors for infection
- Understanding of policy and organisational expectations to improve patient safety outcomes.

Feedback and reporting should also facilitate opportunities to discuss the effectiveness of existing practices and quality improvement initiatives.

Feedback can be provided either informally at an individual level, formally at a departmental or team meeting, at an executive level, or via internal or public reporting systems. Reporting infection surveillance data to peak governance committees is important for raising awareness and accountability for infection prevention and control and seeking additional resources to support infection prevention and control programs. A health service organisation's peak governance committee will usually include representatives of services such as:

- Nursing and medical administration
- Clinical specialties
- Infection prevention and control
- Antimicrobial stewardship
- Clinical governance and quality assurance.

Health service organisations also should ensure that the outcomes of infection surveillance are reported to consumers. Input from consumers, as well as clinicians and peak governance committees, can be used to inform future quality improvement activities to reduce the risk of infection.

National infection surveillance systems

Health service organisations should consider using existing national infection surveillance systems where they are available. These systems have already developed standardised surveillance definitions and data collection methods, and often have a national dataset to use for making comparisons.

Examples of national surveillance systems and supports available in Australia for infection prevention and control include:

- The [National Hand Hygiene Initiative](#), which includes process monitoring of hand hygiene compliance in health service organisations using a defined direct observation audit methodology
- The [Antimicrobial Use and Resistance in Australia \(AURA\) Surveillance System](#), which includes data from targeted and passive surveillance programs for antimicrobial use and antimicrobial resistance in hospital and community settings
- Nationally standardised definitions for [Staphylococcus aureus bloodstream infection](#), [Clostridioides difficile infection](#) and [central line-associated bloodstream infection](#), produced by the Commission to support surveillance of the incidence of these infections
- The [Australian and New Zealand Intensive Care Unit Society central line-associated bloodstream infections \(CLABSI-ICU\) registry](#), which supports the surveillance of the incidence of CLABSI in Australian intensive care units
- The [Communicable Diseases Network Australia](#) co-ordinates national surveillance programs for communicable diseases in Australia.



Using infection surveillance for quality improvement

The purpose of quality improvement

Quality improvement refers to the combined efforts of the workforce and others (e.g. consumers, patients and their families, researchers, planners and educators) to make changes that will lead to:

- Improvements in patient safety
- Improved patient outcomes, such as better health
- Improved system performance, such as better care
- Improvements in clinical practice.

In the infection prevention and control context, quality improvement is often centred on introducing interventions to prevent or reduce the risk of infection associated with clinical care. These interventions may be targeted at reducing the risk of infection associated with specific clinical settings, procedures, or patient groups.

Interventions aimed at reducing infections within an organisation have the potential to improve patient outcomes through reducing mortality and morbidity, improving the overall patient safety culture and protect members of the health workforce from harm. There is also the potential to reduce long-term financial costs, improve the use of resources, and support the organisation to meet the requirements of the NSQHS Standards.

The [NSQHS Standards \(Action 1.8\)](#) require health service organisations to use organisation-wide quality improvement systems. These systems should be used to:

- a. Identify safety and quality measures, and monitor and report performance and outcomes
- b. Identify areas for improvement in safety and quality
- c. Implement and monitor safety and quality improvement strategies
- d. Involve consumers and the workforce in the review of safety and quality performance and systems

Action [3.03 of the NSQHS Standards](#) also requires health service organisations to use quality improvement systems to:

- a. Monitor the performance of infection prevention and control systems
- b. Implement strategies to improve infection prevention and control systems
- c. Report to the governance body, the workforce, patients, and other relevant groups on the performance of infection prevention and control systems.

Quality improvement systems

The elements of quality improvement systems

The elements of a successful quality improvement system include:

- A description of high quality that is reflected through the health service organisations vision, mission, and values
- A definition of the health service organisation's stakeholders
- Clearly defined and aligned organisational and clinical quality objectives
- Clearly defined processes and responsibilities that are required to meet clinical quality objectives
- Training in safety and quality for the health service organisation's workforce
- Processes to verify that the quality improvement system is operating effectively
- Safety and quality indicators to monitor the quality of care, consumer satisfaction and changes in clinical practice
- A supportive governance system that promotes continual quality improvement.

Safety and quality indicators for infection prevention and control quality improvement

When planning a quality improvement program, data is required to identify if a problem exists, and to measure the outcome of any interventions. Health service organisations collect a wide variety of different data, including safety and quality indicators, such as:

- Infection surveillance data
- Incident management data
- Complaints data
- Safety and quality audit reports
- [Hospital-acquired complications](#) data
- Reviews of clinical practice.

Examples of quality and safety indicators which are specific to infection prevention and control include:

- Infection rates related to a particular infectious agent (e.g. *S. aureus* bloodstream infections [SABSI])
- Infection rates related to a particular clinical procedure (e.g. catheter-associated urinary tract infections, ventilator-associated pneumonia)
- Infection rates among high-risk patient populations (e.g. renal dialysis patients, elective surgery patients, haematology, and transplant patients)
- Compliance with processes known to minimise the risk of infection (e.g. compliance with hand hygiene, personal protective equipment use or aseptic technique).

How SABSIs and hand hygiene surveillance can support infection control practice and quality improvement

At a national level, hand hygiene compliance and the rate of bloodstream infections caused by *S. aureus* are considered to be robust indicators of the effectiveness of a health service organisation's infection prevention and control program.

Surveillance of SABSIs has been well established in Australia since 2009, when the national SABSIs case definition and mandatory reporting was endorsed and implemented by all states and territories. The former Australian Health Ministers' Advisory Council endorsed a revised national benchmark for healthcare-associated SABSIs, for the purpose of national reporting of public hospitals, of 1.0 per 10,000 patient days. This benchmark was implemented on 1 July 2020.

Hand hygiene is an essential element of infection prevention and control practice. Hand hygiene compliance is assessed against a national benchmark set by the former Australian Health Ministers' Advisory Council; the current national benchmark is 80%.

Monitoring SABSIs rates and hand hygiene compliance data can provide health service organisations with an indication of their overall infection prevention and control culture and practices. For example, low rates of SABSIs may reflect widespread uptake of aseptic technique during line insertion and good management of peripheral intravenous catheters whereas poor hand hygiene compliance may reflect poor compliance with other infection prevention and control practices, such as PPE use and aseptic technique.

What makes up a quality improvement system

A quality improvement system should have clearly defined objectives and has five key components:

1. Data collection
2. Data analysis
3. Reporting and reviewing of surveillance or project outcomes
4. Initiating practice change
5. Testing the effectiveness of practice change.

Ongoing monitoring, through infection surveillance, enables health service organisations to identify aspects of clinical care that may contribute to the occurrence of preventable healthcare-associated infections.

Once these aspects are identified, the organisation will be better informed to develop targeted interventions to reduce the incidence of these infections occurring in the future.

Reporting and reviewing outcomes

Once infection surveillance data have been analysed, it is important to report the outcomes to the relevant stakeholders to determine whether further action is required to address any changes in infection risk.

The relevant stakeholders for a health service organisation may include:

- **The infection prevention and control committee:** Surveillance data should be provided to this multidisciplinary group to consider the validity of the surveillance findings and whether surveillance outcomes are 'usual' or indicate real changes in infection trends.
- **Clinicians:** Providing timely and relevant feedback to clinicians increases their awareness of preventive measures and how to recognise and address risk factors for infection. Regular feedback also reinforces policy and organisational expectations to improve patient safety outcomes. Reporting infection surveillance data at formal and informal clinician and departmental meetings also provides opportunities to provide feedback on existing quality improvement initiatives and to highlight best practice outcomes.
- **Executive and governance committees:** Reporting infection surveillance data to the health service executive and peak governance committees is important for raising awareness and accountability for infection prevention and seeking additional resourcing to support infection prevention and control programs. Peak governance committees usually include representation from clinical or medical services, infection prevention and control, antimicrobial stewardship, drug and therapeutics, clinical governance, and quality assurance.
- **Consumers and the community:** Consumers provide a valuable perspective on how well care is delivered and what aspects of care are most valued by consumers. Consumer input can be obtained from the different types of partnerships with patients and consumers that exist within the healthcare system. These partnerships may occur at the individual level when providing direct care to a patient, at the department or program level when a consumer is directly involved in the design or delivery of a program, or at the health service organisation level when consumers are involved in the overall governance, policy, and planning. This may overlap with service, department, or program-level feedback, because these are all interrelated components of the health service organisation. There may also be partnerships with local community organisations and members of local communities. Consumers and consumer representatives may also be members of a health service organisation's peak governance committees for patient safety, facility design, quality improvement and patient or family education.

There are some key questions that the stakeholders should consider when infection surveillance outcomes are provided for review. These questions include:

- Has there been a change in infection rates?
- Why has the change occurred?
- How has this change occurred?
- What is the effect of this change and is it meaningful?
- If there has been an increase in infection rates, has there been a change in infection risk? What actions can be taken to address this change in risk?
- If there has been a decrease in infection rates or risk, are there learnings that can be applied across the health service organisation more broadly?

Initiating clinical practice change

When introducing quality improvement programs for infection prevention and control, it is important to understand the current infection risks and infection control practices used within the organisation. This information should be used to prioritise and focus strategies for practice change. Interventions to reduce infection risks may involve changes to current clinical practices, review of current programs or policies, and changes to equipment or processes.

Design intervention

When designing a quality improvement intervention, it is important to:

- Clearly define the specific objectives and goals of the program
- Clearly identify what needs to change
- Clearly identify how the change will be measured.

An intervention needs to directly address the infection risk and be able to be measured. One way to do this is by writing the intervention in the **SMART** format.



Specific: clearly define the goal and the proposed outcome of the quality improvement program



Measurable: identify what will be measured, and how will it be measured



Achievable: determine if the organisation has the resources, skills and knowledge to deliver this change



Realistic: determine if this change be made within the current context and resourcing of the organisation



Time-bound: set a timeline to achieve each milestone in the program

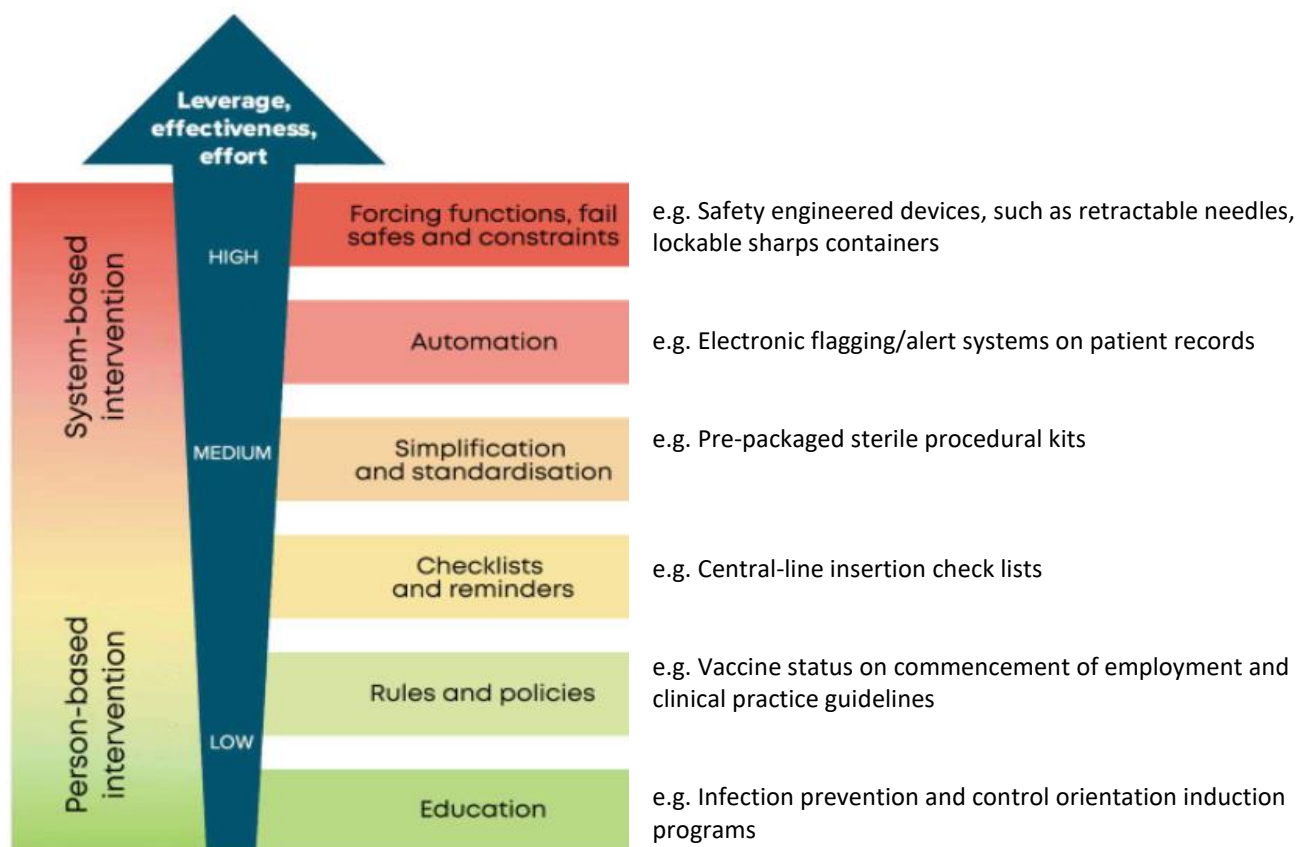
When designing interventions for quality improvement programs, there are a few important early steps that should be taken:

- Ensure that the intervention has executive or management support
- Assess the needs of the health service organisation, or individual department, to determine what the specific issues are and why these may be occurring. For example, if the hand hygiene compliance rate is low, what other factors may be contributing to this behaviour?
- Review current practices or procedures. Consider what is working well, and why, and what is not working well, and why.
- Consider if the proposed intervention is appropriate for the local context. Does the local setting have the same conditions as the setting where the intervention has previously worked? What resources are available? How long will the intervention run for?
- Prioritise the strategies for improvement
- Identify any barriers and facilitators to the interventions. Is the facility or department ready for change? Is the change sustainable?
- Is the intervention person-focused or system-focused? Is there evidence to support the intervention and under what conditions?
- How will the intervention be adjusted depending on the outcomes and progress of the intervention?

Ongoing evaluation of the impact of the intervention should also be considered during the design of the intervention.

The hierarchy of effectiveness

Figure 5.2 Hierarchy of effectiveness model



Adapted from ISMP's hierarchy of effectiveness of risk-reduction strategies. 2020.

The hierarchy of effectiveness (Figure 5.2) outlines the different types of interventions that can be used in health care, based on the coverage of the intervention and effort required to implement the intervention. The hierarchy of effectiveness model promotes behavioural change by presenting the clinician with knowledge (awareness of intervention and rationale for the intervention), choice (option to participate in the intervention) and action (using the intervention).

Strategies that are system-based, such as forcing functions, have a high impact and are more effective in preventing errors. However, these strategies may require more planning, more investment, and more effort to implement. Medium leverage strategies are moderately effective and require periodic updating and reinforcement. Strategies that are person-based are easier to implement but have low leverage because they focus on changing the behaviours of an individual and are least effective in preventing errors at a systems level.

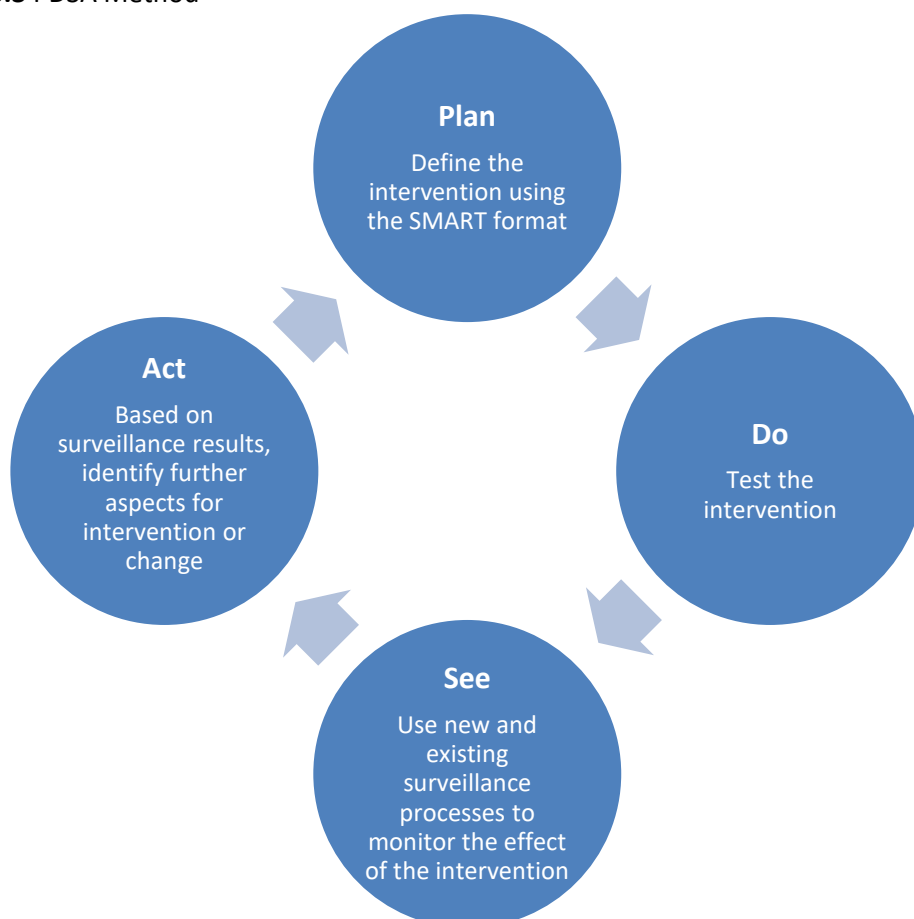
Testing the effectiveness of practice change

Once an intervention has been put into action, the intervention should be routinely monitored to see if it has had any impact on reducing the risk or incidence of infection.

Plan-Do-See-Act method

The Plan-Do-See-Act (PDSA) method can be used to plan and implement the proposed changes, monitor the response to the interventions, and review and act on results. The PDSA is an ongoing process of testing, checking and re-testing and is employed by many organisations as part of a quality improvement system.

Figure 5.3 PDSA Method



Monitoring the impact of the intervention can be done by continuing previous surveillance efforts. The same surveillance methodology (i.e. surveillance definitions, case finding methods) should be used to ensure that any future changes in the risk or incidence of infection are a direct result of the intervention.

Reporting of future surveillance data should provide comparison between the pre- and post-intervention periods, and clearly indicate when the intervention was introduced. Changes in infection risk or rates over a period can be visualised by plotting surveillance data in a statistical process control chart (see Figure 5.2). Implementation of an intervention may or may not have any initial effect, and the intervention may need further refinement and testing. It is important to continue the surveillance effort during this period, as it will provide information on whether changes to the intervention are providing additional benefit and whether further changes to the intervention are necessary. Surveillance should also continue after an intervention has been implemented to detect if the intervention has had a short-term or long-term effect. Interventions that have had a short-term effect may need to be followed up by additional interventions to have a sustained effect on the infection risk or rate.

Module 6: Preventing and managing occupational exposures

This module provides an understanding of the principles for preventing and managing occupational exposures in the healthcare environment. By completing this module, you will gain an understanding of:

- Key definitions and concepts related to occupational exposure
- The governance systems required to prevent and manage occupational exposures in healthcare
- How to identify risks for occupational exposure in healthcare workplaces
- Strategies to assess, prevent and manage the risk of occupational exposure
- The role of quality improvement, surveillance, and reporting systems in managing occupational exposures
- Immediate management of occupational exposure, including basic first aid
- Follow-up management of occupational exposure, including risk assessment, treatment and support for the exposed person, and reporting.

It is recommended that you complete the [Principles of infection prevention and control](#) module and the [Risk management systems for infectious agents and infectious disease](#) module before undertaking this module.

Health service organisations that are required to be assessed against the [National Safety and Quality Health Service \(NSQHS\) Standards \(second edition\)](#) should refer to the [Preventing and Controlling Infections Standard](#). The Standard sets the framework for infection prevention and control systems to identify and manage risks associated with infections, including preventing and managing occupational exposures, in health service organisations.

Occupational exposure in the healthcare environment

What is occupational exposure?

Occupational exposure is an incident during which a member of the workforce is exposed to a hazard in their work environment that has the potential to cause them harm.

Occupational exposure to an infectious agent may occur through direct or indirect contact with an infectious patient, visitor, or colleague, or because of a sharps injury. Table 7.1 provides examples of occupational exposures and the associated modes of transmission of infection.

Table 7.1: Types of occupational exposure and modes of transmission of infection

Types of exposure	Mode of transmission	Examples of infections
Direct contact with the patient, contaminated equipment or environment	Contact transmission	Infectious skin conditions, scabies, multidrug-resistant organisms (MROs)
Sharps or puncture injuries	Contact transmission (inoculation)	Bloodborne viruses
Intubation, respiratory suctioning, coughing, sneezing	Droplet transmission	Pertussis, meningococcal disease, coronavirus, influenza
Aerosol generating procedures, induced sputum, nebulisers	Airborne transmission	Tuberculosis, varicella zoster, measles, COVID-19
Ingestion of droplets, contaminated food or water	Oral-faecal transmission	Gastroenteritis

Members of the health workforce may also be at risk of occupational exposure to hazardous chemicals or materials, such as cleaning solutions, pharmaceuticals, and radiation, all of which require separate management protocols.

Who is at risk of occupational exposure?

All members of the health workforce, including clinical and non-clinical staff, are at risk of occupational exposure to infectious agents.

Why is managing occupational exposure to infectious agents in health care important?

Healthcare worker and patient safety are complementary in infection prevention and control. Protecting members of the health workforce from exposure to infectious agents also protects patients and other staff from this hazard.

The prevention and appropriate management of occupational exposure is a work health and safety obligation for health service organisations and all members of the workforce under national and/or state and territory legislation (See Table 7.2). The [Work Health and Safety Act](#) requires employers to:

- Have systems and processes in place to identify hazards, and assess and control the risks for patients, visitors and members of the workforce, so far as is reasonably practicable (i.e. what can be done and what is possible in the circumstances, for ensuring health and safety, and continuity of health service delivery)
- Ensure that workers and others are not exposed to infectious agents while at work, and where reasonably practicable, employees will take reasonable care to protect themselves and others from exposure to infectious agents at work.

Actions that both employers and employees can take to reduce the risk of exposure to infectious agents are summarised in Table 7.2. The [Work Health and Safety Act \(2011\)](#) also provides further guidance.

Table 7.2: Summary of employer and employees' responsibilities under the Work Health and Safety Act (2011)

Employer responsibilities	Employee responsibilities
<p>Ensuring that:</p> <ul style="list-style-type: none"> • Healthcare workers comply with policies and procedures for preventing and managing occupational exposures to infectious agents • Processes are in place to identify, monitor and manage risks for occupational exposure to infectious agents in the workplace • Safe work procedures and infection prevention and control measures, including the use of personal protective equipment (PPE), are implemented • Workers with an infectious disease adhere to exclusionary (isolation) periods • All incidents, hazards and unsafe working practices are reported. 	<ul style="list-style-type: none"> • Cooperating with reasonable instructions i.e. policy directives, policy guidelines, procedures and safe work instructions or clinical protocols relevant to their role, responsibilities, and accountabilities • Participating in immunisation and health screening programs as per the local and jurisdictional requirements • Being familiar with and always complying with protective measures when an exposure risk is identified to a transmissible infectious agent • Adhering to safe work practices, including: <ul style="list-style-type: none"> – hand hygiene – standard and transmission-based precautions – safe sharps handling and disposal of blood and body fluid spills – waste management – linen handling • Adhering to recommended work exclusion periods to limit transmission of an infectious agent in the workplace.
<p>Providing:</p> <ul style="list-style-type: none"> • An adequate supply of PPE for all healthcare workers • Instruction on using and maintaining PPE where other risk control measures are not feasible • Adequate provisions to manage sharps • Adequate access to first aid supplies (e.g. eyewash equipment) • Adequate direction, support, and training to healthcare workers to enable them to fulfil their responsibilities to prevent exposure to infectious diseases where possible • Access to screening and immunisation programs. 	
<p>Immediately releasing a worker when an occupational exposure occurs to receive first aid, risk assessment and treatment.</p>	<p>Seeking immediate first aid, risk assessment and treatment when an occupational exposure occurs.</p>
<p>Encouraging and supporting healthcare workers to participate in confidential testing after blood or body fluids exposure.</p>	<p>Participating in voluntary testing for bloodborne viruses and other infectious agents based on the nature of the exposure.</p>
<p>Investigating all episodes of occupational exposure in conjunction with work health/staff health/infection prevention and control practitioners.</p>	<p>Immediately reporting all occupational exposure episodes associated with a risk of infectious diseases transmission.</p>

Source: Adapted from [SA Health Preventing and Responding to Work Related Exposure to Infectious Disease Policy Guideline](#), April 2020

Requirements of the NSQHS Standards

The [Clinical Governance Standard](#) and the [Preventing and Controlling Infections Standard](#) of the NSQHS Standards include actions relating to the management of occupational exposure to infectious agents.

The Clinical Governance Standard includes specific actions that relate to the implementation of safety and quality systems, and provision of a safe environment for the delivery of care. These actions are:

- Action 1.10 Risk management
- Action 1.11 Incident management systems and open disclosure.

Action 3.15 of the [NSQHS Standards](#) (Workforce screening and immunisation) requires health service organisations to have a risk-based workforce vaccine-preventable diseases screening and immunisation policy and program that:

- a. Is consistent with the current edition of the Australian Immunisation Handbook
- b. Is consistent with jurisdictional requirements for vaccine-preventable diseases
- c. Addresses specific risks to the workforce, consumers, and patients.

More information on vaccine-preventable diseases and recommendations for members of the health workforce can be found in the current edition of the [Australian Immunisation Handbook](#).

Action 3.16 of the [NSQHS Standards](#) (Infections in the workforce) requires health service organisations to have risk-based processes for preventing and managing infections in the workforce that:

- a. Are consistent with the relevant state or territory work health and safety regulation and the current edition of the [Australian Guidelines for the Prevention and Control of Infection in Healthcare](#)
- b. Align with state and territory public health requirements for workforce screening and exclusion periods
- c. Manage risks to the workforce, patients and consumers, including for novel infections
- d. Promote non-attendance at work and avoiding visiting or volunteering when infection is suspected or actual
- e. Monitor and manage the movement of staff between clinical areas, care settings, amenity areas and health service organisations
- f. Manage and support members of the workforce who are required to isolate and quarantine following exposure to or acquisition of an infection
- g. Provide for outbreak monitoring, investigation, and management
- h. Plan for, and manages, ongoing service provision during outbreaks and pandemics or events in which there is increased risk of transmission of infection.

Governance systems to prevent and manage occupational exposures

Infection prevention and control systems and occupational exposure

Infection prevention and control systems in health service organisations are critical for the prevention and management of occupational exposure and the transmission of infectious agents. The [Australian Guidelines for the Prevention and Control of Infections in Health Care](#) includes information on preventing and managing occupational exposure to infectious agents. State and territory health departments, and many individual public and private health service organisations, also have additional policy and guidance. These policy and guidance documents should be used to develop local policies and procedures for preventing and managing occupational exposure to infectious agents.

Standard and transmission-based precautions

Using standard and transmission-based precautions is fundamental to reducing the risk of occupational exposures.

Standard precautions

Standard precautions are the first-line work practices for infection prevention and control in the healthcare environment. All healthcare workers should use standard precautions when caring for all patients, regardless of suspected or confirmed infection status. Standard precautions are used to reduce or prevent the transmission of infectious agents. Standard precautions should be used for contact with or when handling blood (including dried blood), all other body fluids (excluding sweat), non-intact skin and mucous membranes.

Standard precautions include:

- Hand hygiene, consistent with the [5 Moments for Hand Hygiene](#)
- The use of appropriate personal protective equipment
- The safe use and disposal of sharps
- [Environmental cleaning](#)
- Respiratory hygiene and cough etiquette
- [Aseptic technique](#)
- Reprocessing of reusable medical equipment and instruments
- Waste management
- Appropriate handling of linen.

Transmission-based precautions

Transmission-based precautions are used in addition to standard precautions. Understanding the means of transmission of an infectious agent is important for deciding the most appropriate transmission-based precautions to use.

Key elements of transmission-based precautions are:

- Personal protective equipment
- Patient placement
- Minimising patient movement.

There are three categories of transmission-based precautions:

- **Contact precautions** are used when there is a known or suspected risk of transmission of infectious agents by direct or indirect contact
- **Droplet precautions** are used when there is a known or suspected risk of transmission of infectious agents by respiratory droplets
- **Airborne precautions** are used when there is a known or suspected risk of transmission of infectious agents by the airborne route.

For some infectious agents, a combination of precautions may be required (for example, seasonal influenza requires both contact and droplet precautions).

For more information on standard and transmission-based precautions, see [Module 1: Principles of infection prevention and control](#) of this Workbook.

Systems to prevent occupational exposures

Risk assessment for occupational exposure to infectious agents

Health service organisations should use a risk assessment and risk management approach to prevent and manage occupational exposures in the healthcare environment.

The following key concepts are used in risk assessment and management:

- **Hazard** - A situation or thing that has the potential to harm a person.
- **Risk** - The possibility of harm (death, injury, illness) when exposed to a hazard.
- **Risk control** - Taking action to eliminate or control the risks so far as is reasonably practical. Controls should be constantly reviewed and measured to evaluate their effectiveness.

For example, in the context of occupational exposure, the **hazard** may be exposure to blood or body fluids during an exposure prone procedure. The **risk** is the potential exposure to a bloodborne virus. The **control** would be using safety engineered devices to reduce the risk of sharps injury and using personal protective equipment (PPE) to protect the healthcare worker from exposure to blood or body fluids.

The potential risk for occupational exposure to an infectious agent in health care should be determined by considering:

- The treatments and services provided in the setting
- Whether the setting is clinical or non-clinical and if it is a hospital or community-based service
- Whether the area has high or low patient activity
- The characteristics of patients, and the local epidemiology of potentially transmissible infectious agents
- The type of equipment used by members of the workforce
- Patient behaviours and cognitive capacity
- The availability of training and skills of the members of the workforce to use equipment and perform specific procedures correctly
- Access to and compliance with workforce immunisation programs.

Assessing the risk for occupational exposure to infectious agents is an ongoing process, informed by changes in the environment in which health services are delivered. Members of the workforce who have the potential for occupational exposure to infectious agents should be involved in risk assessments.

Risk assessments should be updated when:

- Clinical procedures or the range of services in a health service organisation change
- New equipment is introduced into the health service organisation
- There is an outbreak of, or the potential for an outbreak of, a known or novel infectious agent.

Risk management for occupational exposure to infectious agents

Risk management occurs on many levels within a health service organisation:

- At the organisational level - for example, organisational policies, the provision of staff training, the provision of suitably qualified personnel to manage and treat occupational exposures, and incident reporting systems

- At the departmental/unit level - for example, clinical procedure guides, the provision of appropriate equipment (e.g. safety-engineered sharps devices, PPE), and staff training
- At the individual level - for example, considering the risks involved when carrying out a specific procedure, questioning the procedure's necessity as part of clinical decision-making and attending education sessions.

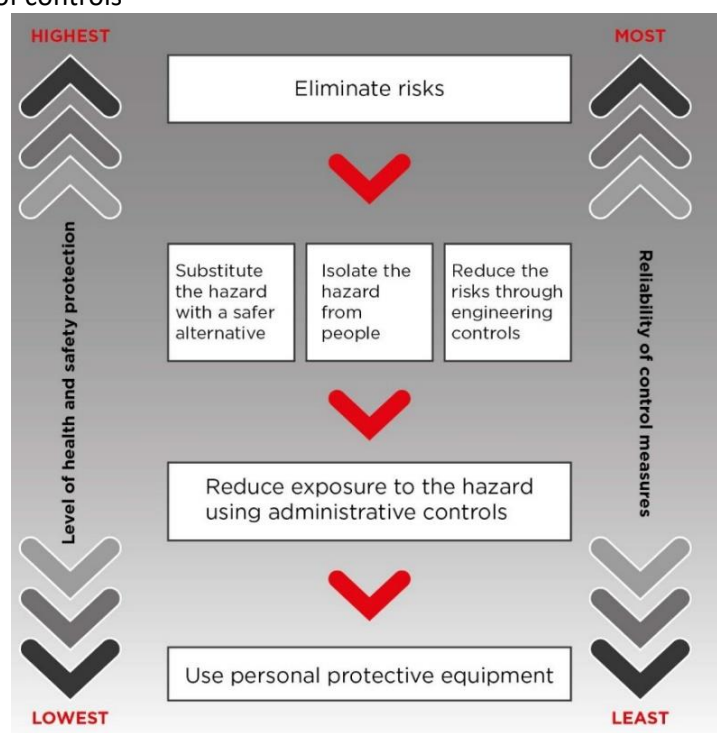
The hierarchy of controls and how it applies to occupational exposure prevention

The hierarchy of controls (Figure 7.1) is a work health and safety management approach to controlling risk, which ranks controls from most to least effective. Administrative controls and personal protective equipment are the least effective, as they do not control the hazard at the source and rely on human behaviour and supervision.

The hierarchy of controls supports the design of infection prevention and control programs and strategies to eliminate and/or minimise the risk of transmission of infectious agents. If it is not reasonably practicable to eliminate risks, then risks must be minimised using one or a combination of other controls, such as:

- Substitution
- Isolation
- Engineering controls
- Administrative controls
- Personal protective equipment.

Figure 7.1: The hierarchy of controls



Source: Safe Work Australia. How to manage work health and safety risks: code of practice. Canberra: SWA; 2018:19, 'Hierarchy of control measures' licensed under CC BY-NC 4.0.

Table 7.3 includes examples of how the hierarchy of controls can be used to identify and manage risks for occupational exposure to infectious agents.

Table 7.3 Examples of IPC strategies to reduce the risk of occupational exposure to infectious agents, based on the hierarchy of controls

Controls	Examples strategies
Elimination: Strategies that remove the infection risk entirely	<ul style="list-style-type: none"> • Clean and contain spills to eliminate the risk of exposure to clinical and biological waste • Dispose of sharps at the point of care to prevent sharps injury • Perform hand hygiene to remove infectious material from hands • Restrict entry of potentially infectious healthcare workers and visitors to the health service organisation.
Substitution: Substitute the hazard with a safer alternative	<ul style="list-style-type: none"> • Replace reusable equipment that is difficult to clean, such as cannulated or channelled devices, with single-use equipment • Introduce safety-engineered devices for cannulation and injections to prevent sharps injury • Administer aerosolised medicines with spacers instead of nebulisers to prevent exposure to aerosols.
Isolation: Physically separating people from the infection hazard	<ul style="list-style-type: none"> • Use patient placement strategies, such as single rooms or cohorting patients • Use physical barriers, such as privacy screens, for infections transmitted by the droplet route.
Engineering controls: Reduce the risk through engineering controls	<ul style="list-style-type: none"> • Optimise ventilation to improve air quality, reduce exposure to infectious respiratory particles, and maintain indoor temperature and humidity (e.g. ensuring correct air exchange rates, minimise crowding within indoor spaces, avoid recirculation of air if possible, and use High Efficiency Particulate Air filters). • Redesign waste management and cleaning areas to minimise exposure to infectious material • Maintain airflow direction away from staff workstations and towards patient care areas where possible.
Administrative controls: Practices and policies that reduce or prevent exposure to hazards.	<ul style="list-style-type: none"> • Develop organisational policies consistent with the current version of the Australian Guidelines for the Prevention and Control of Infection in Healthcare • Provide training in infection prevention and control practices to the health workforce • Provide a risk-based workforce vaccine-preventable diseases screening and immunisation program, consistent with the Australian Immunisation Handbook's current edition and current jurisdictional requirements.
Personal protective equipment (PPE): Effectiveness depends on access to appropriate PPE, correct use, and complementary substitution, administrative and engineering controls.	<ul style="list-style-type: none"> • Provide a sufficient accessible supply of a range of sizes and types of PPE relevant to the infection risks in the healthcare setting • Provide training programs on the correct use of PPE (such as putting on, removal and disposal), and regular competency assessment • Support fit checking and fit testing protocols for particulate filter respirators (e.g. P2/N95).

Source: Adapted from [Hierarchy of controls in infection prevention and control factsheet](#)

For more information on risk assessment and using the hierarchy of controls see the [Risk Management for infectious agents and disease](#) module and the [Hierarchy of controls in infection prevention and control factsheet](#)

Systems for managing occupational exposure

Each health service organisation should have local policies and procedures, which, at a minimum, include guidance on the immediate management of occupational exposure and processes for incident reporting.

Immediate management:

Health service organisations must have systems in place that provide members of the workforce with access to:

- Immediate first aid
- Expert advice and confidential rapid assessment of their injury, infection risk, testing, and timely administration of treatment, if required
- Ongoing support and follow-up treatment, as required.

Reporting occupational exposure:

Health service organisations must have systems in place for:

- Members of the workforce to report occupational exposures to infectious agents when they occur
- Maintaining records of all work health and safety incidents, including occupational exposure to infectious agents
- Complying with their state or territory requirements for reporting occupational exposure to external organisations, such as Safe Work Australia, and public health authorities, if an occupational exposure that results in a notifiable infection
- Reporting on occupational exposure to infectious agents to the local governing body, the workforce, and other relevant groups.

Quality improvement systems:

Information from reporting systems for occupational exposure to infectious agents should be used to:

- Inform strategies for quality improvement programs to reduce the risk of occupational exposure
- Improve clinical practice
- Identify gaps in skills and knowledge
- Evaluate compliance with the organisation's policies, procedures, and guidelines.

Incident reporting systems should support members of the workforce to communicate concerns. Review of processes as part of an incident management review should include members of the workforce, and timely feedback on the outcomes from this review should be provided to the relevant individuals.

Skills and equipment to prevent and manage occupational exposure

Infection prevention and control training should be provided to all members of the health workforce.

This training should include strategies to prevent and manage occupational exposure to infectious agents.

Workforce training programs for preventing and managing occupational exposure to infectious agents should:

- Be included in the organisation's induction and ongoing education and training programs
- Include information on standard and transmission-based precautions, including appropriate use of PPE, sharps safety and linen and waste handling
- Include assessment of, and address gaps in healthcare worker knowledge and skills on PPE use and first aid

- Be targeted to specific risks for occupational exposure related to the range of services and activities of the health service organisation
- Include the importance of the providing timely first aid following occupational exposure, and the skills required to administer appropriate basic first aid
- Include information on reporting requirements, including who to contact when an occupational exposure occurs
- Include instruction on how to obtain information on updates about the risk for occupational exposure in the health service organisation, such as the introduction of new equipment, changes to clinical procedures, or the emergence of novel infectious agents.

Note: All members of the health workforce should know how to provide basic first aid, and who to contact when an occupational exposure to an infectious agent occurs in their health service organisation.

Immunisation, screening and the management of infections in the workforce

Immunisation is the process of inducing immunity to an infectious agent by giving a vaccine. Administering a vaccine stimulates the immune system to produce a protective immune response. This response usually mimics the host's response to natural infection but avoids the disease that is the harmful consequence of infection. On average, an immune response takes around 10 to 14 days to develop. Immunity developed from a vaccine may last for months to many years, depending on the nature of the vaccine, the type of immune response and factors specific to the individual (e.g. age, presence of co-morbidities).

Vaccination can protect both the people vaccinated and others in the community who are not immune. It does this by increasing the level of immunity in the population, which is known as 'herd immunity' or 'community immunity'. Herd immunity minimises the spread of infection.

Each state and territory, and many private health service organisations have requirements for members of the health workforce on vaccination status as part of their terms of employment. It is essential that members of the workforce are aware of these requirements and their immunisation status for vaccine-preventable diseases.

A workforce screening and immunisation program for vaccine-preventable diseases should include systems and processes for:

- Assessment of the immune status of all members of the health workforce, including students, contractors and volunteers
- Identification of the vaccine-preventable disease risks for the workforce
- Providing access to vaccines to non-immune members of the workforce.

Identifying vaccine-preventable disease risks for the health workforce supports the implementation of strategies, such as immunisation, to protect members of the health workforce, as well as patients, other consumers, and the wider community, against vaccine-preventable diseases.

Further information on vaccine-preventable diseases can be found in the current edition of the [Australian Immunisation Handbook](#).

Management of occupational exposures

Immediate management of an occupational exposure

There are three important steps for immediately managing occupational exposure. These are:

Step 1: Immediate first aid

Step 2: Report the incident

Step 3: Risk assessment of the exposure

The confidentiality of the exposed person and the source of the exposure must be always maintained.

Step 1: Immediate first aid

First aid should be administered immediately. The exposed member of the workforce to be:

- Relieved of their duties as soon as possible
- Provided with first aid to reduce the risk of infection or injury (see Table 7.4).

Table 7.4: Summary of first aid for occupational exposures, based on exposure site

Occupational exposure site	Immediate action
Skin	<ul style="list-style-type: none">• Wash the area thoroughly with soap and water as soon as possible• If soap and water are unavailable, a detergent wipe can be used until soap and running water can be accessed.
Mouth	<ul style="list-style-type: none">• Ask the exposed person to spit out any fluid from their mouth• Provide clean water to rinse the mouth out with (do not swallow)• Repeat above steps twice.
Clothing	<ul style="list-style-type: none">• Remove contaminated clothing as soon as possible, and shower if necessary.
Eyes	<ul style="list-style-type: none">• Flush the affected eye with normal saline or water• Remove contact lenses if worn, flush eyes again and clean lenses before reinserting.
Needle stick/sharp injury	<ul style="list-style-type: none">• Remove any embedded material and wash the site as per the instructions for a skin exposure• Clean and dry the injury site, and apply a sterile dressing, if required• If the affected area is bleeding, allow it to bleed. Never squeeze or rub the injury site to induce bleeding, as this will cause more injury to surrounding tissue.

After attending to first aid, the person who sustained the occupational exposure should seek immediate medical assessment. A medical practitioner or other suitably qualified clinician should assess the exposed person for the risk of infection and the need for post-exposure testing and treatment. If the infectious status of the source of the exposure is unknown, an assessment of their risk of infection (e.g. for bloodborne viruses following a sharps injury) and baseline testing should be undertaken with their consent, and as appropriate.

In non-clinical settings, members of the workforce should be provided with basic first aid supplies to manage occupational exposures or other workplace injuries.

Step 2: Report the incident

Once Step 1 is complete, the incident must be reported. The occupational exposure should be reported immediately to the exposed worker's direct manager or supervisor. The incident should be reported as soon as possible, in accordance with the health service organisation's requirements for reporting occupational exposures. When documenting the incident, include as much detail as possible, making sure to record the date, time, location, and source of the exposure.

Step 3: Risk assessment of the exposure

The risk of infection varies following occupational exposure. An assessment of the risk of infection from the exposure should be conducted by a suitably qualified clinician who can order appropriate post-exposure testing and treatment if required. It is important to collect detailed information to support risk assessment of the occupational exposure, such as:

- The type of exposure and nature of any injury, e.g. splash, sharps injury, solid or hollow bore device, mucous membrane
- The source of exposure
- The time elapsed since the exposure occurred
- The infectious status of the source (if known)
- The type and amount of blood or body fluid involved, e.g. blood, respiratory secretions, droplets, aerosols, amniotic fluid
- The susceptibility of the exposed person to infection (e.g. immunisation status, pregnancy, other health concerns/medical history)
- The length of time in contact with blood or body fluid.

Risk of infection with bloodborne viruses

Bloodborne viruses, such as hepatitis B (HBV), hepatitis C (HCV) and human immunodeficiency virus (HIV), may be transmitted by significant percutaneous or mucosal exposure to infectious blood or other body substances.

The risk of infection from a bloodborne virus is dependent on the nature of the exposure, the volume of blood or body fluid involved, and the potential for the source to be positive and/or infectious for a bloodborne virus.

Hollow-bore devices that are used for cannulation, venepuncture, phlebotomy, or injection are of particular concern, because these devices may contain residual blood and therefore increase the risk of transmission of bloodborne viruses.

Tables 7.5 and 7.6 provide information on the potential risk of transmission of a bloodborne virus following exposure to blood or another body fluid from an **infectious source**.

Table 7.5: Potential risk of infection associated with different types of injury

Level of risk	Injury type
Higher risk injury	<ul style="list-style-type: none"> • Deep percutaneous injury • Visible blood on sharps • Needle used on a source's blood vessel
Lower risk injury	<ul style="list-style-type: none"> • Superficial injury, exposure through broken skin, mucosal exposure (usually splashes to eye or mouth) • Old, discarded sharps • No visible blood on sharp • Needle not used on blood vessels e.g. suturing, subcutaneous injection needles
Injury with no risk	<ul style="list-style-type: none"> • Skin not breached • Contact of body fluid with intact skin • Needle (or other sharp object, such as a scalpel) not used before injury

Source: NSW Health HIV, Hepatitis B and Hepatitis C – Management of Health Care Workers Potentially Exposed, May 2017. https://www1.health.nsw.gov.au/pds/ActivePDSDocuments/PD2017_010.pdf

Table 7.6: Risk of bloodborne virus transmission from exposure from an untreated, infected healthcare worker to patient and untreated, infected patient to a healthcare worker (in the absence of additional risk management)

Bloodborne virus	Risk of infected healthcare worker to patient transmission	Risk of infected patient to healthcare worker transmission
Hepatitis B virus	0.2% - 13.19%	1% - 62%*
Hepatitis C virus	0.04% - 4.35%	0% - 7%
Human immunodeficiency virus	0.0000024% - 0.000024%	0.3%

*There is a wide variability in the infectiousness of people with hepatitis B reported in the literature, which depends on their hepatitis B e-antigen status.

Identifying the source of exposure

Patient source of exposure

All health service organisations should have processes to assess a source patient's infectious status during an occupational exposure investigation. These processes should be consistent with state and territory legislation and policy requirements, including requirements for consent and privacy.

A designated person should assess the patient's history to determine the level of risk for infection for the exposed person. The member of the workforce who sustained the occupational exposure should not be involved in the assessment of the patient's history and in testing or counselling of the source patient.

If the source patient can be identified, their identity must be always protected.

Patient history

Depending on the nature of the occupational exposure, the information collected from the patient history may include:

- The patient's vaccination or immunisation history or immune status for vaccine-preventable diseases
- The patient's history of infection (e.g. serological testing results) and/or treatment for infections, such as tuberculosis or bloodborne viruses
- Any other clinical information that may be relevant to the risk of transmission of an infectious agent to the exposed person (e.g. risk behaviours, clinical treatments).

The source patient must give informed consent before any testing to determine their infectious/immune status. The patient must be offered appropriate pre- and post-testing counselling before testing for HBV, HCV and HIV and provided follow-up treatment as appropriate.

The source patient has the right to refuse all testing for infectious agents and to refuse to disclose their infectious status, regardless of the nature of the occupational exposure.

Other or unknown sources of exposure

All reasonable efforts should be made to identify the source. In situations where the source of the exposure is unknown, the risk of infection and appropriate follow-up treatment should be based on the information collected during the risk assessment of the exposure.

When the source of the exposure is unknown, the following information should be considered to determine the risk of infection:

- The type of exposure:
 - Percutaneous injury
 - Mucous membrane exposure
 - Non-intact skin exposure
 - Intact skin exposure
 - Aerosol/droplet exposure
 - Other - environmental, zoonotic

- Type and amount of fluid/tissue
 - Blood
 - Fluids containing blood
 - Other potentially infectious fluid or tissue (semen; vaginal secretions; saliva; cerebrospinal, synovial, pleural, peritoneal, pericardial or amniotic fluids; or wound exudate)
 - Direct contact with concentrated viruses or bacteria
- The likelihood of the source being positive for a bloodborne virus or other transmissible infection
- The prevalence of bloodborne viruses and other infectious agents of concern (for example, influenza, COVID-19) in the community of the likely source.

Testing is not recommended for materials or objects contaminated with blood or other body fluids, such as needles or other sharp instruments, environmental surfaces, waste, or linen implicated in an exposure. The reliability and interpretation of findings in these circumstances are unknown. Testing might also be hazardous to individuals handling the contaminated and sharp instruments.

Management of the exposed healthcare worker

The initial risk assessment, including the characteristics of the occupational exposure, should inform the testing and treatment options offered to the exposed healthcare worker.

Baseline blood testing or other health screening may be required to determine an exposed person's immune and infection status for a range of infectious agents and potential risk of infection. Examples of baseline testing:

- HBV surface antigen status (if non-immune)
- HCV antibody and polymerase chain reaction (PCR) status
- HIV antibody and antigen status
- Antigen status for varicella zoster, pertussis, or measles
- COVID-19 screening, such as PCR or rapid antigen testing.

Determining baseline serology can support comparison with subsequent test results. If serological testing is recommended, it should be offered as soon as possible or practicable after the exposure occurs. Testing of the exposed person should be strongly encouraged and should only be undertaken with informed consent of the healthcare worker.

Other screening tests may be used in particular circumstances. For example, screening healthcare workers who have been identified as having a significantly high level of exposure to a case of active tuberculosis. A risk assessment would be conducted to determine:

- The length and type of exposure
- Any history of prior exposure to TB (including working in high-risk settings and high-risk demographic backgrounds)

This information would determine the need for laboratory and other testing, including tuberculin skin tests.

Follow-up testing will identify if the healthcare worker is seroconverting from a negative status to a positive status, as the incubation time for a bloodborne virus can be as long as six months from the time of exposure. Figure 7.2 provides an example for follow-up testing timeframes.

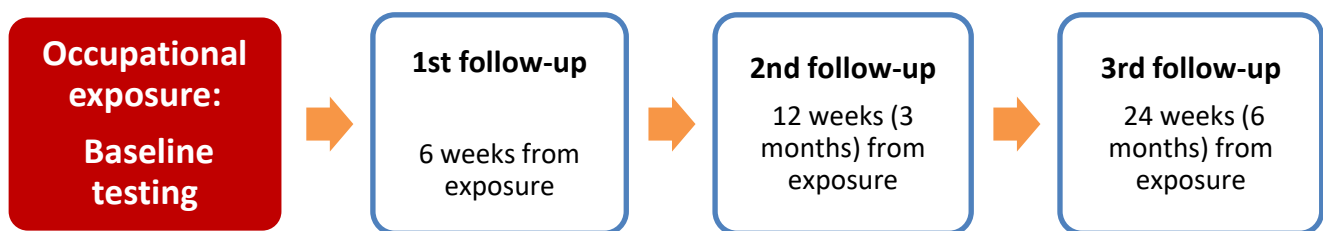
Note: The need for and frequency of follow-up serological testing of exposed healthcare workers should be determined by an appropriately qualified medical practitioner.

Healthcare workers with evidence of previous immunity to HBV do not require follow-up blood testing. Non-immune individuals will require immunisation and further HBV testing.

Tetanus status should be assessed for any member of the workforce who sustain abrasions or wounds.

Consult the current edition of the [Australian Immunisation Handbook](#) for further advice.

Figure 7.2: Example of the continuum for baseline assessment and follow-up time frames



Notes: In high-risk exposures consideration should be given to checking Hep C PCR at 3 weeks post-exposure if earlier diagnosis is desired.

Hepatitis B surface Antigen (HBsAg) may give a false positive if tested within two weeks of giving Hepatitis B vaccine.

Treatment options for occupational exposures

In some situations, it may be appropriate to offer post-exposure prophylaxis (PEP) or treatment, including vaccination, to the exposed person to reduce the risk that they will acquire an infection.

The decision to provide PEP should be determined by a medical practitioner based on an assessment of the risk of infection and the nature of the exposure.

Types of post-exposure prophylaxis or treatments

Antibacterial medication may be prescribed if the healthcare worker has had a high-risk exposure to a bacterial infection, such as meningococcal disease or pertussis. For example, exposure to sputum from involvement with intubation or suctioning an infected patient's sputum.

Antiviral medication is most commonly prescribed when a healthcare worker has been exposed to blood or body fluids known or suspected to be infected with HIV. Antiviral medication may also be considered for some exposures to other viruses, including influenza.

Immunoglobulin may be prescribed for non-immune healthcare workers after exposure to a vaccine-preventable disease to provide antibodies for specific infectious agents. For example, following exposure to viruses such as measles, varicella or hepatitis B.

Vaccination is offered post-exposure when the healthcare worker does not have immunity against a specific vaccine-preventable disease, for example, following exposure of a non-immune healthcare worker to hepatitis A virus, measles, or varicella.

It is recommended that any form of post-exposure prophylaxis or treatment be prescribed and administered as close to the time of the exposure as possible. For example:

- PEP for HIV exposure should be prescribed and started within 72 hours of the exposure
- When hepatitis B immunoglobulin is indicated, it should be administered as soon as possible after exposure, preferably within 24 hours, but before 72 hours following the exposure.

Counselling

An occupational exposure to any infectious agent is a stressful event. An individual's response to an occupational exposure can be wide-ranging; at times, they may be concerned or anxious in the days following the exposure.

Both the healthcare worker and the source patient involved in the occupational exposure should be provided with access to counselling support, regardless of the risk of infection, for as long as required. Counselling should include information on the risk of infection from the exposure and the consequences of positive test results. Counselling should also include information on actions the individual can take to prevent secondary transmission of infectious agents, such as any potential infection risks for their immediate contacts, such as family or sexual partners.

In the case of potential exposure to a bloodborne virus, the exposed person should be advised that during the six-month period following their exposure, they should:

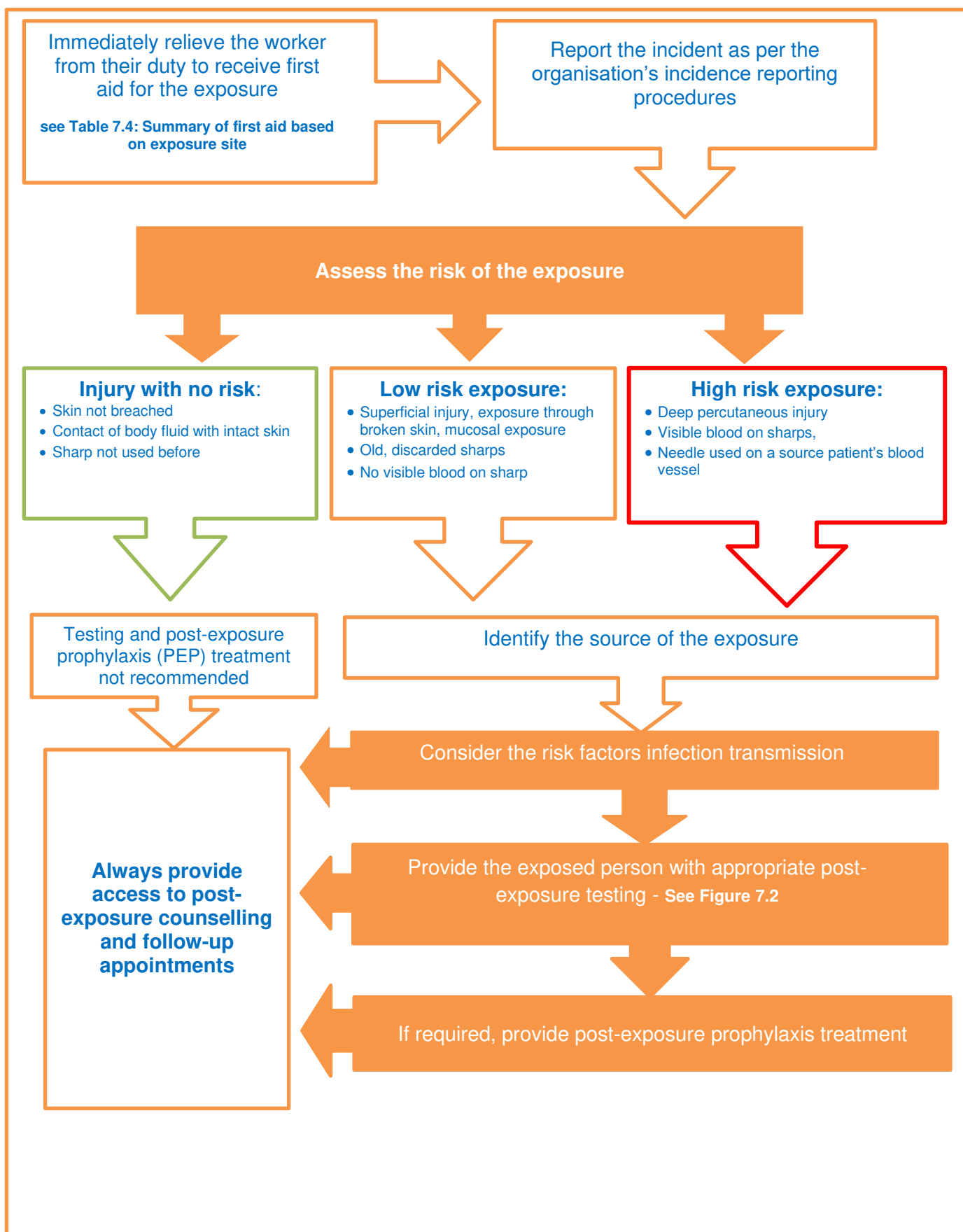
- Not donate plasma, blood, body tissue or parts, breast milk or sperm
- Protect sexual partners by abstaining or adopting safe sexual practices, such as using condoms
- Seek expert medical advice about pregnancy and breastfeeding
- Not share items like toothbrushes and razors
- Not share any injecting equipment if involved in injecting drug use
- Clean up their own blood spills
- Seek medical attention for any acute illness that occurs during the follow-up period.

Healthcare workers performing exposure prone procedures should refer to state, territory or local policy for additional measures to be undertaken.

The risk of side effects from PEP should also be discussed. Any risks from the PEP or the potential infection during pregnancy or breastfeeding should also be discussed.

Figure 7.3 summarises the steps for managing occupational exposure in the healthcare setting.

Figure 7.3 – Sample flow chart for immediate management of occupational exposure to blood and or body fluid



Module 7 Infectious agent screening and immunisation of HCWs (under review)

The online module provides:

- An understanding of the steps involved with providing an occupational screening and immunisation program for HCWs
- An overview of the organisation's responsibilities for health screening and immunisation of HCWs
- Employee responsibilities in relation to certain infectious agents and preventative actions
- An outline of safe work practices to be considered if exposed to these infectious agents
- The requirement for accurate and confidential record keeping in relation to HCW healthcare records.

Some organisational and jurisdictional policies and procedures determine a HCW's risk based on a classification or category that is determined by their occupational risk of exposure to patients, blood and body substances or infectious agents. In addition, some jurisdictions and organisations have included an additional sub-category to reflect a high risk for certain vaccine preventable infections i.e. seasonal influenza may be referred to as Category A mandatory.

The following example gives two category examples.

Category A – direct contact with patients or blood/body substances or infectious agents
Category B – no direct contact with patients, no greater risk of exposure to infectious agents than a member of the general public.

There are clinical areas where an organisation may determine that the risk is considered too high to allow HCWs to work clinically without this evidence of immunisation until all evidence is complete. These include:

- Emergency department
- Operating theatres and post anaesthetic care units
- Paediatrics
- Maternity
- Adult and neonatal ICU and special care units
- Respiratory wards/units
- Transplant and oncology units with immunocompromised patients

Recommend vaccinations for HCWs

Occupation	Vaccine
Healthcare workers (HCW)	
All HCW Includes all workers and students directly involved in patient care or the handling of human tissues	Hepatitis B Influenza MMR (if non-immune) ² Pertussis (dTpa) Varicella (if non-immune)
HCW who work in remote Indigenous communities or with Indigenous children in NT, Qld, SA and WA, and other specified healthcare workers in some jurisdictions	Vaccines listed for 'All HCW', plus hepatitis A
HCW who may be at high risk of exposure to drug-resistant cases of tuberculosis (dependent on state or territory guidelines)	Vaccines listed for 'All HCW', plus consider BCG
Persons who work with children	
All persons working with children, including: <ul style="list-style-type: none"> • staff and students working in early childhood education and care • correctional staff working where infants/children cohabit with mothers • school teachers (including student teachers) • outside school hours carers • child counselling services workers • youth services workers 	Influenza MMR (if non-immune) ² Pertussis (dTpa) Varicella (if non-immune)
Staff working in early childhood education and care	Vaccines listed for 'Persons who work with children', plus hepatitis A
Carers	
Carers of persons with developmental disabilities ³	Hepatitis A Hepatitis B Influenza
Staff of nursing homes and long-term care facilities for persons of any age ³	Influenza MMR (if non-immune) ² Varicella (if non-immune)
Providers of home care to persons at risk of high influenza morbidity	Influenza
Emergency and essential service workers	
Police and emergency workers	Hepatitis B Influenza Tetanus (dT or dTpa)
Armed forces personnel	Hepatitis B Influenza MMR (if non-immune) ² Tetanus (dT or dTpa) Other vaccines relevant to deployment

Table 4: Recommended vaccinations for persons at increased risk of certain occupationally acquired vaccine-preventable diseases. Source: Australian Technical Advisory Group on Immunisation: The Australian Immunisation handbook, 10th.ed. Canberra: Australian Government Department of Health and Ageing; 2013.

Risk assessment and health screening for HCWs

An example of risk assessment table for health screening and immunisation of HCWs is presented below.

Infectious agent or disease	HCW category A	HCW category B	Examples of evidence that may be required as part of the recruitment process for new staff
Diphtheria, Tetanus and Pertussis (Adult dTpa)	Yes	Recommended	One documented dose of adult dTpa vaccine This dose must identify that the vaccine contained a Pertussis component in addition to Diphtheria and Tetanus. Note: This is not the same as a 'Tet Tox' or ADT vaccine.
Tuberculosis (TB)	Yes	No	Assessment of status within 4 weeks of start of employment
Hepatitis A	Selected	Selected	Offer to select staff only, for example: <ul style="list-style-type: none"> laboratory services plumbers, and community, primary and mental HCWs working with developmentally disabled or indigenous people.
Hepatitis B	Yes	No	Documented evidence* of completed, age appropriate, course of vaccine AND documented evidence of antiHBs>10mIU/ml' OR documented evidence of past infection (HBcAb)
Measles, Mumps, Rubella (MMR)	Yes	Recommended	Born before 1966; OR documented evidence of 2doses of MMR at least 1 month apart; OR documented evidence of immune response (IgG) to Measles, Mumps, Rubella.
Chickenpox	Yes	Recommended	Personal history of chicken pox; OR physician diagnosis of shingles; OR documented evidence of IgG varicella serology; OR documented evidence of age appropriate vaccination for Varicella.
Influenza	Recommended for most HCWs but mandatory for identified highrisk HCW	Recommended	Offer annually in autumn Identified high risk HCWs are HCWs who work in emergency departments, ICU (adult, paediatric and NICU), haematology/oncology units, transplant units or other high risk areas as identified by the organisation or jurisdiction

Hepatitis B immunity

If documented evidence is not available but the HCW has serological evidence of >10mU/L Hepatitis B surface antibody serology (antiHBs or HBs Ab) then the following items will assist in determining risk for the HCW:

The assessor should document the person's reported hepatitis B vaccination history and determine the validity of the information, taking into consideration:

- Who provided the vaccines, the number of doses and the timing of the doses
- The person's age at the time each dose was received (NB. two adult doses of hepatitis B vaccine administered 4-6 months apart are adequate when given to persons aged 11-15 years)
- The time between the last vaccine dose course and serology provided, and
- The reasons stated for the inability to provide documented evidence of hepatitis B vaccination.
- Review a recent serology result (antiHBs).
- Assess the risk to both the person and clients based on the type of clinical area/procedures involved.

Advise the person of the importance of a completed age-appropriate course of immunisation to establish long-term protection and the risks associated with incomplete vaccination, even though sufficient antiHBs levels have been documented.

The person should be offered an additional dose(s) of vaccine if the person believes that the antiHBs levels could have resulted from an incomplete course.

Bibliography

National Health and Medical Research Council. *The Australian Immunisation Handbook*. 10th Edition (2013) Canberra. Access link [here](#)

Australian Government, Department of Health. *National Vaccine Storage Guidelines: Strive for 5*. 2nd Edition (last updated April 2018). Access link [here](#)

Health Victoria – Vaccination of HCWs (updated August 2014) Access link [here](#)

CDNA Guidelines for the public health management of Tuberculosis 2015 Access link [here](#)

WHO/UNICEF joint statement Achieving immunization targets with the comprehensive effective vaccine management (EVM) framework, March 2016, Access link [here](#)

South Australia Health, Health Care Worker Immunisation Requirements, Access link [here](#)

NSW Health (New South Wales Health Department) (2018) 2018-009 *Occupational assessment, screening and vaccination against specified infectious diseases*. NSW Health Sydney. Access link [here](#)

Queensland Health Guideline for Vaccination of HCWs June 2016. Access link [here](#)

Vagholkar S, Ng J, Chan R, Bunker J and Zwar N. (2008). *HCWs and immunity to infectious diseases*. Australian and New Zealand Journal of Public Health 2008;32(4): 367-71.

Polgreen P, Polgreen L, Evans T and Helms C. (2009). *A Statewide System for improving vaccination rates for hospital employees*. Infection Control and Hospital Epidemiology 2009; 30: 474-478.

Module 8 Outbreak management (Under review)

The online module provides:

- Information on how to define the steps of an outbreak
- Increased awareness of the need to have effective management and notification systems in place to address relevant state and territory notifiable infectious agents and conditions
- Improved understanding of the role of the state and territory health authorities in outbreak management
- Awareness of the requirements relating to data collection and reporting systems
- Awareness of the main stakeholders required to form an Outbreak Control Team, and
- The ability to recognise the importance of investigating outbreaks as early as possible to use the maximum effect of the risk management principles, for example, identification, control and containment, and acquiring and utilising the best epidemiological data and microbiological results to minimise impact upon the population.

An outbreak can be defined as: "**when there are more cases of infection with the same organism than would normally be expected in one area or period of time**". <https://www.nhmrc.gov.au/health-advice/public-health/preventing-infection>

Factors that can affect the response to an outbreak include

- The virulence of the infectious agent, and
- The vulnerability of the population

Key steps in responding to an outbreak:

Many steps are taken more or less simultaneously, while the results of investigations and implementation of strategies to contain and control will vary with the availability and timeliness of information and the seriousness of the outbreak

1. Implement and reinforce infection control strategies to contain/ prevent further cases
2. Investigate and identify epidemiological links,
3. Communication to key stakeholders and the development of an outbreak control team
4. Develop a case definition
5. Identify and monitor existing and new cases, contact tracing and data collection
6. Possible treatment and prophylaxis
7. Develop and test the hypothesis (source, type and mode of transmission)

Chemical agents for environmental cleaning during an outbreak situation

A major factor in the control of an outbreak involves enhanced environmental cleaning. Appropriate selection and use of chemical agents for environmental cleaning and disinfection should be risk assessed for correct and safe use. PPE, especially gloves are to be changed between and on completion of any cleaning and disinfection activities. Ensure that solutions used for environmental cleaning are compatible with items or surfaces, receive adequate contact time with surfaces and are prepared correctly.

Disinfectants to be used in healthcare settings for environmental cleaning may vary according to national/state/territory recommendations and also between acute and non-acute patient care areas. A risk assessment should be completed.

If using separate cleaning agents and disinfectants, surfaces should be cleaned first with a detergent solution, then a disinfectant is used as per the manufacturer's instructions for use. This is a two-step process, cleaning and then disinfection

If using a combined detergent /disinfectant product for environmental cleaning and follow the manufacturer's instructions for use.

When using disinfectants, ensure staff, patients and items are not harmed by exposure to the disinfectant agents. Follow manufacturer's instructions for use.

The selection of a disinfectant must include confirmation that its characteristics will ensure it is effective against infectious agent(s) involved.

When using disinfectants, ensure staff, patients and items are not harmed by exposure to the disinfectant agents.

Monitoring of cases and the resolution of the outbreak

The development of surveillance lists, case lists, checklists and reporting formats should include appropriate data required by the outbreak management team and state/territory health authorities. Most public health authorities will have protocols to use.

Bibliography and further reading

Australian Guidelines for the Prevention and Control of Infection in Healthcare, (current edition)

<https://www.nhmrc.gov.au/health-advice/public-health/preventing-infection>

Jekel J, Katz D, Elmore J, and Wild D (2007). *Epidemiology, Biostatistics and Preventative Medicine* (3rd Ed.). Saunders: Elsevier, Philadelphia.

Australian Government, Communicable Diseases Information, Access link [here](#)

Victorian Department of Health and Human Services. *The Blue Book: Guidelines for the control of infectious diseases*. Victorian Government, Published 2011 and updated annually. Access link [here](#)

Centres for Disease Control and Prevention (CDC) 2018 Common settings for Norovirus Outbreaks. Access link [here](#)

NSW Health – Infectious Diseases. Access link [here](#)

Centres for Disease Control and Prevention (CDC) 2018, Parasites, Access link [here](#)

Australian Commission on Safety and Quality in Health Care (2017). Recommendations for the control of carbapenemase producing *Enterobacteriaceae* (CPE). Access link [here](#)

Australian Commission on Safety and Quality in Health Care (2018). *Clostridium difficile* infection in Australia, Access link [here](#)

Gravel, D, Garden M, Taylor G, Miller M, Simor A, McGeer A, Hutchinson J, Moore D, Kelly S, Mulvey and Canadian Nosocomial Infection Surveillance Program (2009).

Government of Canada (2013) *Clostridium difficile* (C. difficile) infection in acute care settings, Public Health Agency of Canada. Access link [here](#)

Module 9 Renovation, repairs and redevelopment risk management

The online module provides:

- An overview of basic risk minimisation strategies
- An example of how to show the method of risk assessment
- Methods to recognise the appropriate infection prevention measures for each classification
- Methods to show an understanding of monitoring options to be used during projects in the healthcare setting, and
- A description of significant infectious agents that are associated with renovation and redevelopment in healthcare facilities.

Etiologic agent	Underlying medical condition	Number of patients infected or colonised	Number of patients who died	Circumstances	Year
<i>Scedosporium sp.</i> , <i>Rhizopus sp.</i> , <i>Phoma sp.</i> , <i>Exosporium sp.</i> , <i>Bipolaris sp.</i> , <i>Fusarium sp.</i> , <i>Aspergillus sp.</i> , <i>Candida sp</i>	Children with acute leukaemia	50	10	Major renovation with excavation of grounds for construction of a tower connecting buildings	Pokala, et al., 2014
<i>A. fumigatus</i> <i>A. flavus</i> <i>A. terreus</i>	Acute leukaemia	25	6	Construction and renovation work	Charbrol et al., 2010
<i>A. fumigatus</i>	Haematology unit/acute leukaemia	4	0	Renovation work	Pini, et al., 2008
<i>A. fumigatus</i>	Haematology patients	6	2	Major hospital construction work	Chang et al., 2008
<i>A. fumigatus</i> <i>A. flavus</i> <i>A. terreus</i>	Lung transplant recipients	8	1	Building construction work	Raviv et al., 2007
<i>A. ustus</i>	Ophthalmology patients	3	0 (3 enucleations)	Renovations ophthalmology dept and operating suite	Saracli et al., 2007

Table 7: Summary of documented significant outbreaks of construction related infection

Etiologic agent	Underlying medical condition	Number of patients infected or colonised	Number of patients who died	Circumstances	Year
<i>A. fumigatus</i>	Renal transplant patients	4	4	Building construction work	Panackal et al., 2003
<i>A. fumigatus</i> <i>A. flavus</i>	Surgical inpatients	6	2	Deterioration of insulating material in airflow units	Lutz et al., 2003
Aspergillus	Oncology patients (Bone Marrow Transplant, Acute Myeloid Leukaemia, Acute and Chronic Lymphatic Leukaemia)	36 (over 69 months)	17	28 cases occurred during construction and 4 cases after control measures initiated	Loo et al., 1996
<i>A. fumigatus</i>	Respiratory failure, Crohns disease, chronic bronchitis	6	3 (related to underlying disease)	Spores in fibrous insulation above perforated ceiling were dispersed during minor building in adjacent offices and stores areas	Humphreys et al., 1991
<i>A. fumigatus</i>	Renal disease – chronic renal failure	3	2	Outbreak coincided with hospital renovation in an area near the renal unit where the patients were being accommodated.	Sessa et al., 1996
Aspergillus	Patients on haematology unit	5	5	Large-scale evacuation work while hospital being rebuilt. The isolation rooms that housed the patients overlooked the building site.	Shields et al., 1990

Outbreak papers are included in further resources at the end of the section.

Risk rating	Area/Department
Lowest risk	Office areas Public areas Workshops Unoccupied wards areas not accommodating patients
Potential risk	Nuclear medicine Non-invasive radiology including Magnetic Resonance Imaging (MRI) and Computerised Tomography (CT) Preadmission units and discharge clinics Research laboratories General outpatient areas except surgery and oncology Psychiatric services Allied health, e.g. physiotherapy, occupational therapy, social work, dietetics and so on General wards All other patient care areas unless stated in moderate or highest risk
Moderate risk	Emergency Department Pharmacy Pathology laboratory Respiratory units Physiotherapy respiratory function units Coronary care unit Cardiology clinics Outpatients unit (surgery and oncology) Invasive radiology Paediatrics wards Obstetrics wards including labour ward and delivery suites Surgical wards Geriatric and long term care wards
Highest risk	Units accommodating immunocompromised patients (e.g. HIV/ AIDS units) Intensive care units and high dependency units Sterilising services unit Sterile stock store rooms All operating suites Day surgery units Haematology/oncology inpatient and day units Solid organ transplant units (e.g. renal transplant unit) Bone marrow transplant units Neonatal intensive care/special care units Cardiac catheterisation/angiography units Haemodialysis unit Endoscopy units Anaesthesia and pump areas Recovery units Pharmacy clean rooms/aseptic areas/admixture rooms

Table 8: Patient and geographic risk areas in a HSO for redevelopment **adapted from:** [Australasian Health Facility Guidelines: Part D- IPC](#), Accessed June 2019.

This table describes the level of risk for the transmission of pathogens relating to the level of construction activity.

Classification	Type of activity
Type 1 – insignificant	<p>Inspection and non-invasive activities. These include but are not limited to:</p> <ul style="list-style-type: none"> • Activities that require lifting or removal of ceiling tiles for visual inspection only • Painting (not sanding) • Electrical trim work • Minor plumbing (in a localised area, e.g. patient bathroom), and • Maintenance activities that do not generate dust or require cutting of walls or access to ceilings other than for visual inspection.
Type 2 - Minor	<p>Small scale short duration, maintenance or renovation activities that create minimal dust. These include but are not limited to:</p> <ul style="list-style-type: none"> • Access to duct spaces • Cutting of walls or ceilings where dust migration can be controlled for the installation of minor electrical work or cables • Sanding to repair small patches • Minor plumbing work in one patient care area (1 patient room), e.g. disruption to water supply.
Type 3 - Moderate/major	<p>Work that generates a moderate to high level of dust or work that cannot be completed in a single work shift. This includes but is not limited to:</p> <ul style="list-style-type: none"> • Sanding of walls for painting or wall covering • Removal of floor coverings and ceiling tiles • Plasterwork, duct work or electrical work above ceilings • Major plumbing work, e.g. interruption of sewerage pipes, and • Removal of fixed building items, e.g. countertops, sinks.
Type 4 - Major	<p>Major maintenance, demolition/ excavation/ construction projects that require consecutive work shifts to complete. These include but are not limited to:</p> <ul style="list-style-type: none"> • Removal of ceiling tiles and/or ceilings • Major plumbing work in clinical common areas or affecting more than 2 patient rooms • Removal of plaster walls, block works, bricks, or mortar, and • New construction involving large areas of open soil.

Table 9: Activities and classification for risk rating. **Adapted from:** [Australasian Health Facility Guidelines: Part D- IPC](#), Accessed June 2019

AREAS OF VULNERABILITY	PROBABILITY OF CONTAMINATION			
	Insignificant	Minor	Moderate	Major
<i>Lowest risk</i>	Class I	Class II	Class II	Class III
<i>Potential risk</i>	Class I	Class II	Class III	Class IV
<i>Moderate risk</i>	Class I	Class II	Class III	Class IV
<i>Highest risk</i>	Class II	Class III	Class IV	Class IV

Table 10: Risk rating matrix. **Adapted from:** [Australasian Health Facility Guidelines: Part D-IPC](#), Accessed June 2019

Baseline air sampling should be considered before the starting any activities, especially where there is a disruption of possible contaminants. There are several methods used to determine baseline levels of dust and microorganisms.

Further information can be obtained from the [Australian Institute of Occupational Hygienists](#).

Description of activities and classification by class

This table describes the level IPC intervention required to minimise the risk of transmission of organisms that could be harmful to patients and others during the project works.

Class	Activity conducted during project
Class 1	<ul style="list-style-type: none"> • Minimise raising or disturbing dust during activity • Vacuum ceiling as tile is being displaced or removed for inspection • Immediately replace ceiling tiles displaced for visual inspection • Vacuum work areas • Minimize patient's exposure to construction/renovation area, and • Ensure construction zone is thoroughly cleaned when work is complete.
Class 2	<ul style="list-style-type: none"> • Restrict access to the work area to essential staff undertaking the activity • Wet mop and/or vacuum to remove visible dust during activity • Use drop sheets to control dust and airborne infectious agents • Water mist work surfaces while cutting or sawing • Seal windows and unused doors with duct tape • Seal air vents in construction/renovation area • Disable ventilation system until the project is complete • Place dust mat at entrance and exit to work areas • Contain debris in covered containers before transporting for disposal • Wipe horizontal surfaces to keep dust free • Identify high risk patients who may need to be temporarily kept away from construction area • Ensure that patient care equipment and supplies are free from dust exposure, and • Ensure construction zone is thoroughly cleaned when work is complete with wet mop with hot water and detergent and /or vacuum with HEPA filtered vacuum.

Class 3	<p>In addition to measures introduced in Class 1 and 2:</p> <ul style="list-style-type: none"> • Ensure that IPC consultation has been completed and infection prevention measures approved • Erect impermeable dust barrier from true ceiling to floor (e.g. 2 layers of 6mm plastic sheeting) • Ensure windows, doors, plumbing penetrations, electrical outlets and intake and exhaust vents are sealed with plastic and duct taped • Clean and vacuum air ducts and spaces above ceiling as far as accessible, if necessary • Ensure construction workers wear protective clothing that is removed before entering patient areas • Remove dust barrier carefully to minimise spreading dust and other debris associated with construction • Remove debris at the end of each working day • Increase frequency of cleaning in areas adjacent to construction zone, and Design traffic pattern for construction workers that avoid patient care areas and a traffic pattern for clean or sterile supplies and equipment that avoids the construction area.
Class 4	<p>In addition to measures introduced in Class 1, 2 and 3:</p> <ul style="list-style-type: none"> • Erect an impermeable dust barrier and anteroom with walk off mat into patient care area • Check integrity of barriers daily and repair any damage as soon as identified • Seal holes, pipes, conduits, and punctures appropriately • Ensure negative pressure ventilation systems in construction area is separate to patient care areas by sealing off or redirecting directly to outside. Consider HEPA filtration to redirected air • Regularly visit the patient care areas adjacent to the construction zone to ensure preventative measures are effective, and • Use dust monitors in adjacent areas that have been calibrated to the environment.

Table 11: Description of activities and classification by class. Adapted from: **Adapted from:** [Australasian Health Facility Guidelines: Part D- IPC](#), Accessed June 2019

Construction Survey Tool

Below is an example of a construction/ project survey tool. This type of tool may be used for documentation of daily inspection of construction area by Infection Control or delegate.

Barriers			
Patient doors adjacent to area closed	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Dust proof plastic sheeting barriers in place and sealed at ceiling height	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Dust proof rigid barrier walls in place and sealed at ceiling height	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Ceiling space sealed within the work area (between the ceiling tiles and the next slab or roof)	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Project Area			
Debris removed in covered container	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Rubbish in appropriate container	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Entry and exit points clearly identified	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Traffic Control			
Restricted to construction workers and necessary staff only	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
All doors and exits free of debris	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
General public and patient access diverted	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
COMMENTS			

Roles and responsibilities for planning, consultation, implementation and monitoring of infection prevention activities

This table is an example of the infection prevention roles and responsibilities that need to be considered during construction and renovation, responsibilities may vary in different facilities.

Planning and consultation	Responsibility
<p>Infection prevention staff must be consulted, and involvement should be sought at the planning stage to assist with:</p> <ul style="list-style-type: none"> • Education • Design of the project to maximise the safety of staff and patients, and • Review of the schematic design to ensure all preventative measures to maximise dust control are in place. 	<p>Architects/ builders Engineering services IPC</p>
Project design	Responsibility
<p>The ICP in collaboration with facility administration and nursing staff must identify patient population(s) that may be at risk and the appropriate preventative measures to ensure their safety. This includes providing construction/ renovation workers sole access to ensure they avoid patient care areas</p>	<p>IPC Facility administration</p>
<p>Patients who are at increased risk or immunocompromised should be moved to an area away from the work area/ construction zone if the air quality cannot be assured during construction.</p>	<p>IPC Facility administration</p>
<p>Traffic patterns for construction workers should be established that avoid patient care areas and traffic areas for patient services, e.g. food delivery.</p>	<p>Architects/ builders Engineering services IPC</p>
<p>Management must identify whose responsibility it is to stop construction projects if breaches in preventative measures arise.</p>	<p>Facility administration</p>
Education	Responsibility
<p>All personnel involved in the construction/renovation activity should be educated and trained in the infection prevention measures, methods for dust containment and removal of construction debris should be outlined.</p>	<p>Architects/ builders Engineering services</p>

Dust control	Responsibility
Isolation/ventilation	
A dust barrier should be created from the floor to the true ceiling and edges sealed. Plastic sheeting can be used for short term dust barriers.	Architects/ builders Engineering services
All potential sources of air leak should be sealed in the work area/ construction zone. Traffic patterns for construction workers should be established that avoid patient care areas.	Architects/ builders Engineering services
If possible, an elevator or staircase should be designated for the sole use of construction workers. The ventilation of the elevator or shaft should not be recirculated in the facility	Architects/ builders Engineering services
When major demolition or excavation is undertaken, damping down to limit dust should be considered.	Architects/ builders Engineering services
Open ends of exhaust vents should be capped to prevent air exhausted from the work area/ construction zone from being drawn back into patient care areas or released to outdoor streets around the healthcare facility.	Architects/ builders Engineering services
All windows, doors, vents and other sources of potential air leak should be sealed in the work area/ construction zone.	Architects/ builders Engineering services
The work area/ construction zone should be under negative pressure and all exhausted air should be to the outside of the facility. The exhaust location must not be a risk to other air intakes or external services/ people. Consideration should be given to HEPA filtration for exhausted air from work area.	Architects/ builders Engineering services
Environmental cleaning	Responsibility
Areas adjacent to patient areas should be vacuumed with a vacuum fitted with a HEPA filter and damp dusted daily or more frequently if needed.	Environmental services

Waste containment	Responsibility
If a dedicated lift/ corridor is not available then dedicated times should be allocated and cleanings should be completed following these times.	Architects/ builders Engineering services
All waste containers should be covered and all debris removed daily via a dedicated work area/ construction zone access corridor and/ or lift.	Architects/ builders Engineering services
Monitoring	Responsibility
Daily inspection	
The ICP should conduct daily inspections of the adjacent patient care areas for breaches in infection prevention measures. The need for additional cleaning of adjacent patient areas should be assessed and confirmation of adequate dust control can be made by air sampling during the highest level of demolition work or during periods of high dust generation.	IPC
Laboratory surveillance	Responsibility
A baseline rate of clinical isolates of <i>Aspergillus spp.</i> and other significant infectious agents should be established before starting construction/ renovation work. Throughout the project the rate of clinical isolates should be monitored. An increase in the rate should be investigated to determine if associated with the construction/renovation works. All preventative infection measures should be reviewed to ensure that a breach has not occurred and corrective action should be undertaken immediately.	IPC
Air sampling	Responsibility
Air sampling aims to detect <i>Aspergillus spp.</i> colonies in association with the building works. Sabouraud's Dextrose Agar (SABG). Sabouraud's agar, a selective inhibitory mold agar (IMA) media for fungi is used for this test to monitor for <i>Aspergillus spp.</i>	IPC

Bibliography and further resources

Infection Control Principles of the Management of Construction, Renovation, Repairs and Maintenance in Healthcare Facilities: A Manual for Reducing the Risk of Healthcare Associated Infection by Dust and Water-borne Micro-organisms, 2nd Edition.

Australasian Health facility Guidelines Part D – IPC. <http://www.healthfacilityguidelines.com.au/>

Kanamori H, Rutala W, Sickbert-Bennett E, Weber D. Review of fungal infection prevention in healthcare settings during construction and renovation, Healthcare Epidemiology, Clinical Infectious Diseases, 2015:61, August 2015

Pini G, Faggi E, Donato R, Sacco C; Fanci R, Invasive pulmonary aspergillosis in neutropenic patients and the influence of hospital renovation, Mycosis 2008: 51(2)

Chang C, Athan E, Morrissey O et al. Preventing invasive fungal infection during hospital building works. Intern Med J 2008;38(6b):538-41

Chang C, Cheng A, Devitt B et al. Successful control of an outbreak of invasive aspergillosis in a regional haematology unit during hospital construction works. J Hosp Infect 2008;69(1):33-8

Saracli M, Mutli F, Yildiran S et al. Clustering of invasive *Aspergillus ustus* eye infections in a tertiary care hospital: A molecular epidemiologic study of an uncommon species. Med Micol 2007;45(4):377-84

Raviv Y, Kramer M, Amital A et al. Outbreak of aspergillosis infections among lung transplant recipients. Transpl Int 2007;20(2):135-40

Vonberg R, Gastmeier P. Nosocomial aspergillosis in outbreak settings. J Hosp Infect 2006;63(3):246-54

Cornillet C, Camus C, Nimubona S et al. Comparison of epidemiological, clinical and biological features of invasive aspergillosis in neutropenic and non neutropenic patients: a 6-year survey. Clinical Infect Dis 2006;43:577-84

Morgan J, Wannemuehler K, Marr K et al. Incidence of invasive aspergillosis following hematopoietic stem cell and solid organ transplantation: interim results of a prospective multicenter surveillance program. Med Mycol Supplement 1 2005; 43: S49 – S58

Hope W, Walsh T, Denning D. Laboratory diagnosis of invasive aspergillosis. Lancet Infect Dis 2005; 5: 609 – 22

Humphreys H. Positive-pressure isolation and prevention of invasive aspergillosis. What is the evidence? *Journal of Hospital Infection* 2004;56:93-100

Chow T, Yang X. Ventilation performance in operating theatres against airborne infection: review of research activities and practical guidance. *Journal of Hospital Infection* 2004;56:85-92

Cooper E, O'Reilly M, Guest D, Dharmage S. Influence of building construction work on *Aspergillus* infection in a hospital setting. *Infect Control Hosp Epidemiol* 2003; 24:472-476

Lutz B, Jin J, Rinaldi M et al. Outbreak of invasive *Aspergillus* infection in surgical patients, associated with a contaminated air-handling system. *Clin Infect Dis* 2003;37(6):786-93

Panackal A, Dahlman A, Keil K et al. Outbreak of invasive aspergillosis among renal transplant recipients. *Transplantation* 2003;75(7):1050-53

Faure O, Fricker-Hidalgo H, Lebeau B et al. Eight-year surveillance of environmental fungal contamination in hospital operating rooms and haematological units. *Journal of Hospital Infection* 2002; 50: 155-160

Module 10 Basic epidemiology and statistics (Under review)

The online module provides:

- Information on the occurrence of infection transmission
- How bias and confounding affect results
- The common units of measurement; mean, median and percentiles
- The measure of variability; range and standard deviation,
- The different statistical analysis that can be performed; p value, confidence intervals, odds ratio and risk ratio
- How infection is measured and describe the different epidemiology investigations that are conducted
- The scales of measurement in statistics

Incidence

A measure of the frequency with which new cases of illness, injury, or other health condition occurs among a population during a specified period ([CDC](#)).

5 newly colonised patients with MRSA were detected on a weekly screening in Ward C. A total of 30 patients were screened on this day:

- 23 did not have MRSA
- 2 were known to have MRSA from last week's screening, and
- 5 were the newly detected cases.

Therefore: Incidence ratio = $5/30 = 0.17$ Incidence percentage = 17%

Incidence rate

A measure of the frequency with which new cases of illness, injury, or other health condition occur, expressed explicitly per a time frame. Incidence rate is calculated as the number of new cases over a specified period divided either by the average population (usually mid-period) or by the cumulative person-time the population was at risk ([CDC](#)).

In the following example, 5 patients were identified with *S.aureus* bloodstream infections from Ward A in a 30 day period. Ward A had another 16 patients coming in and out of the ward during these 30 days with a total of 257 patient-days of bed occupation in the ward.

Therefore: Incidence ratio = $5/257 = 0.019$
Incidence rate = 19 per 1,000 patient-days

The incidence rate was 19 patients with *S.aureus* bloodstream infections per 1,000 patient-days. This rate can then be compared to the rates:

- In other wards within the same hospital
- In other similar sized hospitals for the same specialty units, and

- Before and after infection control intervention.

When comparing rates, consideration should be given to *variable risk* as patients may have different risk factors or be undergoing procedures that change their risk factors. The risk affecting the rates can be used to identify higher or lower rates and how they impact upon patient safety.

Prevalence

The number or proportion of cases or events or attributes among a given population ([CDC](#)).

In the following example, 5 newly colonised patients with MRSA were detected on screening in Ward B on one day. A total of 30 patients were screened on this day:

- 23 patients did not have MRSA
- 2 were known to have MRSA from last week's screening, and
- 5 were the newly detected cases.

Therefore: Prevalence ratio = $7/30 = 0.23$
Prevalence percentage = 23%

Types of studies used in epidemiology

Various studies can be conducted on a [sample population](#) by collecting data over a defined time period. Epidemiological data can be used to record disease or infections, to identify modes of [transmission](#) and identify [risk factors](#).

There are two types of studies used in epidemiology; observational and experimental studies.

Examples of observational studies

Ecological study

An example of an ecological study would be a comparison of hospital-wide use of vancomycin with prevalence of VRE in the hospital. Additional studies would be required to further explore the data.

Cross sectional study

A cross-sectional study is a study in which a sample of persons from a population are enrolled and their exposures and health outcomes are measured simultaneously. This type of study can be either prospective or retrospective ([CDC](#)).

An example of a cross sectional study would be an investigation of all patients

in hospital with VRE and whether they have received vancomycin. This study then can lead to analysis of the population as either a case control or cohort study.

Case control study

A case-controlled study is a retrospective observational analytic study that enrolls one group of persons with a certain disease, chronic condition, or type of injury (cases) and a group of persons without the health problem (controls) and compares differences in exposures, behaviors, and other characteristics to identify and quantify associations, test hypotheses, and identify causes ([CDC](#)). An example of a case control study would be an investigation of patients with central venous catheters who had BSI (cases) and those that did not (controls) in the intensive care unit over the same time period to identify the risk factors relating to central venous catheters and acquisition of BSI.

Cohort study

A cohort study is a prospective observational analytic study in which enrollment is based on status of exposure to a certain factor or membership in a certain group. Populations are followed, and disease, death, or other health-related outcomes are documented and compared. Cohort studies can be either prospective or retrospective.

A cohort is a well-defined group of persons who have had a common experience or exposure and are then followed up, as in a cohort study or prospective study, to determine the incidence of new diseases or health events ([CDC](#)).

An example of a cohort study would be an investigation of risk factors in patients with central venous catheters who had BSI and those that did not in the intensive care unit over the same time period.

	Cohort studies	Case control studies
Suited for rare diseases	No	Yes since starting with a set of cases
Suited for rare exposures	Yes since starting with exposure status	No
Allows for studying several exposures	Difficult but examples exists (Framingham study)	Yes
Allows for studying several outcomes	Yes	No
Disease status easy to ascertain	Sometimes difficult	Easier since starting point of the study
Exposure status easier to ascertain	Yes since starting point of the study. Except for retrospective cohorts	Sometimes difficult. Information biases.
Allows computation of risk and rates	Yes	No
Allows computation of effect	Computation of risk ratio and rate ratio	Estimation of risk ratio, rate ratio from odds ratio
Allows studying natural history of disease	Yes Easier to show that cause precedes effect.	More difficult Temporality between cause and effect difficult to establish
Based on existing data sources	Difficult	Yes but access to information sometimes difficult
Easiness to find a reference group	Usually not difficult to identify an unexposed population	No Major potential biases when selecting a control group
Sample size	Large	Small
Cost	Elevated except if retrospective cohorts	Smaller
Time required	Long, sometimes very long except if retrospective cohorts	Shorter
Follow up	Difficult, loss to follow up	No follow up
Logistics	Heavy Many staff, large data sets Long duration	Easier
Concept	Easy to understand	Difficult to understand particularly if case cohort or density case control study
Ethical issues	Major if studying risk factors. Interruption of study if exposure shown to be harmful. Need for intermediate analysis.	None since outcome already happened.

Table 12: Advantages and disadvantages of cohort and case control studies. Source: European Centre for Disease Prevention and Control (ECDC) Field Epidemiology Manual, Access June 2019, access [here](#)

Examples of experimental studies

An experimental study is a study in which the investigator specifies the type of exposure for each person (clinical trial) or community (community trial) then follows the person's or community's health status to determine the effects of the exposure ([CDC](#)). An experimental study may look at the effectiveness of an antibiotic by which a group of people are given the new antibiotic while the others receive the current treatment. All other factors are kept constant while the antibiotic is the only experimental factor (variable) that will or will not show an effect.

Randomised controlled trials (RCT)

An RCT is a study in which a number of similar people are randomly assigned to two (or more) groups to test a specific drug, treatment or other intervention. One group (the experimental group) has the intervention being tested, the other (the comparison or control group) has an alternative intervention, a dummy intervention (placebo) or no intervention at all. The groups are followed up to see how effective the experimental intervention was. Outcomes are measured at specific times and any difference in response between the groups is assessed statistically. This method is also used to reduce bias ([NICE](#)).

An example of a randomised controlled trial would be where patients in the intensive care unit are randomly assigned to either a new antibiotic or the current antibiotic treatment for MRSA bacteraemia and then compared for mortality and length of hospital stay outcomes.

Bias

Bias is defined as any systematic error in the design, conduct or analysis of a study that results in a mistake of the estimate between the exposure and risk of infection.

Bias examples

Selection bias

Selection bias is a systematic difference in the enrollment of participants in a study that leads to an incorrect result (e.g., risk ratio or odds ratio) or inference ([CDC](#)).

Selection bias occurs where volunteers may not be representative of a true population as these are patients who want free treatment and they may differ to non-volunteers.

Information bias

Information bias is a systematic difference in the collection of data about the participants in a study (e.g., about exposures in a case-control study, or about health outcomes in a cohort study) that leads to an incorrect result (e.g., risk ratio or odds ratio) or inference ([CDC](#)).

Information bias can occur if patients are aware of their infection status as they may try to identify possible reasons for obtaining a resistant infection. This group would be more likely to remember recent antibiotics that they have been given

Confounding

Confounding is the distortion of the association between an exposure and a health outcome by a third variable ('confounder') that is related to both ([CDC](#)).

For example, in assessing the association between VRE infection and mortality in a gastro-surgical unit, we need to consider complexity of surgery as a potential confounder. Complex surgical patients are more likely to be on vancomycin and develop VRE but these patients are also more likely to die. As complexity of surgery is associated with both exposure and outcome it is a potential confounder.

Basic statistics

Statistics allow clinicians to have an understanding of the significance of the epidemiological data and to determine if it is statistically significant or not in the applied setting. An understanding of the terminology and how it is applied in research will also assist with the interpretation of scientific journal articles and research findings.

Mean (μ)

Mean is the measure of central location, commonly called the average, calculated by adding all the values in a group of measurements and dividing by the number of values in the group [\(CDC\)](#).

To calculate the mean for the set of 10 numbers displayed here:

10.5, 10.8, 10.9, 11.9, 12.4, 12.8, 15.2, 11.1, 11.7, 10.1

Total sum $X = 117.4$ and number of observations $n = 10$.

Therefore: $117.4/10 = \text{mean } 11.7$.

Median

Median is the measure of central location that divides a set of data into two equal parts [\(CDC\)](#).

To calculate the median for the following set of numbers:

10.5, 10.8, 10.9, 11.9, 12.4, 12.8, 15.2, 11.1, 11.7, 10.1

Arrange them in numerical order:

10.1, 10.5, 10.8, 10.9, 11.1, 11.7, 11.9, 12.4, 12.8, 15.2

The median is between 11.1 and 11.7. The median is the middle number. If there is two middle numbers, the median is halfway between the two middle numbers.

Median = **11.4**

Percentiles

Percentiles are a set of cut points used to divide a distribution or a set of ranked data into 100 parts of equal area with each interval between the points containing 1/100 or 1% of the observations [\(CDC\)](#).

If we use our previous set of numbers:

10.5, 10.8, 10.9, 11.9, 12.4, 12.8, 15.2, 11.1, 11.7, 10.1

Therefore:

- 25th percentile = (10.5, 10.8) = **10.6**
- 50th percentile = (11.1-11.7) = **11.4**
- 75th percentile = (12.4-12.8) = **12.6**.

Normal distribution

Normal distribution is a distribution represented as a bell shape, symmetrical on both sides of the peak, which is simultaneously the mean, median, and mode, and with both tails extending to infinity ([CDC](#)).

The height of adults in Australia follows a normal distribution with a mean (μ) of 174 cm and a standard deviation (σ) of 6 cm.

Therefore:

- 68.2% of observations will be between ± 1 standard deviation (168-180cm)
- 95.4% of observations will be between ± 2 standard deviations (162-186cm), and
- 99.6% of observations will be between ± 3 standard deviations (156-192cm).

Range

Range is the difference between the largest and smallest values in a distribution; in common use, the span of values from smallest to largest ([CDC](#)).

Using the set of numbers from our previous sample: 10.5, 10.8, 10.9, 11.9, 12.4, 12.8, 15.2,

11.1, 11.7, 10.1

We would rearrange them in numerical order:

10.1, 10.5, 10.8, 10.9, 11.1, 11.7, 11.9, 12.4, 12.8, 15.2

Therefore, the **range** is (10.1 – 15.2).

Standard Deviation (σ)

Standard deviation is a statistical summary of how dispersed the values of a variable are around its mean, calculated as the square root of the variance ([CDC](#)).

To use the set of numbers from our previous example: 10.5, 10.8, 10.9, 11.9, 12.4, 12.8, 15.2,

11.1, 11.7, 10.1

We would again arrange them into numerical

order. 10.1, 10.5, 10.8, 10.9, 11.1, 11.7, 11.9,

12.4, 12.8, 15.2

Therefore:

- Mean = 11.7, and
- Calculated SD = **1.5**.

This means that 95% of results will be between (11.7-1.5) to (11.7+1.5), that is, 10.2 to 13.2.

If the distribution is "normal", 95% of all observed results will be located between the mean +/- 1.96 SD.

Confidence intervals

Confidence intervals are a way of expressing how certain we are about the findings from a study, using statistics. It gives a range of results that is likely to include the 'true' value for the population. A wide confidence interval indicates a lack of certainty about the true effect of the test or treatment - often because a small group of patients has been studied. A narrow confidence interval indicates a more precise estimate (for example, if a large number of patients have been studied). The confidence interval is usually stated as '95% CI', which means that the range of values has a 95 in a 100 chance of including the 'true' value ([NICE](#)).

Confidence intervals are a range of values for a measure (e.g. rate or odds ratio) constructed so that the range has a specified probability (often, but not necessarily, 95%) of including the true value of the measure ([CDC](#)).

p value

The p value is a statistical measure that indicates whether or not an effect is statistically significant. For example, if a study comparing two treatments found that one seems to be more effective than the other, the p value is the probability of obtaining these results by chance.

By convention, if the p value is below 0.05 (that is, there is less than a 5% probability that the results occurred by chance) it is considered that there probably is a real difference between treatments. If the p value is less than 0.001 (less than a 1% probability that the results occurred by chance), the result is seen as highly significant. However, a statistically significant difference is not necessarily clinically significant. The following provides an example of the difference between statistical significance and clinical significance.

Example, drug A might relieve pain and stiffness statistically significantly more than drug B. But, if the difference in average time taken is only a few minutes, it may not be clinically significant (adapted from [NICE](#)).

The incidence rate for acquiring VRE from another patient in a four bed room has a Relative Risk of 2.9 [95% CI, 1.3-4.4], $p = 0.01$.

This means that the risk of acquiring VRE from another patient sharing the four bed room is 2.9 times increased with the true value 95% of the time being as low as 1.3 or as high as 4.4. As it does not cross 1, the p value of 0.01 is supported as significant.

Other common statistical tests

Anova: Tests for statistical significance between means of several subgroups (multiple testing).

Chi-square: Tests the relationship between the frequencies of two factors.

Correlation coefficient: A measure of association that indicates the degree to which two variables have a linear relationship. Results can be between -1 and +1.

Fisher's exact: Used to test association of 2x2 frequency table for sparse data or small numbers (<20).

Kruskal-Wallis: Extension of Wilcoxon for comparing more than 2 groups

Mann-Whitney: Used when sample data are not normally distributed. Test compares two independent groups of ordinal scores.

McNemar's Test: A form of Chi-square test for matched pair's data.

Multivariate Analysis: Involves the observation and analysis of more than one statistical variable at a time.

Pearson Correlation: Used to determine if the values of two normally distributed variables are linearly associated.

Regression: Determines the relationship between one dependent (response) variable and one or more independent variables.

T-test: Used to test the hypothesis involving numerical data that is normally distributed. It determines whether the mean observations differ significantly from a test value.

Univariate Analysis: Explores each variable in a dataset separately.

Wilcoxon: Used instead of the T-Test, when sample data are not normally distributed. It is similar to a Mann-Whitney test but used for dependent data, for example, matched or repeated samples.

Bibliography and further resources

Basic and Clinical Biostatistics. 4th Edition. Edited by B. Dawson, RG. Trapp. McGraw- Hill Higher Education, Singapore, (2004)

Electronic version - Basic and Clinical Biostatistics. 4th Edition. Edited by B. Dawson, RG. Trapp. <https://accessmedicine.mhmedical.com/book.aspx?bookID=356>

Bennett and Brachman's, Hospital Infections. 6th Edition. Edited by William R Jarvis. Lippincott Williams & Wilkins, Philadelphia, USA (2014)

Epidemiology. 5th Edition. Edited by L. Gordis. W.B. Saunders Company, USA (2014)

Essential Epidemiology. An introduction for students and health professionals. 2nd Edition. Edited by P Webb, C Bain and S Pirozzo. Cambridge University Press, UK (2011)

European Centre for Disease Prevention and Control (ECDC) Field Epidemiology Manual <https://wiki.ecdc.europa.eu/fem/w/wiki/advantages-and-disadvantages-of-cohort-and-case-control-studies>

Medical calculator (Last accessed 24/05/2019) <http://www.medcalc.be/manual/index.php>

Microbiology an Introduction. 12th Edition. Edited by GJ Tortora, BR Funke and CL Case. Pearson International Edition, San Francisco, US (2016)

National Institute for Health and Care Excellence (NICE), Glossary. Access glossary [here](#)

Principles of Epidemiology in Public Health Practice: Third edition, An Introduction to Applied Epidemiology and Biostatistics, Centres for Disease Control and Prevention (CDC), Atlanta USA, November 2011. <https://www.cdc.gov/csels/dsepd/ss1978/index.html>

Glossary Self Study Course 1978 Principles of Epidemiology in Public Health Practice (CDC). <https://www.cdc.gov/csels/dsepd/ss1978/index.html>

AUSTRALIAN COMMISSION
ON SAFETY AND QUALITY IN HEALTH CARE

Level 5, 255 Elizabeth Street, Sydney NSW 2000
GPO Box 5480, Sydney NSW 2001

PHONE: (02) 9126 3600

FAX: (02) 9126 3613



@ACSQHC

[safetyandquality.gov.au/](https://www.safetyandquality.gov.au/)