Infection Prevention and Control

CLPNA Self-Study Course
2018
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Introduction

Purpose

Infection control was recognized centuries ago as a harsh reality and it remains in the foreground of healthcare today. There are new and evolving infections and diseases that everyone in healthcare delivery should be aware of. It is important that healthcare providers make positive changes to improve protection for themselves and the public they serve.

In 2008 the Government of Alberta took measures to lead infection prevention and control, and client safety by implementing a province-wide infection prevention and control (IPC) strategy with clear direction and standards. The strategy identified key directions and specific actions to prevent infections in healthcare facilities and improve the quality of patient care and patient outcomes. The directions included provincial standards, monitoring, public awareness campaigns, hand hygiene, and education.1

According to Alberta Health’s Infection Prevention and Control Strategy of 2015, “IPC is a term used to describe activities intended to protect individuals from infections. Every day, Albertans prevent and control infections by frequently cleaning their hands, keeping their living and working environments clean and tidy, getting immunized for vaccine preventable diseases and by staying home when sick. In healthcare settings, IPC measures are enhanced to protect more vulnerable populations from acquiring healthcare-associated infections. These types of infections can increase hospital lengths of stay, cause patient health complications and may even result in death.”1(p3)

Overall Learning Objectives

After completing this course, learners will have

- acquired increased knowledge about some common infectious microorganisms in the healthcare system;
- developed increased knowledge of basic principles of infection prevention and control;
- recognized the negative outcomes of lack of infection prevention;
- applied principles and universal precautions to nursing activities, each client situation, and professional issues for safe outcomes and evidence-based practices; and
- determined how to promote awareness about the importance of practices to prevent and control the spread of infections.

Course Outline

This infection prevention and control course consists of four modules.

1. Module 1: A Brief History of Medical Microbiology. This section will give a brief overview of medical microbiology and infectious organisms, including the impact and basic principles that must be understood to mitigate infection.
2. **Module 2: Precautions.** Topics include a brief history of routine practices, routes of transmission of infectious organisms, isolation, point-of-care risk assessment, and additional or necessary precautions.

3. **Module 3: The Infectious Client—Non-Hospital Acquired Infections.** The topics in this module review the different classes of microorganisms (viruses, bacteria, ectoparasites), considerations for the healthcare practitioner during exposure, necessary knowledge, awareness, and prevention.

4. **Module 4: Healthcare-Associated Infections.** This module studies the infections acquired by hospital clients that may be preventable when proper steps are followed.

**Strategies for Learning Success**

To achieve a successful learning experience from this module, learners will

- study the module information;
- access the additional resources as needed for self-study and additional knowledge; and
- summarize learning for the Continuing Competency Program using the online record of learning tool or other organized manner.
Module 1: A Brief History of Medical Microbiology

Specific Learning Outcomes
After successful completion of this module, you will be able to

- review the history of infection control;
- recognize that handwashing helps prevent and control the spread of infection;
- identify the relationship between medical microbiology and infection control; and
- explain the purpose of infection control in the healthcare setting.

Introduction
For longer than there have been hospitals, there have been issues with infection control. A historical example of this is puerperal fever, later called “the doctors’ plague.”

Puerperal fever was caused by a uterine infection contracted during childbirth, and it carried high mortality rates for new mothers following delivery. Between the 1600s and 1800s, the fatality rate of puerperal fever was 10 - 35%; meaning that for every 100 babies born, 10 to 35 mothers died.

While practising obstetrics in Vienna during the 1800s, Hungarian doctor Ignaz Semmelweis noticed the rate of puerperal fever was lower in home deliveries than in hospitals. After further investigation he concluded that by simply washing his hands in an aseptic solution of chlorinated water, he could reduce the mortality rate of puerperal fever by 90%. Unfortunately for Dr. Semmelweis, publishing his results was the beginning of his end. His results went against the conventional wisdom at the time, which was that “doctors [were] gentlemen, and gentlemen’s hands [were] clean”, even if they had just performed an autopsy before proceeding to the delivery room. Ostracized and humiliated, Semmelweis was eventually committed to a mental asylum, where he died shortly after. It was not until Louis Pasteur garnered acceptance of the germ theory of disease in the 1860s that Dr. Semmelweis was vindicated postmortem.

There are many lessons regarding infection control that can be learned from history. The most important lesson is handwashing. Washing hands with plain soap and running water is one of the most important steps to take to avoid getting sick and to prevent spreading infections to others. Healthcare providers can be vectors or carriers of infection from client to client. Today we know better than the misconceptions that prevented Dr. Semmelweis’ lesson from being accepted; the simple act of handwashing can save lives.

†Words or phrases in bold are listed in the Glossary upon first reference.
**Brief History of Medical Microbiology**

Before medical microbiology came along, the best explanation for infection was that it was caused by supernatural forces and the best cure was magic.\(^7\) This changed in the 1700s when a Dutch textile merchant named Antonie van Leeuwenhoek was looking for a method for determining cloth quality. Van Leeuwenhoek discovered that by combining two magnifying glasses, magnification increased. He then developed the first microscope and discovered bacteria, which he referred to as “cavorting wee beasties.”\(^8\)

Medical microbiology saw explosive growth in the 1800s due to Louis Pasteur and Robert Koch, who developed vaccines and better methods of identifying bacteria.\(^9\) By the 1950s, with the development of the polio vaccine and antibiotics such as penicillin, it was concluded that modern medicine had conquered microbiology and the risks of infection. There was a fallacy that the study of microbiology was no longer relevant.

This victory was short-lived for many reasons as over time bacteria developed resistance to antibiotics. When penicillin was first used, it was assumed it could treat all bacterial infections. However, some bacteria demonstrate resistance to penicillin.\(^10\) Other bacteria may show initial susceptibility to an antibiotic but are then able to mutate and acquire resistance; methicillin-resistant *Staphylococcus aureus* (MRSA) is one example.\(^10\)

**Medical Microbiology**

Classifying and isolating a microorganism involves microscopic identification and/or culturing.\(^11\) Microscopic identification depends upon the size of the microorganism. Bacteria, fungi, and ectoparasites (i.e., lice and scabies) can be identified using a light microscope.\(^11\) Light microscopes consist of a series of glass lenses that can magnify an object up to 400 times its size. These microscopes are considered standard equipment in any medical laboratory.

Fungal infections are identified the same way as bacterial infections. Identifying smaller microorganisms such as viruses requires the use of an electron microscope.\(^11\) Electron microscopes use a high-energy beam to flood the specimen and form an image on a cathode ray tube. This microscope can magnify an object to one million times its size.\(^12\)

**Immunology**

The invention of the microscope made it possible to see microorganisms. However, there are different processes of identifying pathogenic microorganisms beyond smearing a specimen on a microscope slide.

If there is a viral infection, the virus present has proteins called antigens.\(^11\) When a virus infects a client, his or her immune system produces antibodies against the antigens to destroy the virus. By testing for the presence of these antibodies, the illness causing virus can be identified. For example, testing a swab of a client’s nasopharyngeal tract for viral antibodies may assist with diagnosis.
There may be other indicators of viral infections for those receiving healthcare. One example is of a client presenting with hepatitis. A yellow hue in the client’s skin and eyes is a commonly observed symptom. To confirm a diagnosis the client’s blood should be tested for the presence of antibodies against the three viruses that most commonly cause hepatitis: hepatitis A, hepatitis B, and hepatitis C. If the test reveals the client has no antibodies against hepatitis B or C but has developed enough antibodies against hepatitis A, it confirms a positive diagnosis.

**Routine Practices and Additional Precautions for Viral Infections**

When a client has a viral infection, *routine practices* and *additional precautions* should be in place in the healthcare setting. These recommendations include an ongoing risk assessment to minimize the risk of exposure and transmission of an infectious disease from client to client, client to healthcare provider, and healthcare provider to client across the continuum of care.

All healthcare providers must be aware of the additional precautions required until a confirmed diagnosis of the disease. For instance, if a client with a certain or presumed diagnosis of hepatitis A is admitted to a hospital, he or she should immediately be placed on contact, blood, and body fluid precautions.

To ensure immediate steps are put in place for prevention of an outbreak and to mitigate applicable risk, “physicians, health practitioners and others listed in Sections 22(1) or 22(2) of the *Public Health Act* shall complete [the Alberta Health] Notifiable Disease Report (NDR) form used to notify the Medical Officer of Health (MOH) (or designate) of all confirmed and probable cases by the Fastest Means Possible (FMP) i.e., direct voice communication.”

In Alberta, anyone diagnosed with a viral infection or accidentally exposed to a potential viral infection, shall be investigated to determine the infection source, regardless of their home address. As per the *Public Health Act* and *Communicable Diseases Regulation*, an NDR form ensures Alberta Health is abreast of specific diseases with the level of urgency necessary to ensure the health and safety of all Albertans.

**Infection Control in the Healthcare Setting**

The purpose of infection control in healthcare settings is to monitor and prevent nosocomial infections during the delivery of healthcare services. A healthcare-acquired infection (HAI), also known as a nosocomial infection, can be transmitted to both client and healthcare provider and spread to other clients, families, colleagues, or the public. Nosocomial infections are caused by bacteria, viruses, fungi or parasites. The best approach is to determine the risks of infection, how infections are spread, and how to implement preventative measures.
HAIs can be bacterial, viral, fungal or ectoparasitic and may develop in the bloodstream, urinary tract, respiratory tract, skin, bone, intestine and other vital organs such as lung and heart. Healthcare providers must be aware that infections can spread easily and through accidental exposure from healthcare providers, family, or visitors.

**Conclusion**

In this module you learned how infection prevention was discovered through a snapshot of microbiology history. Over time, basic infection control techniques such as appropriate hand washing has been identified as a key factor and preventative measure to minimize infection and enable the delivery of safe healthcare. By adopting infection prevention and control strategies and precautionary measures, we can minimize the spread of infection, prevent outbreaks, and protect ourselves, our clients, our families, and future generations.
Module 2: Precautions

Specific Learning Outcomes
After successful completion of this module, you will be able to

- describe the history of isolation precautions in Canada;
- summarize the practice of universal blood and body fluid precautions;
- explain a point-of-care risk assessment; and
- describe routine (standard) practices and additional precautions in infection prevention and control.

A Brief History of Isolation Precautions in Canada

Originally, infectious diseases meant isolation for a client in particular hospitals or sanatoriums. Later, clients with infections were put into categories, and specific practices and precautions were put in place. This was often time-consuming with a higher chance of accidental exposure to various infections for healthcare providers.13

Major modification of isolation precautions occurred with the appearance of the human immunodeficiency virus (HIV) in the 1980s.13 Because a client with HIV may not necessarily display symptoms of illness, there was a chance that healthcare providers could unknowingly be exposed to the virus if they came into contact with certain body fluids of an infected individual.17 At that time the fatality of HIV appeared to be certain and so the only choice was to treat all clients as potentially infectious and practice universal blood and body fluid precautions.18

Universal blood and body fluid precautions use various methods to prevent transmission of blood, body fluids, and other pathogens through contact.13 These precautions include routine practices and additional precautions such as hand hygiene, biomedical waste and sharps handling, environmental cleaning, respiratory hygiene, visitor management, and use of personal protective equipment (PPE) with all clients, including

- gloves;
- gowns; and
- masks and eye protection.

In 1996 the American Centers for Disease Control and Prevention revised their isolation guidelines, and in 1999 the Public Health Agency of Canada set out guidelines in “Routine Practices and Additional Precautions for Preventing the Transmission of Infection in Healthcare Settings.”13, 19
Isolation Precautions

The following case examples use the outbreak of a deadly infectious viral disease named severe acute respiratory syndrome (SARS) to demonstrate the critical impact isolation precautions can have and the importance of applying them in practice.20 The first example highlights that when insufficient attention is paid to the necessary precautions, the healthcare provider may put themselves and others at risk. The second shows the potential impact of ignoring the need to have responsive precautions in place.

Example 1:
On March 6, 2003, a gentleman arrived in Vancouver from China with respiratory distress and went directly to his physician. Upon examination, the physician sent him to the emergency room of a tertiary-care hospital, where he was immediately placed under full respiratory precautions. Within hours, he was transferred to a negative pressure isolation room (NPIR) in the intensive care unit.21 Several weeks later another person returned to Vancouver from China with similar symptoms, was transferred from her physician’s clinic directly to the hospital, and placed in an NPIR. Interestingly, a nurse who treated the second client neglected to wear eye protection, developed respiratory-distress symptoms the following day, and was admitted to a hospital and placed in an NPIR. As Vancouver already had an established protocol for clients who returned from Asia suffering from flu-like symptoms, the spread of illness was contained. Today, when clients are diagnosed with an unknown strain of influenza the appropriate precautions are immediately applied until the etiology of the illness is more determined.21

Example 2:
In Ontario, a young man returned to Toronto from China and, within weeks, died at home. Shortly thereafter his son became ill, was admitted to the hospital, and died less than a week later. At this point, the rest of the man’s family was brought into the hospital and put in isolation within 24 hours. Reported cases continued, and eventually the infection spread to 225 residents in Toronto. Of this total number, only three were from the initial case, also known as the index case. Toronto had no policy or protocol in place regarding clients returning from Asia suffering from flu-like symptoms, and as a result the SARS outbreak had a devastating effect.21

These examples illustrate the rationale behind identifying an infectious disease as soon as possible after a client is admitted. They also show that routine practices and appropriate precautions are equally important. With any presenting infection, until the causative agent is diagnosed, routine practices and additional precautions should be in place to protect the client, the public, and the healthcare team.

Infectious Organisms and Isolation

There are two kinds of precautions: routine (also known as standard), and additional precautions (divided into three categories: contact, droplet, and airborne).13 To prevent the spread of infectious diseases, facilities should have policies and procedures that implement routine practices and additional isolation precautions for every client (and microorganism). Additional isolation precautions are typically categorized as: contact, droplet, and airborne.13 Contact, droplet, and airborne isolation precautions are applied when routine practices will not prevent significant infectious agents (such as antibiotic-resistant organisms) from creating health risks to others in the healthcare setting. However, it
is doubtful there would be enough resources to put every client with an infection in an NPIR.

Theoretically, any infectious organism can be spread by contact, droplet, or airborne transmission. There are numerous factors that determine the best route of transmission for a pathogen, such as size, virulence, and viability, as well as the host’s immune response to that pathogen. Therefore, it is important not to place infectious organisms into restrictive categories. An example is *Bordetella pertussis*, the highly contagious respiratory tract infection commonly called whooping cough. Usually the disease is spread by coughing and releasing droplets into the air. But these infectious droplets can also land on inanimate objects, becoming potentially infectious through contact.\(^{13}\)

*Bordetella pertussis* demonstrates the complexity and variability of infectious organisms. **Point-of-care risk assessment (PCRA)** is necessary to determine the most suitable isolation precautions to apply.

**Point-of-Care Risk Assessment (PCRA)**

It is essential for healthcare providers to complete a PCRA prior to interaction with the client and/or the client’s environment.\(^{13}\) This type of assessment provides the healthcare provider with information to determine and apply the right control measure (routine practices and when necessary, additional precautions) to prevent transmission of infectious organisms.\(^{13}\) During this assessment, the following questions should be asked:

- What kind of contact with the client will occur?
- What procedures are healthcare providers going to perform in the care of the client? For example, a physician about to perform an aerosol-generating medical procedure (AGMP) will wear different PPE than a dietician performing a clinical assessment.\(^{13,22}\)
- Will infectious materials be a safety or health concern? For example, will a client with diarrhea require a different approach than a client who is coughing and sneezing?
- What is the client’s mental status? Is the client able to maintain personal hygiene, or does he or she require assistance? Does the client understand hand hygiene? If droplet or airborne precautions are enforced, will the client follow all PPE protocols?
- Is the client in a single room or a ward room?
- Are there any special circumstances regarding the client’s health and condition? For example, clients undergoing chemotherapy will be more susceptible to infection and may require reverse isolation. A pediatric client may also require specific considerations and accommodations in hospital. Children require different precautions as their immune systems are not as well developed as adults.\(^{13}\)

Are visitors required to follow the same PPE protocols? For example, if a client with scabies is placed on contact isolation it is critical that any visitor follows PPE protocols to protect other clients in other wards and other visitors, staff, and the community at large.\(^{13}\)
Routine (Standard) Practices

Routine practices are the IPC practices used “in the routine care of all clients at all times in all healthcare settings, determined by the circumstances of the client, the environment and the tasks performed.” They apply to all healthcare providers and should be taught to clients, family, and visitors. Routine practices include the following:

- **Point-of-care risk assessment**—A PCRA should be completed upon client admission to hospital to determine which applicable routine precautions will be required for prudent nursing care.

- **Hand hygiene**—Hand hygiene is one of the greatest defences against transmission of infection. It is critical for family, visitors, and staff, as well as clients, to maintain strict hand hygiene at all times, including prior to leaving their hospital rooms. Alcohol-based hand rinse containing at least 60% alcohol is effective for the majority of pathogens. But, regrowth of bacteria on the skin occurs slowly after use of alcohol-based hand antiseptics. In addition, anything involving a non-enveloped virus (i.e. adenovirus, parvovirus, influenza) or spore-forming bacteria (i.e. *Clostridium difficile*) will require the use of soap and water, particularly during an outbreak or situation where there is a high risk of transmission. Thoroughly washing hands with soap and water remains the best defence.

- **Client flow**—There are various client flow measures that should be considered in routine practices, including triage procedures and respiratory hygiene of clients and visitors (as well as adequate space between clients and visitors) if any form of respiratory infection is suspected.

- **Aseptic technique**—Aseptic technique must be followed during handling of equipment, medication administration, or invasive procedures.

- **Personal protective equipment**—PPE includes gloves, gowns, masks, and eye protection. PPE must follow principles of routine/standard precautions. Healthcare providers must properly don, doff, and dispose of PPE following single use because PPE is not reusable or recyclable.

- **Isolation procedures**—Isolation procedures begin with proper hand hygiene. Other protocols may include avoiding contact with other clients, refraining from entering public areas, and maintaining individual client-care equipment.

- **Visitor management**—Visitors must follow the same protocol as clients and any healthcare providers.

- **Safe handling of sharps** – Safe handling of sharps reduces exposure to bloodborne pathogens. Healthcare providers should use appropriate barriers and safe work practices when using sharp instruments and devices (i.e. needles, scalpels, etc.), after procedures and when cleaning used instruments. Safe handling also includes point of use disposal receptacles for sharps and use of puncture resistant containers with clear labels, as well as a handle and tight fitting lid to reduce risk in the work area.
• Management of the patient care environment:
  o cleaning of the patient care environment
  o cleaning and disinfection of non-critical patient care equipment
  o handling of waste and linen

• Education of patients, families and visitors

This is a sample list of routine (standard) practices within a healthcare setting or hospital. For further information on these suggested practices and other practices that may impact healthcare services, please refer to the Public Health Agency of Canada website at www.phac-aspc.gc.ca.

Additional Precautions

Routine practices of infection prevention and control during all client-care services at all times in every healthcare setting are today’s expectation. When a client exhibits symptoms of an infection, additional precautions may also be applied. There are three main categories of additional precautions: contact, droplet, and airborne. The characteristics and/or the impact of the infectious agent will help determine the appropriate additional precaution guideline to implement.

Additional precautions are necessary when a client is diagnosed with an infectious agent that cannot be controlled with routine practices. For example, when an infection is spread through the droplet route, (i.e. respiratory virus), a single room should be considered. If a single room is not possible; two clients with the same diagnosis can share a room. Another example of where additional precautions should be used is when a client has an MRSA infection he or she may be placed in the same room as other clients who are positive for MRSA.

Healthcare providers should be aware that some microorganisms may require more than one type of precaution (i.e. during influenza season, droplet and contact precautions are required). Other factors to consider include, client’s health, age, and environment, when determining what kind of additional precautions are required, i.e. a pediatric client may require both airborne and contact precautions. It is recommended that client, family, and visitors be educated about the precautions in place.

Contact Precautions

Research shows that infectious microorganisms are spread from an infected source to a host either through direct physical contact or touch and indirect contact or exposure from an inanimate object. If a client is suspected of having an infection that can spread by direct or indirect contact, contact precautions should be implemented. There are several conditions and/or clinical presentations that indicate contact precautions should be implemented. Some of these clinical presentations include acute viral respiratory infections, cold, cough, fever, draining wounds, and various rashes. For further examples see Public Health Agency of Canada, Routine practices and additional precautions for preventing the transmission of infection in healthcare settings. Many different microorganisms can cause the given clinical presentations. It is important for healthcare providers to recognize these potentially infectious clinical presentations and take appropriate contact precautions until the contributing agent has been identified. Public Health determines if contact precautions remain in place or can be removed.
Once again, hand hygiene and use of protective gloves are key factors in infection prevention. Long-sleeve gowns should also be worn during any direct contact with either the client or any inanimate objects that may serve as reservoirs for causative microorganisms. If the client is required to be transferred to another area of the hospital,

- clean clothing and bedding should be provided;
- draining wounds should be contained;
- infected areas should be covered;
- hospital personnel in the area the client is being transported should be informed of the precautions;
- and efforts should be made to minimize the amount of time the client spends in the waiting area and outside department or hospital room.13

Droplet Precautions
As discussed previously, necessary additional precautions will depend on the microorganism’s primary route and risk of transmission. Consider the size and gravity of the pathogenic microorganisms. In droplet exposure and transmission, large droplets containing an infection are formed and may travel up to two metres during coughing, talking, sneezing, and medical actions; landing on inanimate objects (may contribute to contact transmission) or deposited on mucous membranes of a host.13(p18)

Brief lists of conditions and/or clinical presentations that indicate droplet precautions should be implemented include:

- influenza;
- pertussis (whooping cough);
- mumps; and
- meningitis.13

In addition to any other precautions required in a given case, droplet precautions can include a single room and/or an airborne-infection isolation room (with air exchange on a regular basis); diligent hand hygiene; use of gloves; following PPE protocols including using a respirator mask (N95 or higher); and isolation precautions when necessary.13 Droplet precautions recommend that long-sleeve gowns should be worn during any direct contact and facial protection (i.e. masks, eye protection, face shields) can be worn when necessary. If transport is necessary at any time, the client should wear a mask. If the client is unable to wear a mask, the transport personnel should ensure they are appropriately protected.13

Public Health determines if droplet precautions remain in place or can be removed.29 For further information, see Public Health Agency of Canada, Routine practices and additional precautions for preventing the transmission of infection in healthcare settings.13(p75-81)

Airborne Precautions
When an infectious microorganism is transferred through the air, airborne precautions are necessary.13 During airborne transmission, small particles with microorganisms are released over a small or large area, and inhaled. These particles are small enough for immediate airborne exposure or can float in the air for a longer period of time until contact with a susceptible host.13(p 19)

Airborne precautions are suggested guidelines for reducing the transmission risk of infectious droplet nuclei.
A brief list of conditions and/or clinical presentations that indicate airborne precautions should be implemented including:

- Tuberculosis;
- Measles;
- Chickenpox (until lesions are crusted over);
- Severe Acute Respiratory Syndrome (SARS);\(^{20}\) and
- Disseminated herpes zoster (until lesions are crusted over).\(^{13}\)

Clients presenting with any of the indicative conditions and/or clinical presentations should be placed under airborne precautions until the cause of the infection has been identified and Public Health determines if precautions should continue. These clients require airborne-infection isolation rooms where air is exchanged on a regular basis. If this type of room is not available, clients should wear protective masks and keep the door closed.\(^{13}\)

Healthcare providers should wear N95 respirator masks in addition to applying routine precautions.\(^{13}\) If there is more than one client in the room and the nurse is caring for both clients, changing a respirator mask is not required between clients. Immediately after use the mask should be discarded in a no-touch receptacle, followed by hand hygiene.\(^{13}\)

Patients and visitors have a responsibility to comply with isolation precautions where indicated.\(^{13}\) For further information see Public Health Agency of Canada, *Routine practices and additional precautions for preventing the transmission of infection in healthcare settings*.\(^{13}(p81-89)\)

**Conclusion**

Isolation procedures and protocols were developed many years ago, but they are more necessary today as global outbreaks continue. There are basic and important precautions to implement for every client. Routine and additional (contact, droplet and airborne) precautions are necessary as pathogenic microorganisms can be undetected, contagious, and even deadly for some populations. Infection control begins and ends with handwashing, whether a client is suspected of an infectious disease or under routine observation. Finally, a direct point-of-care risk assessment should be completed for every client to identify possible risk of exposure and potential transmission of microorganisms.
Module 3: The Infectious Client—Infections Acquired Outside the Healthcare Setting

Specific Learning Outcomes

After successful completion of this module, you will be able to

• name three classes of microorganisms;
• define incubation period and give an example;
• explain why it is important to receive the annual influenza vaccine; and
• describe how tuberculosis presents challenges for infection control.

Introduction

Module 2, point-of-care risk assessment (PCRA) was reviewed as a process that should be completed as soon as an infection is suspected. Ideally, a PCRA should be done frequently throughout a client’s hospital stay. This module provides awareness of common infections acquired by clients in a community setting that may be transmitted to others once the infected client enters a healthcare setting.

Once a client is admitted to a facility providers have a responsibility to implement procedures, protocols and practices to reduce the client’s risk of acquiring an infection during their stay. As discussed in Module 2, diligent infection prevention and control procedures must be followed (i.e. hand hygiene). These procedures require the collaborative effort of many people and involve education and training of healthcare providers around the risk of HAIs, adherence to hand hygiene protocols and best practice, and the cooperation and support of clients, their families, visitors and friends. Without proper infection controls in place; there are microorganisms that have the potential to cause an outbreak.

Microorganisms Commonly Acquired Outside the Healthcare Setting

There are different classes of infectious microorganisms that are easily spread, including viruses, bacteria, and ectoparasites. Table 1 lists clinically significant microorganisms that are commonly acquired outside the healthcare setting.

| Viruses, leukocytes, and lymphocytes |
Table 1: Classes of Clinically Significant Microorganisms Commonly Acquired Outside the Healthcare Setting

<table>
<thead>
<tr>
<th>Class of Microorganism</th>
<th>Name of Microorganism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virus</td>
<td>Varicella-zoster</td>
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<tr>
<td></td>
<td>Measles</td>
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<td></td>
<td>Rubella</td>
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<td></td>
<td>Mumps</td>
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<td></td>
<td>Polio</td>
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<td>Hepatitis A, B</td>
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<td>Influenza</td>
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<td>West Nile Virus</td>
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<td>Zika Virus</td>
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<tr>
<td>Bacteria</td>
<td><em>Mycobacterium tuberculosis</em></td>
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<td></td>
<td><em>Neisseria meningitidis</em> (meningococcal disease)</td>
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<td></td>
<td>Pneumococcal Disease</td>
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<td><em>Bordetella pertussis</em> (whooping cough)</td>
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<td>Diphtheria Tetanus</td>
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<td><em>Streptococcus pyogenes</em> (group A strep)</td>
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<tr>
<td>Ectoparasites</td>
<td>Lice</td>
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<td></td>
<td>Scabies</td>
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Source individuals may enter the healthcare setting with an active disease. They may be in the asymptomatic and/or incubation period of an infection. Important time frames to consider when dealing with infectious diseases include the following:

- **Incubation period**—The time from initial exposure to appearance of signs and symptoms of infection.
- **Communicability period**—The point in time when infection can be transferred from an infected person to a healthy person.

These periods vary between microorganisms.

**Viruses**

A virus is a simple, non-cellular structure. This small, infectious biological agent reproduces inside other living cells in plants, animals, and microorganisms. While there are many viruses, Table 1 lists a few of the clinically significant agents commonly acquired in community settings. A brief explanation of each virus follows.

**Varicella-Zoster Virus**

Ninety-five percent of the population in the industrialized world will develop a natural immunity to varicella-zoster virus by age fifteen. Varicella-zoster virus is the causative agent of two diseases: varicella (chickenpox), the primary infection, and herpes zoster (shingles) is a secondary infection. Chickenpox is usually a childhood disease of children, teens and young adults characterized by a slight fever and the formation of itchy eruptions in the skin. After recovery the virus may lay dormant in the dorsal root ganglia. Upon reactivation, the latent varicella infection manifests in adults as shingles. Shingles causes a painful rash with blisters forming a striped shape on one side of
the body. The varicella-zoster virus is transmitted by air as chickenpox, so clients with chickenpox need to be placed on droplet and airborne precautions. The skin eruptions in both chickenpox and shingles are also contagious and require contact precautions. The incubation period is between 10 to 21 days or up to 28 days if varicella-zoster immunoglobulin (VZIG) is given.

Varicella-zoster infections can be potentially fatal to pregnant women and immunocompromised clients; therefore, it is critical to prevent the spread to these vulnerable population groups. As a general group, immunocompromised patients can be cared for in the same environment as other patients; however, it is always advisable to minimize exposure to other patients with transmissible infections (i.e. influenza). Centers for Disease Control and Prevention (CDC) in the United States recommend adults who are believed susceptible and who have had significant exposures to varicella zoster receive VZIG to prevent complications.

Measles
Due to the use of vaccines, measles is a rare occurrence in Canada. However, outbreaks of measles in Canadians with no immunity is a resurfacing issue. Measles is a febrile illness that consists of a fever of 38°C or higher, coughs, rhinitis, conjunctivitis, and a generalized maculopapular rash for at least three days. Potential complications of measles also include pneumonia, acute encephalitis, myocarditis, pericarditis, and hepatitis.

There are sequential stages in an infection of measles. The early stage of infection and incubation begins 7 to 14 days (average 10 to 12 days) after initial exposure and resembles a severe respiratory tract infection. This stage may have malaise, fever, anorexia, conjunctivitis, cough, and running nose. There may also be diarrhea (especially in infants), while older children may complain of photophobia. Near the end of the early stage, Koplik spots occur. Koplik spots are white spots on the red base of the mouth’s inner lining. They usually start to slough off just as the maculopapular rash of measles begins to present. The rash usually begins around day 14 post exposure, starting on the face and preceding to the extremities. This rash will last for five days. During the second and third days of the rash, the client usually complains that they feel the worst.

Measles is a very contagious acute viral disease. The communicability period starts around four days before the onset of the rash and lasts approximately four days after the rash begins, from 7 to 21 days. The disease is most infectious near the end of the early stage, when coughing and a runny nose are the most severe.
Airborne and contact precautions should be enforced as measles is transmitted by respiratory droplets as well as by direct contact with nasal/throat secretions from infected clients.\textsuperscript{36} For hospitalized clients; providers of care must have immunity. Susceptible healthcare providers who have been in contact with measles cases should notify the Medical Officer of Health (MOH) (or designate) of all confirmed, probable and suspect cases of measles.\textsuperscript{38} Clients who have been exposed should be discharged before the fifth day after exposure. For clients unable to be discharged, airborne precautions should be followed from day 5 of exposure until day 21.\textsuperscript{38}

Adults born during or after 1970 who did not receive a measles vaccine or ever had a case of measles should consider the measles vaccination. A second dose of the measles, mumps, rubella (MMR) vaccine should also be given to adults born during or after 1970 who have a greater exposure risk, such as healthcare providers.\textsuperscript{39}

Rubella
Again, due to the use of vaccines, rubella is a rare occurrence in Canada.\textsuperscript{40} Rubella is a form of the measles virus. Clinically, rubella is a mild infection consisting of a generalized erythematous maculopapular rash, lymphadenopathy, sore throat and a low-grade fever. There is usually a prodromal period of one to five days and sometimes additional symptoms of malaise and upper respiratory symptoms before formation of the rash. The rash typically begins on the face, spreads over the body in the next 24 hours, and lasts for three days.\textsuperscript{40, 41}

Pediatric and adult complications of rubella are rare and include encephalitis and thrombocytopenia. Complications of prenatal rubella infections are the most severe. A rubella-immune titre is part of prenatal testing. Pregnant women who are exposed to or develop signs of rubella measles are at risk of congenital rubella syndrome (CRS). This antenatal infection of the rubella virus (either asymptomatic or symptomatic) can result in spontaneous abortions, premature deliveries, and other congenital defects (cardiac, auditory, neurological), depending on the gestational age at which the maternal infection occurs.\textsuperscript{12, 41, 97}

For adult and pediatric clients the communicability period of rubella is seven days before and seven days after the rash. During this period, the person will be highly contagious. Interestingly, 25% to 50% of those affected with rubella do no develop a rash or have any symptoms.\textsuperscript{41}

Rubella can spread in various ways. Some examples of how rubella spreads include: direct contact (touching, kissing) or through the air (coughs, sneezes, talking).\textsuperscript{40} Clients infected with rubella should be placed under droplet precautions until seven days after the onset of the rash. All contact with pregnant women should be avoided. Healthcare providers working with pregnant women should have their rubella-immune status determined. Those exposed to rubella should be excluded from work starting day 7 to 21 postexposure.\textsuperscript{12} Again, immunization is the best defence of a combined vaccine of either measles -mumps-rubella (MMR) or measles-mumps-rubella-varicella (MMRV).\textsuperscript{40} Side effects of either vaccine are very mild and the vaccine remains safer than contracting the rubella virus.\textsuperscript{40}

Mumps
Mumps is a virus known for causing puffy cheeks and a swollen jaw.\textsuperscript{42} These symptoms are the result of swollen salivary glands. Like measles and rubella, reported cases of mumps by Canadians are rare due to the use of the
measles, mumps, rubella, and varicella (MMRV) vaccines. There are reports of outbreaks or a secondary spread of mumps when immunity is unknown or when there has been prolonged, close contact with someone who has the disease. Symptoms can include fever, pain, and enlargement in the parotid glands. Potential complications of mumps include orchitis (swelling of the testicles), pancreatitis, meningitis, encephalitis, and deafness.

Transmission of mumps requires more intimate contact than viruses such as varicella-zoster or measles. Mumps is transmitted through direct contact with contaminated respiratory secretions. The incubation period of mumps is 14 to 25 days. The communicability period is 12 to 29 days after exposure, with maximum infectiousness occurring two days before symptoms to four days after onset. Clients infected with mumps who are asymptomatic can also transmit the disease. Clients infected with mumps should be placed on droplet isolation precautions for nine days after the onset of parotid gland swelling.

Healthcare providers can be carriers of this virus. Outbreaks of mumps have occurred where healthcare providers without immunity were exposed to clients infected with the virus. Immunization may be a job requirement, depending on the employer.

Polio (Poliomyelitis)
Polio or poliomyelitis is a crippling infectious disease caused by the poliovirus. This highly contagious virus is transmitted from an infected person to another person by oral contact with secretions, through droplets from a sneeze or cough and from faecal material. The incubation period is approximately 7 to 10 days but most poliovirus infections are asymptomatic with 24% of people complaining of flu-like symptoms. These symptoms may include headache, sore throat, fatigue, fever and nausea. In some severe cases, the polio virus can attack the brain and spinal cord resulting in paralysis. Anyone can contract polio but this virus is known to affect children under three years of age. As the virus can spread immediately before and one to two weeks after symptoms appear, the infected person should be placed under droplet and contact isolation precautions.

In 1988, the World Health Organization set out to eradicate polio in the world. This program and their efforts was over 99% successful but not every country participated. There are still small occasional outbreaks caused by travellers. To date, the polio vaccine has been highly successful at protecting children who receive all the recommended doses (99 children out of 100).

Hepatitis A
Hepatitis A is an acute infectious disease of the liver. It is usually spread by consuming food or water contaminated with feces or through direct contact with an infectious person. In the hospital setting it can be easily spread by healthcare providers who come in contact with blood or feces. The infected person may be symptom free or experience mild to severe symptoms including fever, loss of appetite, fatigue, abdominal pain, diarrhea, nausea, vomiting, and jaundice. The incubation period is 15 to 50 days. The period of communicability depends on whether the client develops jaundice. Jaundice will appear around 14 days after exposure and continue for approximately seven days. For clients who do not develop jaundice, the communicability period is seven days before the onset of hepatitis symptoms and last about 14 days. Usually hepatitis A is a self-limiting infection with no chronic effects on the liver, but in extremely rare conditions, it can cause liver failure and death.
Healthcare providers are at risk of spreading the hepatitis A virus to clients. Those who become infected with this virus should not work during the first week of symptoms. Clients suspected of being infected, children and adults incontinent of stool or have poor hygiene practices should be placed on contact precautions. Fortunately, there is a safe and effective vaccine for prevention of hepatitis A.

Hepatitis B
Hepatitis B is a disease of the liver caused by the Hepatitis B virus (HBV). Hepatitis B is a silent disease that the client may not even know they have and has been slated more infectious than HIV. The majority of people (95 percent) will contract acute Hepatitis B and recover from the infection within six months resulting in lifelong immunity. The other five percent will not recover and will become chronically infected. Symptoms of hepatitis B can take two to six months to appear. Research shows that only 50 percent of those infected develop symptoms but remain contagious and will spread the viral infection to others through sexual contact or contaminated blood (including needle stick injuries from a client with hepatitis B).

Symptoms can range from mild to severe and include abdominal pain, fever, dark urine, jaundice, nausea and vomiting. As hepatitis B is preventable through vaccination, healthcare providers at high risk should consider vaccination. Always wear latex gloves when in contact with blood or bodily fluids.

Influenza Virus
The influenza virus links back to the Spanish influenza epidemic of 1918. Spanish flu was a global strain of the influenza virus that killed an estimated 50 million people while infecting 20 to 40% of the worldwide population. Instead of the usual flu victims, such as juveniles and the elderly, this strain of influenza targeted mostly young adults.

The volatility of the influenza virus has been marked through history. Its virulence cannot be predicted. Since the Spanish influenza outbreak of 1918, there have been three other pandemics: one in 1957 (Asian influenza—H2N2), another in 1968 (Hong Kong influenza—H3N2), and one in 2009 (H1N1 influenza).

Signs and Symptoms of Influenza
Influenza virus results in an acute upper respiratory tract infection that has fever, a dry cough, fatigue, and a sore throat. Children infected with the virus may also develop bacterial infections such as ear infections and pneumonia. In adults secondary bacterial pneumonia is the most frequent complication. A less common but often fatal complication is primary viral pneumonia.

There are three distinct types of human influenza viruses: A, B, and C. Influenza A and B viruses can both cause serious infections and are typically referred to as “the flu.” Influenza C only causes a mild infection and is usually not a cause of epidemics. Different strains of influenza A and B are identified by the letters H and N. These letters represent glycoproteins found on the surface of the virus—the hemagglutinin (H) and the neuraminidase (N). There are many different subtypes of both hemagglutinin and neuraminidase, which creates different strains of influenza A. Influenza B is not as virulent as influenza A and targets mostly pediatric clients.

The incubation period of influenza is between one to four days. The communicability period depends on the age of the client. For adults it begins before symptoms appear until five days after, while pediatric clients are contagious seven to ten days after their initial symptoms.
present. Immune-compromised clients have an even longer communicability period.  

In Canada the influenza virus is present year-round, however most commonly presents between the months of November and April. Transmission is through airborne respiratory droplets from an infected person sneezing or coughing. Transmission may also occur through contact (direct or indirect) with secretions on surfaces. The human influenza virus can survive on a surface for hours. Clients admitted with influenza or flu-like symptoms should be treated with airborne precautions.

**Prevention efforts in place**

For other viruses mentioned, vaccination was recommended for prevention, and influenza is no exception. Unfortunately, the strains of pathogenic influenza virus change on a yearly basis. Unlike other viruses, one vaccination will not provide immunity for every influenza virus. Each year a new vaccination is needed for the influenza strain, depending on which viruses are circulating and which viruses will be prominent during the coming season. The yearly vaccination is the best protection against the flu.

**West Nile Virus**

West Nile Virus is transmitted to humans through a bite from an infected mosquito. While this virus affects anyone, research shows that one in five people become ill. While rare, there have been reports of severe neurological illnesses. The risk of severity increases with age. Common mild symptoms people experience, according to Alberta Health, includes fever, chills, fatigue, rash, nausea and vomiting. More severe symptoms include drowsiness, tremors, confusion, difficulty swallowing, unconsciousness and eventually death. Treatment for West Nile Virus is on an individual basis with the family physician.

The first documented case of WNV in Alberta was July 2003. Alberta now participates in annual monitoring of WNV for when and where greatest risk of transmission to humans may occur for public safety and awareness.

**Zika Virus**

Zika virus is spread to humans in two ways. First, Zika virus is again transmitted through a bite by an infected mosquito. The second way this virus can spread is through sexual contact with an infected person and in rare cases, through blood transfusions infected with the virus. Pregnant women are at particular risk as the virus can spread to the unborn baby causing rare, serious birth defects.

Most people who contract Zika virus experience no symptoms but about 20 % some symptoms for a few days including headache, fever, rash, conjunctivitis, muscle and joint pain. According to Alberta Health, there is no risk to Albertans within the province. The mosquito carrying the virus cannot survive in Alberta, due to our climate. However, the risk remains if Albertans travel to other countries that carry the infected mosquitoes. To date, there have been 40 cases of Zika virus in Alberta and all cases were due to travel.

**Bacteria**

Bacteria are microscopic living organisms that can be found everywhere. These single-celled organisms are either beneficial or dangerous, depending on the bacteria. One example is *Escherichia coli* (*E. coli*), which is present in the colon and aids in digestion but can also cause disease. Various types of bacteria can cause harm to clients in a hospital setting. A brief explanation of a few common bacteria that healthcare providers should be aware of are as follows.
**Mycobacterium tuberculosis**

Tuberculosis (TB), an infectious lung disease caused by bacteria (*Mycobacterium tuberculosis*), is alleged to infect almost one-third of the world’s population. For most Canadians the risk of TB is low. Individuals with the highest risk of TB are those with non-HIV immune suppression (and other medical risk factors for TB), long-term visitors to countries with high TB occurrence, Aboriginals, children, inmates of correctional facilities, and foreign-born Canadians.

**Challenges of TB**

TB presents challenges for infection control as anyone can be a host. It is transmitted by droplets of moisture released into the air. As these droplets evaporate, they form infectious droplet nuclei. These droplet nuclei can be formed when a client with infectious TB forcefully breathes out (i.e. during sneezing, coughing, or singing). Any medical procedure that produces aerosols, such as a bronchoscopy or an autopsy, may also release droplet nuclei.

A healthy individual should be able to keep the infectious bacteria from developing into a pathological TB condition. There are two main types of TB infections: respiratory and non-respiratory. Non-respiratory TB infections are a result of the bacteria escaping from the lungs and being transported by the lymphatic system to other areas of the body through high oxygen and high blood flow. Clients with non-respiratory TB are at low risk of causing nosocomial infections.

**Pathogenesis**

A TB infection can be easily missed. Only a small percent of individuals infected with this bacteria (approximately 5%) progress to an active disease. Screening of vulnerable or at risk individuals with active TB or latent TB (those infected by TB bacteria but not yet ill and cannot transmit disease) reduces the risk to others around them. This surveillance is an important and critical goal of global health initiatives. If the TB infection progresses to an active TB directly after contact with the infection, the “primary” disease occurs.

Statistics show that about 95% of individuals are hosts for a latent TB infection or LTBI. It appears that the individual has an immune system strong enough to interrupt transmission of the disease to an active case. This state of inactivity can last for years (around 90% of hosts) or a lifetime (around 5 to 10%).

For about 10% of LTBI hosts, reactivation of the TB disease will occur. This number may be significantly higher for hosts in an immune compromised health state or under five years of age. The TB infection will develop into either non-respiratory TB or respiratory TB where there is a high probability of transmission to others (see Figure 1 for a flowchart of the pathogenesis of tuberculosis).
Figure 1: Pathogenesis of Tuberculosis

Pathogenesis of Tuberculosis

Exposure to TB Infection

Initial Infection

- Around 5%
  - Yes
  - Develop TB Disease

- Around 95%
  - Yes
  - Develop Latent TB Infection (LTBI)

- About 5% - Lifetime
  - Reactivation TB Disease
    - Non-respiratory TB Disease
    - Respiratory TB Disease
      - Possible Transmission of TB to Others

- About 95% - Lifetime
  - Ongoing LTBI - No Disease

Transmission of TB Disease in Healthcare Environments

The transmission of respiratory TB in healthcare settings is a recognized risk. With each cough or sneeze, there is potential for releasing infected droplets. Globally, clients with active TB can infect 10 to 15 other people through close contact over a period of one year. A PCRA indicating airborne precautions should be completed upon admission to hospital until the causative agent of the symptoms has been determined. Airborne precautions need to be in place if a client’s diagnosis for active TB is confirmed and the client is exhibiting the following symptoms:

- fever;
- cough;
- night sweats;
- hemoptysis (coughing up blood);
- anorexia; and
- weight loss.

If a client with non-respiratory TB is scheduled for aerosol-generating medical procedure, the client should be under airborne precautions, and healthcare providers will require respirator-type masks (N95) to perform the procedure.

Diagnosis of Active and Latent TB

There are different tests to identify TB cases. Some of these include the tuberculin skin test (TST), also known as the Mantoux test, chest X-ray, acid fast staining, and clinical symptoms. However, none of these are 100% effective or accurate. Isolation of Mycobacterium tuberculosis from culture remains the gold standard method of confirming infection; however, the bacteria cannot be seen using the usual stain and require specialized acid-fast bacteria (AFB) staining. The bacteria are difficult to isolate for culture and sensitivity, since they require special culture media and can take up to eight weeks to grow. Sensitivity testing will take longer to determine if it is a resistant strain.

Meningococcal Disease (Neisseria meningitidis)

Meningococcal disease refers to an illness caused by the bacteria Neisseria meningitidis. Meningococcal disease is a contagious infection spread by direct contact with an infected person through respiratory secretions and/or droplets. Rapid medical attention is important if meningococcal disease is suspected.

The symptoms of meningococcal disease include a sudden onset of fever, headache, nausea, vomiting, stiff neck, a petechial rash, and delirium. Untreated, the fatality rate is high. Statistics show up to 10% of the general population can be carriers. Outbreaks usually occur in groups that share enclosed quarters or are in direct contact with a colonized person. The incubation period is two to ten days. The disease is communicable seven days prior to clinical symptoms and until the bacteria is no longer present. Clients infected with meningococcal disease should be placed under droplet precautions.

There are vaccines available for Neisseria meningitidis; unfortunately, the vaccines are limited to certain strains (or serogroups) of the bacteria.

Pneumococcal Disease

While there are many types of pneumococcal disease, the invasive streptococcus pneumoniae is a notifiable disease by public health professionals in Alberta. This invasive disease is a gram-positive encapsulated diplococcic that presents as pneumonia with bacteremia and meningitis, however bacteremia has an unknown site of origin. Bacteremia is a serious and sometimes fatal disease that infects the blood. The American Centers for Disease Control and Prevention (CDC) reports that in children under five years of old with this blood stream infection, about 1 out of 100 will die. Death rate is between 5 to 7% but occurs more
often in the elderly client.\textsuperscript{72,73} This invasive disease produces bacteria that can invade parts of the body that would normally be considered healthy.\textsuperscript{73} The respiratory tract is a common area for infection but the disease can also manifest as septicemia, endocarditis, arthritis, and peritonitis.\textsuperscript{72}

**Diagnosis of invasive pneumococcal disease**
The clinical presentation of signs and symptoms of the invasive pneumococcal disease may provide the diagnosis. The most common symptoms include a sudden onset of chills, fever, shaking or rigors but sometimes very difficult to confirm as pneumococcal infection rather than other infections. Individuals can also complain of chest pain, dyspnea, hypoxia, productive cough, tachypnea, malaise and weakness. Isolation of streptococcus pneumoniae from an otherwise normally sterile site is necessary to make a confirmed diagnosis.\textsuperscript{73}

**Routine practices and additional precautions recommended**
Pneumococcal disease is transmitted through infectious droplets released into the air or contact (direct contact with mucous secretions or indirect contact with contaminated items).\textsuperscript{72} Although not highly contagious, routine practices in hospital must be applied. Additional droplet precautions may be warranted when there is an antibiotic resistant infection.\textsuperscript{72} The period of communicability varies as long as the infection lives within the respiratory tract. Within 24 hours of antibiotic initiation, the infection is typically under control and the client is no longer infectious. In addition, depending on the type of infection, the incubation period can be as few as 1-3 days.\textsuperscript{72}

**Immunization is the best defence**
There are different immunizations for various forms of pneumococcal disease. The CDC states the best defence remains a good offense through pneumococcal vaccines to protect against 90 types of pneumococcal bacteria responsible for the most serious illnesses.\textsuperscript{73}

**Bordetella pertussis**
*Bordetella pertussis* bacterium is the cause of pertussis, a disease more commonly known as whooping cough. It is a highly contagious respiratory disease. Infants and young children who do not receive the vaccination are at a greater risk for contracting this serious and potentially fatal disease.\textsuperscript{74}

Since pertussis is usually described as a disease of childhood, many healthcare providers believe it is not a threat and assume they have immunity based on vaccinations or age.\textsuperscript{74} However, studies have shown that immunity to pertussis can start to decrease in older adults. It is important for healthcare providers to know their immune status. The symptoms of pertussis in adults are not as severe as in children, yet an infected carrier could easily spread this disease without knowledge.\textsuperscript{74}

Pertussis is spread by direct contact with infectious droplets. Its incubation period is usually 7 to 10 days but can last up to 20 days. There are three stages of pertussis infection: catarrhal, paroxysmal, and convalescent. The communicability period is most infectious during the first stage and the beginning of the second stage.\textsuperscript{74}

The catarrhal stage occurs 7 to 10 days after infection with symptoms of a runny nose, sneezing, a low-grade fever, and an occasional cough. The paroxysmal stage appears 10 to 14 days after infection, when risk of complications can occur. The frequency and severity of coughing increases, and the client is unable to inhale and may become cyanotic. These coughing spasms may result in a high-pitched “whoop” sound.\textsuperscript{74} Coughing episodes may also
include the release of clear, tenacious, and potentially infectious mucus, followed by vomiting. Coughing episodes are more common at night and may last up to 10 weeks. The third stage is the convalescent stage, a gradual recovery with decreasing coughing, eventually disappearing in two to three weeks.\textsuperscript{74}

Of infants diagnosed with pertussis, 20 to 30% are admitted to hospital and placed under droplet isolation precautions. Healthcare providers unaware of their immune status should wear masks when in contact with infected clients.\textsuperscript{74}

\textbf{Diphtheria}

Diphtheria is another childhood disease caused by \textit{Corynebacterium diphtheriae} bacterium.\textsuperscript{76} This contagious disease can be very serious, even death for infants and children under five years. The infectious bacteria invades the lining of the lungs and respiratory system destroying health tissues making it difficult for the individual to breathe or swallow.\textsuperscript{76} Likewise, diphtheria is transmitted through respiratory droplets (coughing and sneezing) and when an individual is in direct skin-to-skin contact with the disease. Routine practices for infection prevention would be expected as well as isolation precautions of both droplet and contact precautions are necessary.\textsuperscript{76}

The common signs and symptoms of diphtheria include fever, sore throat, weakness, swollen neck glands and difficulty breathing. Diphtheria is preventable through safe and effective immunization. It is recommended that healthcare providers caring for these children take full precautions, including ensuring their immunization records are up-to-date.\textsuperscript{75, 76} If diagnosis is confirmed diphtheria, antibiotics are necessary to destroy the bacteria. Before treatment, almost half of the children died from this disease.\textsuperscript{75, 76}

\textbf{Tetanus}

Tetanus (or lockjaw) is a serious disease caused by \textit{Clostridium tetani} bacterium.\textsuperscript{77} The bacterium is found in dust, soil, human or animal feces. It will enter the body through a cut or wound including bites (animal saliva), scrapes, burns or puncture (from a dirty needle or rusty nail). The tetanus bacterium produces a neurotoxin that causes damage to nerves controlling muscle. The individual will experience painful, stiff movement, difficulty swallowing or breathing. Other symptoms noted are fever, sweating, headache, seizures, tachycardia and hypertension. The incubation period is around 3 to 21 days. If not treated quickly, the Public Health Agency of Canada states that about one in five people who get tetanus will die.\textsuperscript{77, 78}

Tetanus does not spread from person to person. Immunization is the key to prevention of tetanus and is the reason that tetanus is very rare in Canada. It is recommended that individuals receive a tetanus booster every 10 years or after incurring a deep or dirty wound if they do not have record of a booster in the past five years. Vaccines are available for anyone five years of age and older from local public health agencies, pharmacies and physician clinics.\textsuperscript{77}

\textbf{Streptococcus pyogenes (Group A Strep)}

\textit{Streptococcus pyogenes} is known as the causative agent of strep throat. It is also known for causing necrotizing fasciitis, or flesh-eating disease. Clients with wounds infected with \textit{Streptococcus pyogenes} are assessed for precautions. If the wound drainage can be controlled with dressing materials, routine precautions can be maintained; however, if drainage cannot be controlled with wound management, contact precautions should be implemented.\textsuperscript{79}
Ectoparasites

Scabies and lice are the most common types of ectoparasites. Clients infected with ectoparasites are placed under contact precautions. These precautions are in place, with lotion(s) and cream(s) applied to exterminate both mites and eggs. This usually occurs after one or two treatments. Household surfaces should be screened and treated. Bedding and clothes also require hot-water laundry.

Conclusion

There are three classes of microorganisms that can be acquired outside of the healthcare setting that, as a healthcare professional, you need to have a basic understanding including viruses, bacteria and ectoparasites. In addition, it is important to know the signs, symptoms, and transmission risks or amount of time from initial exposure to appearance of these infectious organisms. Lastly, tuberculosis prevents an ongoing challenge for infection control. As healthcare professionals, we need to be aware of the pathogenesis of TB and how to protect both ourselves and the clients we serve. Routine practices (including rigorous hand hygiene) and recommended additional precautions are vital to mitigate the effects organisms could cause on the client, the healthcare environment and anyone in direct contact.

Public Health Agency of Canada confirms that the incidence of various infectious diseases appears to have dramatically reduced after vaccines came into widespread use in Canada. The importance of continued vaccination is key as without vaccination, Canadians will continue to remain at risk of a vaccine-preventable infectious disease until the disease itself is eradicated.

As healthcare providers you can set positive examples for your clients by following infection prevention recommendations and keeping up to date with vaccinations, including the annual influenza vaccination. You have the responsibility to look after your own health to avoid compromising client safety.
Module 4: Healthcare-Associated Infections (HAI)

Specific Learning Outcomes
After successful completion of this module, you will be able to

- define HAIs;
- discuss three different ways an HAI can spread; and
- name one routine precaution that all healthcare providers must follow with every client.

Introduction
In Module 3 you learned about infections that are usually acquired outside the hospital yet have the potential to spread and infect a client as they enter the healthcare system. This module reviews the most common HAIs a client could acquire while in the hospital. An HAI, or nosocomial infection, is “an infection that a client contracts in a setting where healthcare is delivered (hospital), in an institution (long-term care facility),” or other place of care. Nurses have a significant role in preventing HAIs. Clients diagnosed with an HAI had no infection reported on hospital or facility admission or when treatment began.

HAIs are a major burden on the healthcare system. There are approximately 5 to 10% of hospitalized clients in Canada develop an HAI. This amounts to approximately 220,000 cases a year. For 8,000 of these Canadians an HAI will result in death.10

The majority of HAIs are bacteria, viruses, fungi, and parasites.10 These microorganisms are spread through the air, by direct or indirect contact, or through infected blood or body fluids.10 HAIs have also been associated with the overuse and/or misuse of antibiotics as microorganisms have had opportunities to develop resistance.82 A Public Health Agency of Canada report on infectious diseases states that MRSA, a multi-drug-resistant form of Staphylococcus aureus, is a good example of a HAI spread by both direct (touch) contact and indirect contact by individuals sharing personal articles (such as toothbrushes, needles, or razors).82, 13

Another example is E. coli. E. coli is bacteria commonly found in the intestines.83 This bacterium will appear susceptible to an antibiotic in the lab but is actually resistant. Client care may be affected if the physician receives a report that the infectious bacterium is susceptible to specific antibiotics when in fact it is not. In the clinical state the bacteria would be resistant to the prescribed medication.84

These two examples show medicine is not predictable. If a client is not responding to antibiotics, the cause should be investigated. Is the client receiving the right antibiotic? The right dose? The right administration? Or is the organism a new, resistant strain? The good news is that the majority of HAIs require contact precautions. Vigilance is required to keep an HAI from spreading to other clients and...
healthcare providers. It is important to follow routine precautions with every client, namely hand hygiene. Secondly, a PCRA should be part of a routine health assessment with each client, every shift. Look for signs of infection that may indicate an HAI has entered the body, including the skin, blood, heart, and lungs. Rapid diagnosis of an HAI is paramount.

You may recall that staining allows bacteria to be classified. Did you know that bacteria causing HAI include both gram-positive and gram-negative organisms? Some gram-positive organisms include bacilli, clostridia (Clostridium difficile), staphylococci (Staphylococcus aureus), streptococci, and enterococci (Enterococcus faecalis, Enterococcus faecium). Gram-negative organisms in this group include E. coli, klebsiellas, and pseudomonades.

Gram-Negative Bacteria

Gram-negative bacteria are a group of organisms divided into two main classes: bacteria that cannot ferment glucose (non-fermentative gram-negative), and bacteria that can ferment glucose (enterobacteriaceae).

Examples of pathogenic enterobacteriaceae include Klebsiella pneumonias, Enterobacter cloacae, and E. coli. Nosocomial infections caused by these organisms include

- central line–associated bloodstream infection;
- catheter-associated urinary tract infection;
- ventilator-associated pneumonia; and
- surgical-site infections.

Gram-negative bacteria are easy to identify, but determining the correct antibiotics can be a challenge. Antibiotics traditionally used to treat gram-negative bacteria infections included extended spectrum β-lactams (penicillins, cephalosporins, ciprofloxacin), carbapenems, and aminoglycosides. Unfortunately, gram-negative bacteria have developed resistance to these drugs. Improper and excessive antibiotic use globally has resulted in the advancement of resistant strains.

Routine precautions including good hand hygiene between clients and managing wound drainage are important continuous nursing actions. If a client is identified as having a gram-negative bacteria infection, following routine precautions would ensure an outbreak is limited. Further, when contact precautions are implemented, the bacteria will be easier to manage.

Gram-Positive Bacteria

Clostridium difficile

Clostridium difficile (C. difficile) is a gram-positive bacterium that grows under anaerobic (the absence of oxygen) conditions and is found in the intestines of healthy individuals. The problem lies when C. difficile becomes a major pathogen.

Part of the body’s immune system against pathogenic bacteria is when it prevents foreign organisms from growing on its surfaces. Organs such as skin or the digestive tract are constantly exposed to microorganisms considered “harmless” bacteria. But when certain conditions are created, this bacterium will produce toxins as well as serious, potentially life-threatening episodes. For instance, the skin has Staphylococcus epidermidis growing on it to prevent Staphylococcus aureus, while the stomach contains E.coli that effectively shields the digestive tract against the Salmonella species. These types of bacteria are referred to as the body’s “normal flora.” When there is a disruption to a person’s normal flora, it allows pathogens to slip by defences, causing a C. difficile infection.
The following actions can disrupt the normal flora of the intestine:

- antibiotics;
- chemotherapy;
- gastrointestinal surgery;
- use of nasogastric tubes; and
- stomach ulcer medication.\(^89\)

*C. difficile* has the ability to form spores that protect bacteria in a hibernation-like state, where it remains dormant until conditions are ideal. This is one reason *C. difficile* is able to survive alcohol-based hand wash—the spores cannot be destroyed by alcohol—but soap and hot water are recommended as the number-one defence.\(^10\)

*C. difficile* infection causes mild to severe diarrhea and other serious intestinal conditions such as sepsis, bowel perforation, and pseudomembranous colitis.\(^10\) *C. difficile* can be very difficult to control as it attacks weak, vulnerable clients, the frail elderly and entire healthcare facilities.\(^10\)

**Methicillin-Resistant *Staphylococcus aureus* (MRSA)**

MRSA first appeared in Europe over 40 years ago.\(^90\) At first it was rare, but it is now a challenge for IPC in healthcare. To add to the challenge, community-acquired MRSA has started to appear.\(^10\)

After *Staphylococcus aureus* developed resistance to penicillin, a newer version of β-lactam antibiotics was needed—in this case, methicillin. Other drugs followed, such as oxacillin and cloxacillin. Eventually, *Staphylococcus aureus* developed resistance to these drugs. The terms *oxacillin resistance* and *cloxacillin resistance* are used interchangeably with *methicillin resistance*.\(^91\)

Even though there has been a recent increase in community-acquired MRSA, MRSA is found mainly in healthcare settings among clients. Clients spread it to other clients through infected healthcare workers, dirty blood pressure cuffs, or incompletely cleaned environmental surfaces such as tables or bed rails.\(^10\)

The alarming thing is that a majority of MRSA carriers have no signs or symptoms. MRSA has infected the asymptomatic client and colonized certain areas of his or her body (such as the nostrils) without making the client sick. This client will now unknowingly spread MRSA throughout the hospital. Areas that can be colonized and therefore swabbed to determine the presence of MRSA are the nose, axilla, rectum, throat, wounds, and implanted devices.\(^10\)

For MRSA infections the treatment of choice is the antibiotic vancomycin. The use of vancomycin should be monitored to prevent the development of vancomycin-resistant *Staphylococcus aureus* (VRSA).\(^92\)

**Vancomycin-Resistant Enterococci (VRE)**

VRE are gram-positive coccetti that inhabit the enteric system of the body. There are two species of enterococci that can become VRE: *Enterococcus faecalis* and *Enterococcus faecium*.\(^93\)

VRE resistance possesses vanA and vanB genes. These genes allow for production of enzymes that interfere with the vancomycin action against the cell wall. For years vancomycin was the last antibiotic of choice against multi-drug resistant gram-positive organisms. Vancomycin cannot be given orally but is administered intravenously. This may be the reason for maintaining regulated use and preventing vancomycin from developing resistance to antibiotics.\(^93\)
However, vancomycin resistance in enterococci has developed. Like MRSA the major source of transmission to clients has been from either healthcare providers or fomites. Since there is resistant to vancomycin, more expensive antibiotics are required to treat a client infected with VRE. Another challenge VRE causes healthcare is that the genes that cause VRE, vanA and vanB, may be transferred to *Staphylococcus aureus*, making it resistant to vancomycin, resulting in the formation of VRSA.94

**Conclusion**

Nosocomial infections or HAIs are a serious and costly problem in today’s healthcare system. As nurses, it is necessary to understand and apply best practices in breaking the infection link to prevent HAIs that our clients are contracting during healthcare delivery. The majority of HAIs are spread easily, through the air, or by direct and/or indirect contact with the bacteria itself. HAIs are preventable.

The practice of infection prevention and control is extremely important for maintaining client safety and positive outcomes. HAIs have become an expensive burden for the current healthcare system. Diligent hand hygiene cannot be taken for granted and remains the number-one defence against HAIs. It is paramount as healthcare professionals we set the right example. It is also our role to engage family, visitors and others about routine precautions and practices that can stop, or at least slow down any new cases of HAIs.
Glossary of Terms

**ADDITIONAL PRECAUTIONS**: may be necessary when routine practices are insufficient, when medical procedures increase the risk of infection transmission (AGMPs), or when the client challenges routine precautions (care of a pediatric client or cognitively impaired client).¹³

**AEROSOL-GENERATING MEDICAL PROCEDURE** (AGMP) – a procedure that promotes or generates aerosols and droplets of respiratory pathogens causing an increased risk of infection (i.e. intubation, CPR, bronchoscopy, physiotherapy, tracheostomy care, aerosolized or nebulized medication administration).⁹⁵

**AIRBORNE EXPOSURE AND TRANSMISSION**: may occur when an infected source produces droplets (of varying size) that contain microorganisms through sneezing, coughing, or talking. Droplets are impelled short and long distances and inhaled by a susceptible host.¹³

**CLIENT**: refers to the individual, group, community, or population that is the recipient of care services and delivery.

**COMMON VEHICLE TRANSMISSION**: occurs when a single contaminated source (multi-dose vials, equipment) transfers infectious agents to multiple hosts.¹³

**CONTACT EXPOSURE AND TRANSMISSION**: occurs when infectious microorganisms are spread from an infected source to a host, either by direct physical contact or through touch and indirect contact of an inanimate object.¹³

**CONTACT PRECAUTIONS**: are necessary when microorganisms are transferred through physical contact between an infected source and a host or through transfer from another object. These precautions begin with thorough hand hygiene and use of protective gloves and long-sleeve gowns. It is also important to cover draining wounds or infected areas on the client.¹³

**DIRECT CONTACT EXPOSURE**: transfers microorganisms between two people by direct physical contact of skin, such as handshaking.¹³

**DROPLET AND AIRBORNE PRECAUTIONS**: required when there are possible microorganisms in droplet form (within mucous membranes during coughing, sneezing, or talking) that are propelled through the air. Precautions can include a single room and may include an airborne-infection isolation room (with air exchange on a regular basis); diligent hand hygiene; following PPE protocols including a respirator mask (N95 or higher); and isolation precautions when necessary.¹³

**DROPLET EXPOSURE AND TRANSMISSION**: may occur when droplets holding microorganisms are transferred from person to person by the respiratory system. Infectious droplets can travel up to two metres through the air. When an immediate surrounding area or surface becomes contaminated, contact transmission may also occur.¹³

**EPIDEMIC**: affecting or tending to affect a disproportionately large number of individuals within a population, community, or region at the same time.⁹⁶
HEALTHCARE-ASSOCIATED INFECTION (HAI): (also nosocomial infection) an infection a client acquires while in hospital or other care facility where healthcare is delivered.

HEALTHCARE PROVIDER: refers to any person involved in the care delivery of the client.

INDEX CASE: the first identified case or client that indicates existence of an outbreak of a communicable or transmissible disease.

INDIRECT CONTACT EXPOSURE: occurs unintentionally through passive transfer between an infected source and a host. This form of exposure can easily be avoided. Examples of indirect contact exposure are when poor or no hand hygiene occurs between client care or when using client equipment from one client to another without properly cleaning and disinfecting between clients.\textsuperscript{13}

NEGATIVE PRESSURE ISOLATION ROOM (NPIR): An isolation room that has a relative air pressure difference than other areas in a healthcare facility. The isolation room will have a negative pressure that keeps air from flowing out and into adjacent rooms or areas.\textsuperscript{98}

PANDEMIC: occurring over a wide geographic area and affecting an exceptionally high number of individuals of the population (i.e. Spanish flu).\textsuperscript{96}

PERSONAL PROTECTIVE EQUIPMENT: Personal protective equipment (PPE) may be worn by a susceptible host to provide a physical protective barrier between him/her and an infectious agent or source. Examples of PPE include gloves, gowns, masks, facial protection, eye protection (including face shields, or masks with visor attachments) and respirators. When appropriate and available, PPE should be used by patients, healthcare providers, visitors, etc.\textsuperscript{13}

POINT-OF-CARE RISK ASSESSMENT (PCRA): asks pertinent information healthcare providers should know in order to create a comprehensive care plan, including routine or other necessary precautions, physician orders, client’s ability to care for self, or any special circumstances regarding the client’s health condition.\textsuperscript{13}

ROUTINE (STANDARD) PRECAUTIONS: refers to the set of practices in place for all clients, at all times, in all healthcare settings.\textsuperscript{13} Precautions are also in effect and relevant for healthcare providers, family, visitors, and the client. Practice examples include hand hygiene as one of the best defences against transmission of infection; PPE including gloves, gowns, masks, and eye protection; isolation procedures; PCRA; management of sharps safety; and education.\textsuperscript{13}

SOURCE: an individual, healthcare provider, family, and other visitors who may have been exposed to infectious microorganisms. The source may be at varying stages of infection—active, incubation period, or indefinitely colonized—at focal points such as the skin and mucous membranes.\textsuperscript{13}

SUSCEPTIBLE HOST: an individual who is vulnerable to an infectious agent or microorganism.\textsuperscript{13}

VECTORBORNE TRANSMISSION: occurs when infectious agents are transmitted through insect vectors. This transmission is rare in Canada.\textsuperscript{13}
References


Suggested Reading


