Chapter 11

Isolation Precautions

Russell N. Olmsted

Key Points
• Microorganisms causing healthcare-associated infections can be spread from infected or colonised patients to others, including patients, family, visitors, and healthcare workers. • Standard Precautions/Routine Practices and Transmission-based/Additional precautions can reduce risk and prevent transmission if they are applied properly and consistently. • Standard precautions/ Routine Practices are based on the principle that all blood, body fluids, secretions, excretions except sweat, non-intact skin, and mucous membranes may contain transmissible infectious agents. These precautions apply to care of all patients, regardless of suspected or confirmed infection status, in any setting in which healthcare is delivered. • Transmission-based/Additional Precautions are used for patients with documented or suspected infection or colonisation with highly transmissible microorganisms which may not be fully prevented by Standard Precautions/Routine Practices.

Background

Transmission of infectious agents (microorganisms) within a healthcare setting requires three elements: a source (or reservoir) of infectious agents, a susceptible host with a portal of entry receptive to the agent, and a mode of transmission for the agent.[1-3] One framework for understanding this complex relationship is the chain of infection (See Figure 11.1a), which has six links: the infectious agent, reservoir, portal of exit, mode of transmission, portal of entry, and susceptible host. Breaking any one of the links in the chain will prevent infection from occurring (See Figure 11.1b). Isolation precautions are aimed at interrupting the connection – breaking the chain - of these elements to prevent transmission. This chapter focuses on use of isolation precautions and provides details on Standard Precautions/Routine Practices (SP/RP) that are aimed at breaking the chain of infection at transmission.

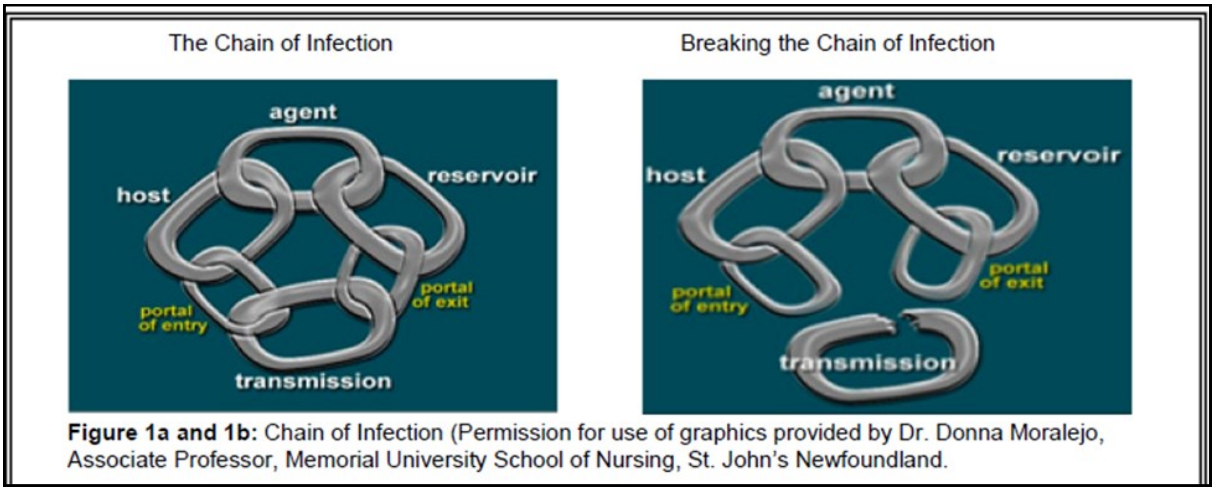


Figure 1a and 1b: Chain of Infection (Permission for use of graphics provided by Dr. Donna Moralejo, Associate Professor, Memorial University School of Nursing, St. John's Newfoundland.

Figure 11.1. Chain of Infection[2]

The chain of infection is a concept that also underlies healthcare-associated infection (HAI) prevention strategies, e.g., portal of exit of microorganisms from a patient with acute infection. Application of this concept of breaking is illustrated in Figure 11.2. This concept includes:

1. Removing or minimising the reservoirs where microorganisms may be present using disinfection, e.g., surfaces and equipment used for patient care;
2. Hand hygiene to prevent cross transmission (transfer of potentially harmful microorganisms); and
3. Aseptic technique to prevent entry of microorganisms into patients from invasive procedures (insertion of a central venous catheter or urinary catheter).

Transmission of Infection

Methods of transmission important in health care include contact, droplet, and airborne.

Contact

The predominant mode of transmission of infectious agents in healthcare facilities is by direct or indirect contact. SP/RP are aimed at breaking the chain of transmission at the portal of exit for microorganisms spread by contact. For some microorganisms or clinical situations where SP/RP may not be sufficient, transmission-based/additional precautions, e.g., Contact Precautions, are added to prevent cross transmission from patient-to-patient. Examples of microorganisms spread by contact include *Clostridium difficile*, norovirus, and multidrug-resistant *Acinetobacter baumannii.*

Direct transmission occurs when infectious agents are transferred from one person to another — for example, a patient's blood containing a blood-borne pathogen like hepatitis c virus entering a healthcare worker's body through an unprotected cut in the skin.

Indirect transmission involves the transfer of an infectious agent through a contaminated intermediate, inanimate surface/object or person—for example, a healthcare worker's hands spreading infectious agents after touching an infected body site on one patient and not performing hand hygiene before touching another patient or a healthcare worker coming into contact with a bedrail and then providing direct patient care without using hand hygiene.

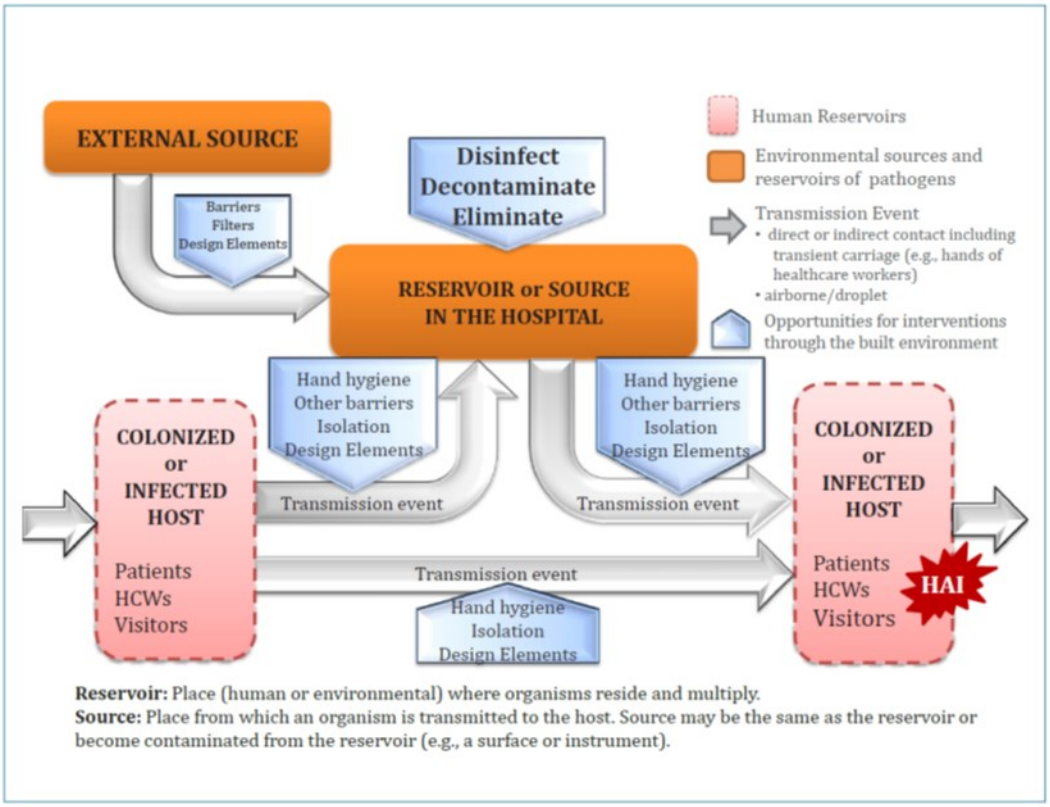


Figure 11.2. Chain of transmission healthcare associated infection (HAI) model[4]

Droplet

Droplet transmission occurs when droplets containing infectious microorganisms are propelled a short distance (i.e., within 2 metres) through the air and are deposited on the mucous membranes of a host.[5-10] Droplets may also contaminate the immediate environment when they settle on surfaces and then spread by contact. Droplets are generated when an infected person coughs, sneezes, or talks. Infections transmitted through the droplet mode include adenovirus, rhinovirus, rubella, influenza, *Bordetella pertussis,* and *Neisseria meningitidis*.

Airborne

Airborne transmission applies to microorganisms present in airborne droplet nuclei or small particles in the size range of <5 microns. These particles remain infectious for a prolonged time and can be carried over a long distance through the air. They can then be inhaled by susceptible individuals and may cause acute infection. The WHO has identified some additional sub-categories under the general category of airborne transmission. These are:

Obligate airborne transmission refers to pathogens that are transmitted only by deposition of droplet nuclei under natural conditions (e.g., pulmonary tuberculosis).[8]

Preferential airborne transmission refers to pathogens that can initiate infection by multiple routes, however they are predominantly transmitted by droplet nuclei (e.g., measles, chickenpox).[8]

Figure 11.3 contrasts droplets and droplet nuclei. Examples of infectious agents spread by the airborne route include *Mycobacterium tuberculosis*, rubeola virus (measles), and varicella-zoster virus (chickenpox).

Some procedures, such as suctioning, endotracheal intubation, cough induction by chest physiotherapy, and cardiopulmonary resuscitation (also referred to as aerosol generating procedures) can produce particles of smaller size that can be inhaled deep into the respiratory tract. When performed for a patient with a droplet-transmissible infection it may need to be performed in an airborne infection isolation room (AIIR) if available.

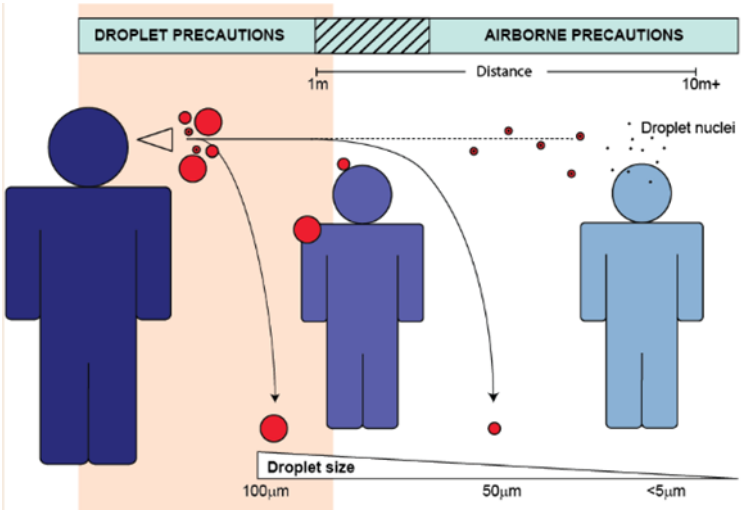


Figure 11.3. Droplet size and appropriate precautions. Adapted from: Virology Down Under at http://virologydownunder.blogspot.com/2014/08/ebola-virus-may-be-spread-by-droplets.html

Challenges Involving Diseases with Multiple Modes of Transmission

Middle East Respiratory Syndrome Coronavirus (MERS-CoV) is an infectious agent with multiple modes of transmission. Current evidence suggests this is spread from an infected person's respiratory secretions, such as through coughing, from droplets that carry this virus over a short distance (1-2 metres) and probably via contact.[11] However, the precise ways the virus spreads are not currently well understood. Persons at risk of infection include those who have had close contact, such as caring for or living with an infected person. MERS-CoV is also spread in healthcare settings, such as hospitals, during care of patients. A combination of Contact and Airborne Precautions are recommended.

Development of Isolation Precautions Systems

In the early 20th century patients with potentially transmitted pathogens were segregated from other patients in separate wards. With development of preventive strategies like vaccines, emphasis on hygiene, and effective antibiotics, the incidence of common communicable diseases dropped considerably and there has been a shift to use of SP/RP for HCWs treating patients with specific diseases.

Universal Precautions

In 1985, the concept of Universal Precautions (UP) was created, primarily in response to the emergence of human immunodeficiency virus (HIV) and its associated disease, acquired immunodeficiency syndrome

(AIDS).[1] The objective was to prevent infections transmitted by blood and other potentially infectious materials that could contain HIV prior to the development of AIDS. These precautions had an impact because they were the first directed toward protection of HCWs from exposure to blood and other body fluids that contain bloodborne pathogens in a patient who is asymptomatic. For the first time, emphasis was placed on precautions for all persons, regardless of their presumed infection status.

Body Substance Isolation

A system called Body Substance Isolation (BSI) was developed in 1987.[12] It was similar to UP, however it extended routine precautions to avoiding contact with all moist and potentially infectious body substances even if visible blood was not present. It emphasised that all body fluids from patients may contain microorganisms that can be transmitted to others; therefore, HCWs were to use barriers when anticipating direct contact with moist body substances, stool or urine, mucous membranes or non-intact skin during care of any patient. There was also an emphasis on hand hygiene to prevent transmission of microorganisms between care activities. BSI did not add other barriers or practices developed within UP to prevent sharps injuries, however the aim was preventing transmission of pathogens involving the most common mode of transmission, contact. It also did not address microorganisms spread by other modes, such as droplet or airborne routes.

Control and Prevention of Multidrug-Resistant Organisms

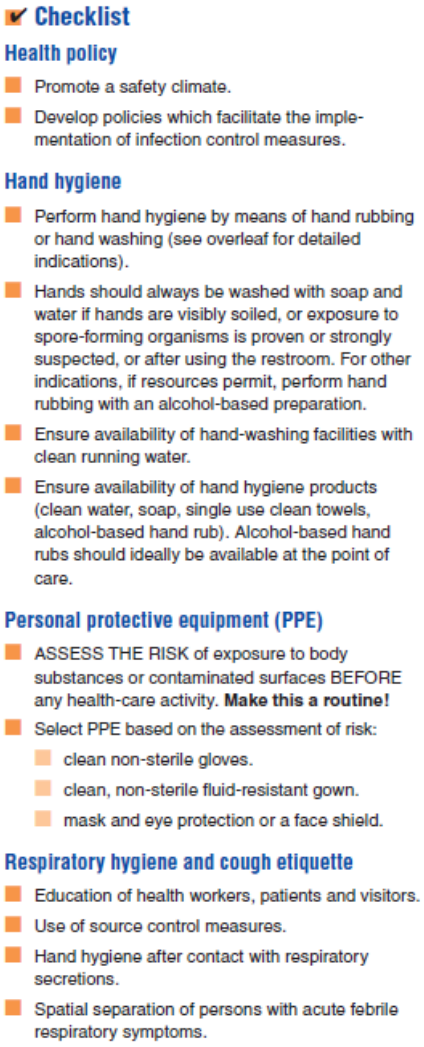
Multidrug-Resistant Organisms (MDRO) are predominantly bacteria that are resistant to one or more classes of antimicrobial agents. Examples of MDROs include meticillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant *Enterococcus spp*. (VRE), and carbapenem-resistant Enterobacteriaceae (CRE). MDROs are spread through contact. Management strategies include administrative support, judicious use of antimicrobials, surveillance (routine and enhanced), standard and contact precautions, environmental measures, education, and decolonisation.[13-15]

Standard Precautions/Routine Practices

SP/RP combine the major features of UP and BSI and are based on the principle that all blood, body fluids, secretions, excretions except sweat, non-intact skin, and mucous membranes may contain transmissible infectious agents. These practices are recommended for use when caring for all patients, regardless of suspected or confirmed infection status, in any setting in which health care is delivered. They are a foundation for infection prevention and control (IPC).[1-2,16-17] The World Health Organization summarised key components of SP/RP in Figure 11.4.

Core components include:

- Hand hygiene;
- Respiratory hygiene/cough etiquette – a source control measure to minimise transmission of acute respiratory infection;
- Use of personal protective equipment (PPE) guided by risk assessment and the extent of contact anticipated with blood and body fluids or pathogens;
- Environmental cleaning and disinfection of patient care equipment and inanimate surfaces that are touched with high frequency;
- Careful handling of used linens;
- Safe injection practices – including use of gloves and mask during spinal procedures, e.g., lumbar puncture to collect cerebrospinal fluid, myelography, or placement of catheter to provide epidural analgesia;
- Prevention of needle sticks and injuries from sharp instruments;
- Safe waste management; and
- Education of patients and family.



✔ Checklist

Health policy

- Promote a safety climate.
- Develop policies which facilitate the implementation of infection control measures.

Hand hygiene

- Perform hand hygiene by means of hand rubbing or hand washing (see overleaf for detailed indications).
- Hands should always be washed with soap and water if hands are visibly soiled, or exposure to spore-forming organisms is proven or strongly suspected, or after using the restroom. For other indications, if resources permit, perform hand rubbing with an alcohol-based preparation.
- Ensure availability of hand-washing facilities with clean running water.
- Ensure availability of hand hygiene products (clean water, soap, single use clean towels, alcohol-based hand rub). Alcohol-based hand rubs should ideally be available at the point of care.

Personal protective equipment (PPE)

- ASSESS THE RISK of exposure to body substances or contaminated surfaces BEFORE any health-care activity. **Make this a routine!**
- Select PPE based on the assessment of risk:
  - clean non-sterile gloves.
  - clean, non-sterile fluid-resistant gown.
  - mask and eye protection or a face shield.

Respiratory hygiene and cough etiquette

- Education of health workers, patients and visitors.
- Use of source control measures.
- Hand hygiene after contact with respiratory secretions.
- Spatial separation of persons with acute febrile respiratory symptoms.

Figure 11.4. Checklist: Infection control standard precautions in health care.[3]

Application of Standard Precautions/Routine Practices

For most care use of SP/RP is safe and effective to prevent transmission of microorganisms between patients and protect HCWs. HCWs should assess patients at the time of initial presentation for any clinical signs and symptoms of active infection and employ precautions based on this assessment for any risks of exposure to blood/body fluids. HCWs may use a point-of-care risk assessment to guide use of PPE as appropriate.[2]

Hand hygiene

Hand hygiene is the most effective intervention to prevent transmission of microorganisms. HCWs should use the WHO Five Moments for Hand Hygiene as a framework for when to perform hand hygiene.[18] Hand hygiene is especially important after contact with blood, body fluids, secretions, excretions, and contaminated equipment or surfaces – even when gloves are worn.

Respiratory Hygiene/Cough Etiquette

The following measures to contain respiratory secretions are recommended for all individuals with signs and symptoms of a respiratory infection.

- Use of facial tissues or covering a cough, e.g., against a sleeve or one's shoulder or turning head away from others, to contain respiratory secretions and prompt disposal of used tissues.
- Provide a standard mask to individuals with a cough.
- Maintain spatial separation of two metres between patients symptomatic with an acute respiratory infection (manifested by a new cough, shortness of breath, and fever) and those who do not have symptoms of a respiratory infection.

Source Control

SP/RP also include the concept of source control; this means the prompt identification of a patient with a communicable disease followed by spatial separation from others. There may also be the additional use of precautions for the suspected type of infection. Source control at triage (initial evaluation of the patient's symptoms and reason for coming to the healthcare facility) includes prompt review and detection of symptoms of active infection, use of respiratory hygiene/cough etiquette, and spatial separation of those with a communicable disease from others. The following are some examples of the application of source control.[2]

- Emergency Department and other acute ambulatory care settings:
    - Signs to direct patients with symptoms of acute infection to specific waiting areas away from others (e.g., cough, fever, vomiting, diarrhoea, coryza, rash, or conjunctivitis).
    - A physical barrier (e.g., plastic partition at triage desk) should be located between infectious sources, e.g., patients with symptoms of a respiratory infection, and susceptible hosts – e.g., other patients.
    - Patients with acute respiratory infections should be placed directly into an examination room or an AIIR room, as indicated by the type of respiratory infection suspected.
    - Patients with an acute diarrheal illness should be placed into a single occupancy examination room with dedicated toilet or commode whenever possible and as soon as possible.
- Inpatient Care:
    - Accommodation of inpatients in a single-patient room facilitates IPC by providing spatial separation from others. Single-patient rooms with a private toilet, designated patient hand washing sink, and designated staff hand washing sink may reduce opportunities for cross-transmission between patients, particularly when the patient has poor hygiene, contaminates the environment, or cannot comply with IPC measures because of physical, behavioural, and/or cognitive impairment(s).
    - Patient flow refers to patient transfer/transport within and outside of the facility. There is a potential for exposure to and transmission of microorganisms as a result of patient activity and transport due to inadvertent contact with other patients, patient care items, or environmental surfaces. Patients should not be transported between patient care units, departments, or facilities unless medically necessary. Frequent patient transfers should be avoided, as this increases the number of interactions with staff and other patients, providing opportunities for spread to occur.

Patient Care Equipment

Handle patient care equipment soiled with blood, body fluids, secretions, or excretions with care to prevent exposure to skin and mucous membranes, clothing, or the environment.

Personal Protective Equipment

Using PPE provides a physical barrier between microorganisms and the wearer. It offers protection by preventing microorganisms from contaminating hands, eyes, or clothing with the potential to then being spread to other patients and staff.

Gloves

Wear clean gloves when touching blood, body fluids, secretions, excretions, or mucous membranes. Change gloves between patients and different tasks/procedures on the same patient to prevent cross-contamination between body sites. Remove gloves immediately after use and cleanse hands.

Protection of Work Clothes/Uniform

Contamination of work clothes can be considerable (from splashes or spills of body fluids) and is reduced by a protective gown or apron; wearing a plastic apron/gown during clinical procedures reduces the risk of contamination. Remove it as soon as possible. If it is necessary to use the gown/apron later on the same patient, remove it without touching the outer side. After use, the gown/apron should be removed by undoing the neck and then the waist ties, without touching areas that are visibly or may be contaminated; then turn it inside on itself and roll it up.[17, 19]

PPE Training and Maintaining Competency

Education and training on IPC policies and procedures, including use of PPE, should be provided to all HCWs during employment orientation, as a result of special circumstances, e.g., outbreaks, new equipment or information, and on a regular basis thereafter. Use of PPE, in particular, should include practice with PPE components.[20]

Face and Respiratory Protection

Masks and eye protection (e.g., goggles, face shields) protect eyes and mucous membranes against blood/body fluid splashes. When small infectious particles may be generated, e.g., during aerosol generating procedures, HCWs should put on a particulate respirator to prevent mucous membrane exposure.

Sharps safety

Work practices to prevent sharps injuries include awareness of risks when using sharp devices, avoiding recapping used needles, and careful disposal of used sharps and contaminated waste. Staff should be aware of hazards caused by overfilling sharps disposal containers and keep hands behind the tip of any sharp item.

Linen, waste, and reusable dishes and eating utensils

Soiled Linen

Handle, transport, and process linen that is soiled with blood, body fluids, secretions, or excretions with care using PPE as appropriate and making sure that there is no leaking of fluid.

Waste

Medical waste (e.g., sponges, dressings, and surgical drapes soaked with blood or secretions) should be contained in impervious waste-holding bags or double bagged and disposed of according to local regulations. Used needles and other sharp items should be handled with care to avoid injuries during disposal. Used medical sharps should be disposed of immediately in designated puncture-resistant containers located at the point-of-use.

Dishes and Eating Utensils

The combination of hot water and detergent is sufficient to decontaminate dishware and eating utensils. Therefore, no special precautions are needed for dishware (e.g., dishes, glasses, cups) or eating utensils.

Family members providing care

Family members should be educated by HCWs to use proper hand hygiene and appropriate precautions to prevent spread of infections to themselves and other patients. Precautions for family members are the same as those used by staff.

Visitors[21]

Visitors with symptoms of acute infection (e.g., cough, fever, vomiting, diarrhoea, coryza, rash, or conjunctivitis) should not visit unless the visit is essential, in which case they should be instructed and supervised in precautions to minimise transmission of infection.

- Visitors should not have medical conditions that put them at risk for serious disease if they acquire the patient's infection (e.g., a visitor with chronic lung disease could acquire a respiratory virus).
- Generally, visitors should have access to the same PPE as staff when providing direct patient care. However evidence to support the use of PPE by visitors is lacking.
- HCWs should instruct family and visitors of correct use of PPE.
- If used by visitors, PPE should be changed before visiting a different patient.

Transmission-based/Additional precautions

Transmission-based Precautions are used for containing highly transmissible and/or epidemiologically important pathogens. There are three categories of Transmission-Based Precautions: Contact, Droplet, and Airborne Precautions.[1-2, 22] Transmission-Based Precautions are used when the route(s) of transmission is (are) not completely interrupted using SP/RP alone. For some diseases that have multiple routes of transmission (e.g., MERS-CoV, Ebola) more than one category may be used. When used either singly or in combination, they are always used in addition to SP/RP. Tables are available outlining category recommendations for various microorganisms.[1-2] Also see Table 11.1.

Contact Precautions (CP)

These precautions apply to microbes which are spread by contact with the patient or the patient's environment. It is also used when the infection involved has a very low infective dose (e.g., norovirus) and/or situations where heavy contamination of the patient's environment is anticipated (e.g., a child with respiratory syncytial virus who has difficulty containing his/her coughs). Examples of microorganisms to which CP usually apply include CRE, vancomycin-resistant *Staphylococcus aureus*, and *C. difficile*. The elements of CP include those of SP/RP and the following additional components.

Patient Placement and Transport

Place the patient in a single-patient room (or in a room with another patient infected with the same pathogen). If a single occupancy room is not available, assure there is at least one metre of space between beds. When transport or movement from the room is necessary, ensure that infected or colonised areas of the patient's body are contained and covered. HCWs should remove and dispose of contaminated PPE and perform hand hygiene before transporting patients. They should then don clean PPE to handle the patient at the transport destination.

Personal Protective Equipment

Wear clean gloves when entering the room and a clean gown/apron if substantial contact with the patient, environmental surfaces, or items in the patient's room is anticipated. Donning PPE on room entry and discarding it before exiting the patient room is performed to contain pathogens, especially those that have been implicated in transmission through environmental contamination.

Patient Care Equipment

Use disposable noncritical patient care equipment (e.g., blood pressure cuffs) or implement patient-dedicated use of such equipment. If use of equipment for multiple patients is unavoidable, clean and disinfect the equipment before use on another patient.

Table 11.1. Clinical syndromes/conditions warranting empiric transmission-based precautions.[1]

Clinical Syndrome or Condition†	Potential Pathogens‡	Empiric Precautions (Always includes Standard Precautions/Routine Practices)
Diarrhoea: Acute diarrhoea with a likely infectious cause in an incontinent or diapered patient	Enteric pathogens§	Contact Precautions (paediatrics and adult)
Meningitis	*Neisseria meningiditis* enteroviruses *M. tuberculosis*	Droplet Precautions for first 24 hrs of antimicrobial therapy; mask and face protection for intubation Contact Precautions for infants and children Airborne Precautions if pulmonary infiltrate Airborne Precautions plus Contact Precautions if potentially infectious draining body fluid present
Rash or exanthems, generalised, aetiology unknown		
Petechial/ecchymotic with fever (general) - If positive history of travel to an area with an ongoing outbreak of VHF in the 10 days before onset of fever	*Neisseria meningiditis* Ebola, Lassa, Marburg viruses	Droplet Precautions for first 24 hrs of antimicrobial therapy Droplet Precautions plus Contact Precautions, with face/eye protection, emphasizing safety sharps and barrier precautions when blood exposure likely. Use N95 or higher respiratory protection when aerosol-generating procedure performed
Vesicular	Varicella-zoster, herpes simplex, variola (smallpox), vaccinia viruses Vaccinia virus	Airborne plus Contact Precautions Contact Precautions only if herpes simplex, localized zoster in an immunocompetent host or vaccinia viruses most likely
Maculopapular with cough, coryza and feve	Rubeola (measles) virus	Airborne Precautions
Respiratory Infections		
Cough/fever/upper lobe pulmonary infiltrate in an HIV-negative patient or a patient at low risk for human immunodeficiency virus (HIV) infection	*M. tuberculosis*, Respiratory viruses, *S. pneumoniae*, *S. aureus* (MSSA or MRSA)	Airborne Precautions plus Contact precautions
Cough/fever/pulmonary infiltrate in any lung location in an HIV-infected patient or a patient at high risk for HIV infection	*M. tuberculosis*, Respiratory viruses, *S. pneumoniae*, *S. aureus* (MSSA or MRSA)	Airborne Precautions plus Contact Precautions Use eye/face protection if aerosol-generating procedure performed or contact with respiratory secretions anticipated. If tuberculosis is unlikely and there are no AIIRs and/or respirators available, use Droplet Precautions instead of Airborne Precautions Tuberculosis more likely in HIV-infected individual than in HIV negative individual
Cough/fever/pulmonary infiltrate in any lung location in a patient with a history of recent travel (10-21 days) to countries with active outbreaks of SARS, avian influenza	*M. tuberculosis*, severe acute respiratory syndrome virus (SARS- CoV), avian influenza	Airborne plus Contact Precautions plus eye protection. If SARS and tuberculosis unlikely, use Droplet Precautions instead of Airborne Precautions.
Respiratory infections, particularly bronchiolitis and pneumonia, in infants and young children	Respiratory syncytial virus, parainfluenza virus, adenovirus, influenza virus, human metapneumovirus	Contact plus Droplet Precautions; Droplet Precautions may be discontinued when adenovirus and influenza have been ruled out
Skin or Wound Infection		
Abscess or draining wound that cannot be covered	*Staphylococcus aureus* (MSSA or MRSA), group A streptococcus	Contact Precautions. Add Droplet Precautions for the first 24 hours of appropriate antimicrobial therapy if invasive Group A streptococcal disease is suspected

* Infection control professionals should modify or adapt this table according to local conditions. To ensure that appropriate empiric precautions are implemented always, hospitals must have systems in place to evaluate patients routinely according to these criteria as part of their preadmission and admission care.

† Patients with the syndromes or conditions listed may present with atypical signs or symptoms (e.g.,neonates and adults with pertussis may not have paroxysmal or severe cough). The clinician's index of suspicion should be guided by the prevalence of specific conditions in the community, as well as clinical judgement.

‡ The microorganisms listed under the column "Potential Pathogens" are not intended to represent the complete, or even most likely, diagnoses, but rather possible etiologic agents that require additional precautions beyond Standard Precautions/Routine Practices until they can be ruled out.

§ These pathogens include enterohemorrhagic *Escherichia coli* O157:H7, *Shigella spp*, hepatitis A virus, noroviruses, rotavirus, and *C. difficile*.

Environmental measures

Ensure that rooms of patients on CP are prioritised for frequent cleaning and disinfection (e.g., at least daily) with a focus on frequently touched surfaces[23] (e.g., bed rails, over-bed table, bedside commode, lavatory surfaces in patient bathrooms, doorknobs) and equipment in the immediate vicinity of the patient.

Droplet precautions (DP)

This category is intended to prevent transmission of pathogens spread through droplets that moves through the air over a short distance, i.e., 1-2 metres Droplets are generated by a cough or sneeze from the person with infection. Examples of infections include influenza, pertussis, and rubella.

Patient Placement and Transport

Ideally place patient in a single-patient room. If a single-patient room is not available, cohorting those with the same infection in a multi-bed room can be used. If transport or movement is necessary, instruct the patient to wear a mask and follow respiratory hygiene/cough etiquette.

Personal Protective Equipment

HCWs should wear a standard mask during close, direct patient care (e.g., $\leq$ 1-2 metres).

Airborne Precautions

These precautions are aimed at preventing transmission of infectious agents that are suspended in the air, remain infectious, and can spread over long distances; the microorganisms are carried through the air in droplet nuclei. Droplet nuclei are dried-out residuals of respiratory droplets <5 μm in diameter which can be inhaled into the lower respiratory tract.

There is emerging evidence that some viruses causing acute respiratory tract infections (e.g., severe acute respiratory syndrome [SARS], MERS-Coronavirus [MERS-CoV], and influenza) can be spread through droplet nuclei over short distances. This is especially an issue if aerosol generating procedures are performed. The mechanism of this spread is described as opportunistic airborne transmission.[8] These procedures include intubation, cardiopulmonary resuscitation, bronchoscopy, autopsy, and surgery where high-speed devices are used. Airborne Precautions are recommended by the WHO when performing these procedures on patients with suspect or confirmed infection caused by these viruses.[24]

Patient Placement and Transport

Place patient in a negative pressure, AIIR. If transport or movement is necessary, instruct the patient to wear a standard mask and follow respiratory hygiene/cough etiquette. For a patient with skin lesions associated with varicella or smallpox or draining skin lesions caused by *M. tuberculosis*, cover the affected areas to prevent aerosolisation or contact with the infectious agent in skin lesions if transport from the AIIR is needed.

Engineering Control; AIIR

The AIIR is an environmental control that provides a mechanical ventilation rate of >12 air changes/hour (ACH) to remove airborne contaminants and discharge them to the outdoors. ACH is the volume of outdoor air flowing into a given space in an hour divided by the volume of air in the space. The AIIR is a single-patient room that is equipped with dedicated exhaust (removal of air in the room via an air duct that exhausts it directly outdoors). If dedicated exhaust of air from the room is not feasible, it can be filtered through a high efficiency particulate air (HEPA) filter before exhausted.

If AIIRs are not available, the WHO has provided guidance on how to use natural ventilation (NV) systems to minimise risk of airborne disease transmission.[25] NV refers to use of natural forces to introduce and distribute outdoor air into or out of a building. These natural forces can be wind pressures or pressure generat-

ed by the density difference between indoor and outdoor air. The WHO recommends that if NV is used for IPC, the minimum ventilation rate should be higher than the existing requirement for mechanical ventilation to compensate for the expected fluctuations in ventilation rate and difficulties in controlling airflow direction.

HCW restrictions

Restrict susceptible HCWs from entering the rooms of patients known or suspected to have measles (rubeola), varicella (chickenpox), disseminated zoster, or smallpox if other immune HCWs are available.

Personal Protective Equipment

HCWs should wear a particulate respirator when entering the room or home of a patient on Airborne Precautions. Most respirators used for health care purposes are disposable with filtering face pieces covering the mouth, nose, and chin. A respirator provides a higher level of filtration of airborne particles than regular masks by capturing at least 95% of particles with a diameter of 0.3 microns.

The other type of respiratory protection that may be used is a powered air-purifying respirator (PAPR). PAPRs use a fan to blow air through a filter to the user. They need to be cleaned and disinfected in between use. They also require use of batteries to power the fan.

Typically the use of a respirator is recommended for entry of any HCW into room for suspect or proven active tuberculosis (TB). For measles or chickenpox, HCWs who are immune would not necessarily need respiratory protection other than that needed under SP/RP. However, there is some evidence that HCWs immune to measles who did not wear a respirator while caring for a patient with confirmed measles developed breakthrough infection.[26] These investigators recommend HCWs should wear respirators when evaluating suspected measles patients regardless of immunity status.

Types of Respirators

- Australia: P2 - filter efficiency of at least 94%.
- Europe: Filtering face pieces (FFP) that have filtering efficiencies ranging from 80, 94, and 99%; FFP1, FFP2, and FFP3 respectively.
- U.S.: Non-oil resistant, National Institutes of Occupational Safety & Health–certified, filter efficiencies increase with the number: N95, N99 and N100.

Precautions for Family/Visitors to Patients under Transmission-Based Precautions

The Society for Healthcare Epidemiology of America published recommended guidance on roles and responsibilities of family/visitors to patients on isolation precautions.[22] These include:

- All visitors should perform hand hygiene prior to entering a patient room and immediately after leaving the room.
- For endemic situations with MRSA and VRE, do not use CP for visitors in routine circumstances.
- If visitors to patients with MRSA or VRE will be interacting with multiple patients, they may be at greater risk for transmitting pathogens between patients and should use CP in a fashion similar to that of HCWs.
- For parents/guardians/visitors with extended stay in a patient's room, including overnight visitation, Transmission-Based Precautions may not be practical.
- Visitors to rooms of patients on DP or Airborne Precautions should use surgical masks. However, visitors with extensive documented exposure to the symptomatic patient prior to hospitalisation, such as parents/guardians/ family members, may be excluded from these precautions; they may either be immune to the infectious agent or already in the incubation period.

A summary of elements of SP/RP and Transmission-Based Precautions are outlined in Table 11.2.

Table 11.2. Standard and transmission-based precautions summary. Adapted from reference 17.

Type of Precautions	Examples of infectious agents	Single room or cohort	Gloves	Gown/ Apron	Face Protection	Eye Protection	Handling of equipment	Visitors*
Standard/ Routine Practices	Standard precautions/routine practices apply for all work practices to prevent the likelihood of transmission of infection							Hand hygiene Respiratory hygiene and cough etiquette
Contact	MROs, *C. difficile*, intestinal tract pathogens (e.g., norovirus), highly contagious skin infections	X	X	X	&	**	Single use or reprocess before reuse on next patient	Same precautions as staff
Droplet	Influenza, RSV, norovirus, pertussis (whooping cough), meningococcus	X	**	**	Surgical mask	**	Single use or reprocess before reuse on next patient	Restrict visitor numbers and precautions as for staff
Airborne	Pulmonary TB, chickenpox (varicella)#, measles (rubeola)#, SARS	Negative pressure	**	**	Respirator	**	Single use or reprocess before reuse on next patient	Restrict visitor numbers and precautions as for staff

* Visitors should be given instruction about correct procedures when transmission-based precautions are applied and given appropriate resources to support them in meeting these requirements.

** As required — worn whenever there is the potential of direct or indirect contact with blood or body substances – or the potential of exposure to splashes or sprays to mucosa

& Surgical mask required if infectious agent isolated in sputum

If staff or visitor HAVE HAD chickenpox / measles in the past or vaccination for these diseases, mask, gown and gloves are not required

Acute Respiratory Infections and New Emergent, Re-Emergent Diseases

The WHO has published IPC guidelines for patients presenting with acute respiratory infections (ARI).[22] The rationale for these guidelines is that often these illnesses have the potential for rapid spread and may cause epidemics or pandemics. Diseases or syndromes to which these guidelines apply include:

- Novel coronaviruses that cause SARS and MERS-CoV;
- Human influenza caused by a new subtype, including human episodes of avian influenza;
- Pneumonic plague; and
- Novel ARIs that can cause large-scale outbreaks or outbreaks with high morbidity and mortality.

The principles of IPC for ARI patient care include:

1. Early and rapid recognition of patients with possible ARI;
2. Application of SP/RP for all patients;
3. Additional transmission-based precautions in selected patients (e.g., based on the presumptive diagnosis); and
4. Apply SP/RP and Droplet Precautions at the initial evaluation of a patient with a suspected ARI. Modify isolation precautions according to the specific diagnosis, as it becomes available.

Management of patients with MERS-CoV has been outlined by the WHO.[11] The WHO has also developed IPC guidance for suspected or confirmed haemorrhagic fever cases with a focus on ebola.[19]

Syndromic and empiric applications of Transmission-Based Precautions

Diagnosis of many infections requires laboratory confirmation. Since laboratory tests, especially those that depend on culture techniques, often require two or more days for completion, empiric use of precautions based on symptoms the patient exhibits at the time of presentation for care is recommended. This action will minimise risk of transmission while diagnosis of infection is underway. Table 11.2 provides guidance on the recommended category of transmission-based precautions to use based on symptoms observed during initial assessment of the patient.

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