



**THE NATIONAL
INFECTION PREVENTION AND CONTROL
GUIDELINES
FOR ACUTE HEALTHCARE FACILITIES**

2017

Foreword

The National Infection Prevention and Control Committee (NIPC) was appointed by the Singapore Ministry of Health in 2014 and charged with a number of tasks including reform and consolidation of national guidelines.

It is with great pleasure therefore that I present the 2017 National Infection Prevention and Control Guidelines for the acute care setting. This version is built on many previous publications from sources including Singapore's Ministry of Health (MOH), the Infection Control Association of Singapore (ICAS), and international sources including Centers for Disease Control and Prevention (CDC), the World Health Organization (WHO) and peer-reviewed literature.

Specifically in this version, we have excluded sections dedicated to the non-acute sectors, and we will compile this in a separate document. We have also brought in and modified pre-existing standalone documents related to multi-drug resistant organisms and environmental cleaning.

These guidelines can be used as a reference for healthcare professionals, management and operations staff to ensure protocols and processes for infection prevention and control are appropriately adapted and in place in all of Singapore's acute healthcare settings.

The NIPC committee and secretariat welcome feedback, particularly in areas for improvement which will as a matter of course be considered for future editions.

Finally, I would like to give particular acknowledgement to the writing committee (see acknowledgement page) and all infection prevention and control specialists who provided expert input to the drafting of these guidelines.

Dale Fisher
Chairperson,
National Infection Prevention and Control Committee

Acknowledgement

The National Infection Prevention and Control Guidelines 2017 has been endorsed by the National Infection Prevention and Control Committee (NIPC). The composition of the NIPC is provided in Table 1.

Table 1. Composition of NIPC

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The MOH would like to acknowledge Dr Ling Moi Lin (Director, Infection Prevention and Control, Singapore General Hospital) for leading the various groups of experts in the writing and revision of the guidelines. The experts who contributed in their individual capacity to the revision of the guidelines are listed in Table 2.

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PART I.

SPECIFIC PRECAUTIONS

Chapter 1. Standard Precautions

Chapter 2. Droplet Precautions

Chapter 3. Contact Precautions

Chapter 4. Airborne Infection Isolation Precautions

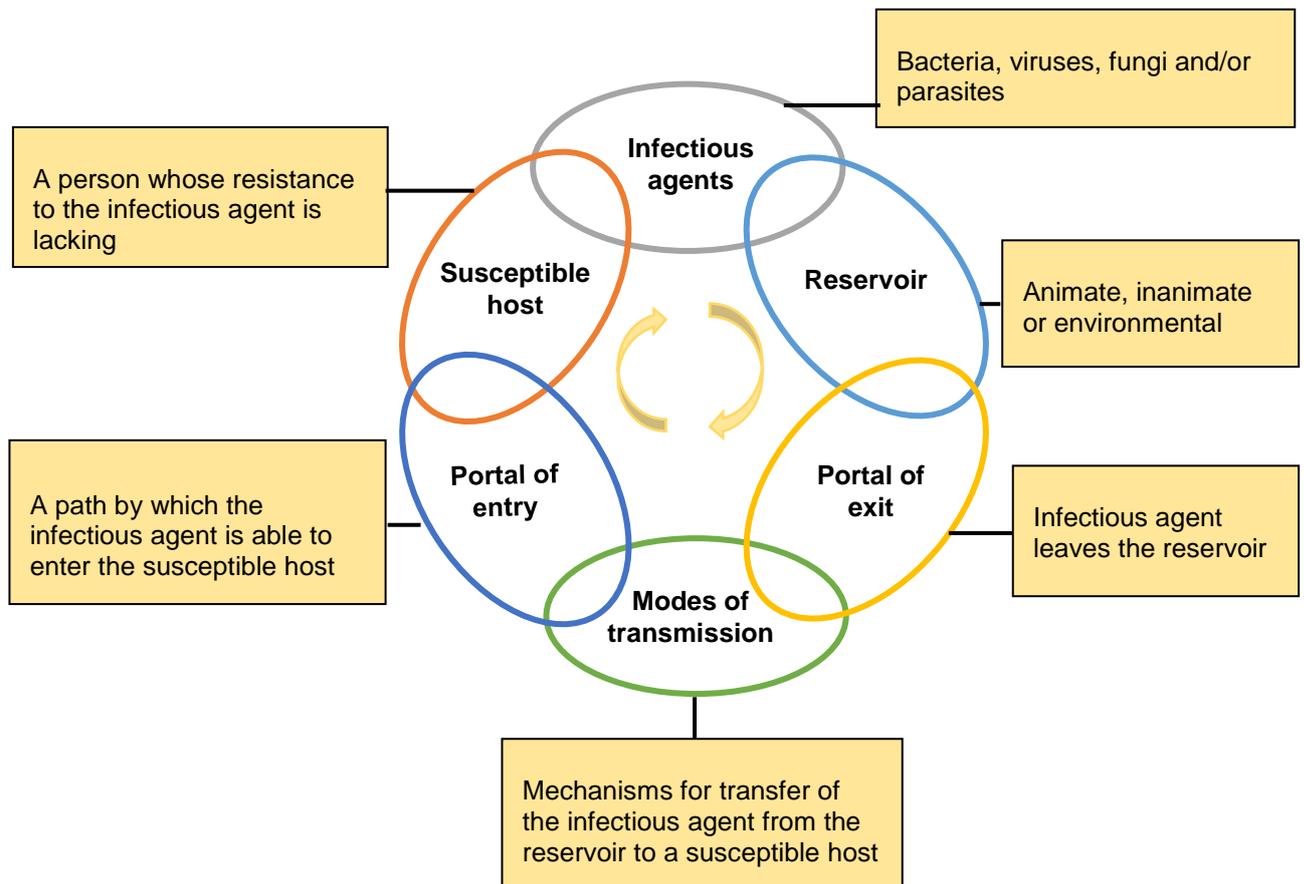
Chapter 5. Protective Environment

Chapter 1. Standard Precautions

1 Chain of Infection

The chain of infection represents the transmission of microorganisms and subsequent infection within a healthcare setting, with each link in the chain representing a factor related to the spread of microorganisms. Transmission does not take place unless all six of the elements in the chain of transmission are present. Transmission occurs when the agent in the reservoir exits through a portal of exit, travels via a mode of transmission and gains entry through a portal of entry to a susceptible host.

1.1 Six Elements to the Chain of Infection



For an infection to develop, each link of the chain must be connected.

Breaking any link of the chain can stop the transmission of infection.

1.1.1 Infectious Agent

Any microorganism (or microbe) that can cause an infection such as a bacterium, virus, parasite or fungus. Factors affecting the organism's chances of causing an infection are *virulence* (ability to multiply and grow), *invasiveness* (ability to enter tissue), and *pathogenicity* (ability to cause disease).

1.1.2 Reservoir

The place where the infectious agent resides, survives and reproduces, e.g. food, water, toilet seat, elevator buttons, human feces and/or respiratory secretions.

1.1.3 Portal of Exit

A way for the infectious agent to leave the reservoir, such as the respiratory tract (nose, mouth), intestinal tract (rectum), urinary tract, or blood and other body fluids.

1.1.4 Modes of Transmission

The mechanisms by which the infectious agent transfers from one carrier to another by either direct contact, indirect contact, droplet, common vehicle, airborne or vector borne means. Transmission varies by the type of organism and some infectious agents may be transmitted by more than one route.

1.1.5 Portal of Entry

The opening where the infectious agent enters the host's body such as mucus membranes, open wounds or tubes inserted in body cavities like urinary catheters or feeding tubes.

1.1.6 Susceptible Host

The person who is at risk for developing an infection from the infectious agent. A person may be more susceptible to disease due to age (people at extremes of age generally are more at risk), underlying chronic diseases (like diabetes and asthma), conditions that weaken the immune system (like HIV and certain medications) and invasive devices (like feeding tubes and malnutrition).

Healthcare professionals (HCPs) must assess the risk of exposure to blood, body fluids and non-intact skin, and identify strategies to decrease exposure risk and prevent transmission of microorganisms. Strategies would be based on the:

- a) client/patient infection status (including colonization);
- b) characteristics of the client/patient;
- c) type of care activities to be performed;
- d) resources available for control; and
- e) HCP's immune status.

Risks are assessed for:

- a) contamination of skin or clothing by microorganisms in the client/patient/resident environment;
- b) exposure to blood, body fluids, secretions, excretions and/or tissues;
- c) exposure to non-intact skin;
- d) exposure to mucous membranes; and
- e) exposure to contaminated equipment or surfaces.

2 Rationale for Standard Precautions

Standard Precautions are the minimum infection prevention practices that apply to all patient care, regardless of suspected or confirmed infection status of the patient, in any setting where healthcare is delivered. These practices are designed to both protect HCPs, and prevent them from spreading infections among patients, especially those involving blood-borne pathogens. Standard Precautions include:

- a) hand hygiene;
- b) use of personal protective equipment (e.g. gloves, gowns, masks);
- c) safe injection practices;
- d) safe handling of potentially contaminated equipment or surfaces in the patient environment; and
- e) respiratory hygiene/cough etiquette.

3 Components in Standard Precautions

3.1 Hand Hygiene

The practice of good hand hygiene, either by use of alcohol-based hand rubs or hand washing with soap and water, is critical to reduce the risk of transmission of infections.

The use of soap and water is recommended when hands are visibly soiled (e.g. blood and/or body fluids), or after caring for patients with known or suspected infectious diarrhoea (e.g. *Clostridium difficile*, norovirus). Otherwise, the preferred method of hand decontamination is with an alcohol-based hand rub, as recommended by the US Centres for Disease Control and Prevention (CDC) and the World Health Organization (WHO), because of its effectiveness against a broad spectrum of epidemiologically important pathogens. Additionally, it increases compliance with recommended hand hygiene practices as it requires less time in cleaning the hands (20-30 sec, versus 40-60 sec when using soap and water).

3.2 Personal Protective Equipment (PPE)

This refers to wearable equipment that is intended to protect HCPs from exposure to or contact with infectious agents. These include gloves, gowns, facemasks, respirators, goggles and face shields. The selection of PPE is based on the nature of the patient interaction and potential for exposure to blood, body fluids or infectious agents.

3.2.1 Gloves

Gloves shall be worn when it is anticipated that the hands will be in contact with body fluids, such as via mucous membranes, non-intact skin, tissue, blood, secretions, excretions or equipment and environmental surfaces that are contaminated with body fluids. They are not required for routine healthcare activities in which contact is limited to intact skin of the client/patient (e.g. taking blood pressure, bathing and dressing the client/patient). While hand hygiene should be universal for all patient contact, the use of gloves should be task specific. Gloves should be discarded after completion of the task. Sterile gloves should be used in operating theatres and when performing sterile procedures such as central-line insertions. Hand hygiene shall be done before wearing and after removing gloves.

3.2.2 Mask, eye protection and face shield

Mask, eye protection and face shield shall be used by a HCP to protect the mucous membranes of the nose and mouth, when it is anticipated that a procedure or care activity is likely to generate splashes or sprays of body fluids, or is performed within 1.5 meters of a coughing client/patient. Masks shall be used in operating theatres and when performing aseptic procedures (e.g. central line insertions, lumbar punctures, blood cultures or urinary catheter insertion) to protect the sterile field. Also, a mask should be worn by a coughing client/patient when outside his/her room, if tolerated, to limit the dissemination of infectious respiratory secretions (cough etiquette). It should be discarded after each use, or changed when moist or soiled.

Eye protection should also be worn for wound irrigation procedures if there is any risk of sprays or splashes. These may include:

- a) safety glasses
- b) safety goggles
- c) face shields
- d) visors attached to masks

Hand hygiene should be done before wearing and after removal of mask/eye protection/face shield.

3.2.3 Apron / Gowns

A gown shall be worn when it is anticipated that a procedure or care activity is likely to generate splashes or sprays of body fluids such as blood, secretions or excretions. A sleeveless apron may be worn where full coverage is not required. Aprons and gowns should be removed and discarded immediately after each use, followed by hand hygiene to avoid transfer of micro-organisms to other patients or environment.

3.3 Safe injection practices

A sharps injury prevention program must be in place in all healthcare settings. This should include follow-up for exposures to blood-borne pathogens. Used needles and sharp objects are potential sources of transmission of infections and must be

handled with care to prevent accidental injuries. Precautions shall be taken to prevent injuries when handling needles, scalpels and other sharp instruments and devices during procedures, cleaning and disposal. These precautions include:

- a) Not recapping used needles;
- b) Disposal of used needles and syringes as one unit;
- c) Not removing, bending, manipulating or breaking used needles by hand;
- d) Discarding all sharps into an appropriate puncture-resistant sharp disposal container;
- e) Not crossing the path of a sharp and ensuring correct positioning of hands;
- f) Using hands-free technique when passing sharps during clinical procedures;
- g) Removing sharp container and replacing with a new one immediately when it is three-quarters full, and ensuring that the cover is securely closed to prevent leakage or protrusion of needles/sharps before disposal; and
- h) Placing contaminated instruments in a puncture-resistant container when transporting to the reprocessing area.

3.3.1 In event of body fluid spills:

- a) Pour chlorine based disinfectant (e.g. NaDCC granules or solution) of at least 10,000ppm chlorine over body fluid spills.
- b) Wear gloves and use disposable paper towels to clean up body fluids spills.
- c) Dispose them into a biohazard bag and mop the area with institution recommended disinfectant.

3.3.2 Use of multi-dose vials:

- a) Visually inspect injection vial for any signs of contamination, e.g. visible dust particles. Discard vial if sterility is in question.
- b) Disinfect the rubber septum of the medication vial with 70% alcohol and allow it to dry, before puncturing it with a sterile needle to draw medication from the vial.

- c) Use a sterile, single-use, disposable needle and syringe for each withdrawal of medication.
- d) Limit the use of a multiple-dose vial to only a single patient, whenever possible, to reduce the risk of contamination.
- e) Multi-dose vial should be labelled with patient's details and the date it was first opened.
- f) Multi-dose vial should be discarded within 28 days of opening unless the manufacturer specifies a different (shorter or longer) length of use for that medication.
- g) Multi-dose vial for multi-patient use should be kept in a centralized medication area and should not be brought into the patient's treatment area (e.g. operating room, patient room/cubicle).
- h) Only vials that are clearly labelled by the manufacturer for multiple dose use can be used more than once.

3.3.3 Use of single dose vial/ampoule and intravenous solution (bag/bottle):

- a) A single dose medication vial/ampoule or intravenous solution (bag, bottle or otherwise) shall be used for one patient only.
- b) Do not combine or pool leftover contents for later use.
- c) Do not store used single-dose vial/ampoule and intravenous solution (bag, bottle or otherwise) for later use

3.4 Medical Equipment Cleaning

Healthcare facilities should ensure that all reusable medical equipment (e.g. blood glucose meters and other point-of-care devices, surgical instruments and endoscopes) are cleaned and reprocessed appropriately prior to use on another patient. Reusable medical equipment must be cleaned, reprocessed (by disinfection or sterilization) and maintained according to the manufacturer's instructions. HCPs must wear appropriate PPE when handling and reprocessing contaminated patient equipment. All single-use medical equipment should not re-used.

3.5 Environmental Hygiene

Facilities should establish policies and procedures for routine cleaning and

disinfection of environmental surfaces as part of their infection prevention program. Cleaning refers to the removal of visible soil and organic contamination from a device or environmental surface, through the physical action of scrubbing with a surfactant, detergent and water, or appropriate chemical agents. Surfaces that are most likely to become contaminated with pathogens, including those in close proximity to the patient (e.g. bedrails) and frequently touched surfaces in the patient-care environment (e.g. doorknobs), should be emphasized for cleaning and disinfection. Healthcare facilities should have policies and procedures to ensure appropriate cleaning and decontamination of spills of body fluids.

Environmental services staff should be responsible for, and trained in, routine cleaning and disinfection of environmental surfaces. Cleaning procedures should be periodically assessed to ensure that they are consistently and correctly performed. HCPs should follow the manufacturer's recommendations for choice of products for cleaning and disinfection (e.g. amount, dilution, contact time, safe use, and disposal).

3.6 Linen

Linen soiled with body fluids should be handled, transported and processed in a manner that prevents skin and mucus membrane exposure. This can be achieved by:

- a) Handling soiled linen as little as possible, with a minimum of mechanical agitation, and bagged at the location at which it is used, to prevent contamination of air, environment and staff.
- b) Not sorting or pre-rinsing of soiled linen in patient care areas.
- c) Segregating used linen accordingly and placing them into the appropriate laundry bag. All laundry bags should be tied securely and not overfilled.
- d) Performing hand hygiene after handling used linen.

3.7 Respiratory hygiene / cough etiquette

Respiratory hygiene and cough etiquette involves using source control measures to prevent patients with respiratory infections from transmitting their infection to others. These include:

- a) Covering mouth and nose with a tissue when coughing or sneezing.

- b) Offering a surgical mask to patients or visitors who are coughing.
- c) Using tissue to contain respiratory secretions and disposing them in a non-touch disposal bin (e.g. bin with foot pedal-operated lid).
- d) Performing hand hygiene after contact with respiratory secretions.

At patient care areas, the HCP is required to provide surgical masks and non-touch disposable bins for patients' and visitors' use.

4 Recommendations

- a) Standard Precautions should be part of the work culture of all healthcare settings and the daily practice of each HCP during the care of all clients/patients at all times. [BII]
- b) A risk assessment should be made by the HCP before each interaction with a client/patient or contact with their environment to determine the precautions that are required to prevent disease transmission during the planned interaction. [BIII]
- c) A comprehensive hand hygiene program should be established in all healthcare facilities. [AI]
- d) All HCPs and other staff who may be exposed to body fluids should receive education on the proper use of PPE. [BII]
- e) Gloves should be worn when it is anticipated that the hands will be in contact with body fluids, or equipment and environmental surfaces that are contaminated with body fluids. [AII]
- f) Gloves may not be necessary for routine healthcare activities where contact is limited to the intact skin of the client/patient. [AIII]
- g) Hand hygiene should be performed before putting on and after removal of gloves for aseptic procedures. [AIII]
- h) Gowns are to be removed immediately after the task for which it has been used in a manner that prevents contamination of clothing or skin and prevents agitation of the gown. [BII]
- i) A mask and eye protection should be worn to protect the mucous membranes of the eyes, nose and mouth when it is anticipated that a

procedure or care activity is likely to generate splashes or sprays of body fluids. [All]

- j) Clients/patients who visibly soil the environment or for whom appropriate hygiene cannot be maintained are to be placed in single rooms with dedicated toileting facilities. [All]
- k) A sharps injury prevention program should be implemented in all health care settings. [All]

5 **Glossary**

Body fluid: Fluids originating from inside the bodies of people. These include blood, mucous, pus, gastrointestinal fluids (e.g. saliva, vomitus, gastric juices, and faeces) and other system-specific fluids (e.g. amniotic fluid, cerebrospinal fluid, urine).

Blood-borne pathogen: Pathogenic microorganisms that are transmitted via human blood and cause disease in humans. They include, but are not limited to, hepatitis B virus (HBV) and human immunodeficiency virus (HIV). Although a number of blood-borne pathogens can be transmitted percutaneously, HIV-1 remains the most common among such incidents.

Cough etiquette: infection prevention measures to decrease the transmission of respiratory illness (e.g. influenza and cold viruses). These include:

- Covering mouth and nose when coughing or sneezing with a tissue
- Offering a surgical mask to patients or visitors who are coughing
- Using tissue to contain respiratory secretions and disposing them in a non-touch disposal bin (e.g. bin with foot pedal-operated lid)
- Performing hand hygiene after contact with respiratory secretions

Disinfection: using specialized cleansing techniques that destroy or prevent growth of infection-causing organisms.

Hand washing: The physical removal of microorganisms from the hands using soap (plain or antimicrobial) and running water.

Micro-organisms: Microscopic organisms which include bacteria, viruses, fungi, algae and protozoa.

Personal Protective Equipment: Clothing or equipment worn by staff for protection against hazards.

Sterilization: using specialized cleansing techniques to destroy all living microorganisms, such as pathogenic or saprophytic bacteria, vegetative forms, and spores.

6 References

Siegel JD, Rhinehart E, Jackson M, Chiarello L, and the Healthcare Infection Control Practices Advisory Committee, 2007 Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings. <http://www.cdc.gov/ncidod/dhqp/pdf/isolation2007.pdf>
Accessed on 24 October 2013

Chapter 2. Droplet Precautions

Droplet Precautions, when used in addition to Standard Precautions, are intended to prevent transmission of pathogens spread through contact with respiratory secretions. Droplet Precautions are indicated for patients infected with the following pathogens:

- a) *Adenovirus pneumonia* (include Contact Precautions)
- b) *Bordetella pertussis* (whooping cough)
- c) *Diphtheria*
- d) *Haemophilus influenzae* type b (Hib) – (Infants and children)
- e) Influenza virus
- f) Mumps
- g) *Neisseria meningitides*
- h) Rhinovirus
- i) Rubella (German Measles)
- j) Group A *Streptococcus* (for the first 24 hours of antimicrobial therapy).

1 **Patient Placement**

A single patient room is preferred for patients who require Droplet Precautions. When a single-patient room is not available, consultation with infection prevention and control team is recommended to assess the risks associated with placing the patient with other patients (e.g. cohorting, keeping the patient with an existing roommate). When patients on droplet precautions are cohorted in multi-bed rooms, it is recommended to place them at a bed to bed distance of >1.5 meters.

2 **Signage**

Droplet precautions signage to guide people on the precautions to be taken, with instructions for appropriate donning and removal of PPE, should be displayed at the entrance of the patient's room.

3 Personal Protective Equipment (PPE) / Hand Hygiene

Healthcare professionals (HCPs) should wear a surgical mask before any close contact with an infectious patient; hand hygiene should be performed before putting on and after removing the mask. Patients on Droplet Precautions who are transported outside of the room should also wear a mask, if tolerated, and follow Respiratory Hygiene/Cough Etiquette.

4 Environmental control

Patient-care items, bedside equipment and frequently touched surfaces should be cleaned in between patient use with hospital-approved disinfectants.

5 Patient-care equipment and linen

Where possible, dedicate the use of non-critical patient-care equipment and items such stethoscope, sphygmomanometer or bedside commode to a single patient (or cohort of patients infected or colonised with the same pathogen). If sharing of common equipment or items is unavoidable, ensure adequate cleaning and disinfection in between patient use. Contaminated linen should be handled as little as possible to prevent gross microbial contamination of the air. All linen from the patient's isolation room should be handled as per hospital protocol.

6 Patient transport

Patient movement and transport out of the room should be avoided unless absolutely necessary. If a patient needs to be transported out of the room, inform the receiving department of the need for Droplet Precautions. Staff involved in the patient's transfer should wear appropriate PPE during transportation. The patient should wear a surgical mask and follow Respiratory Hygiene /Cough Etiquette in order to minimise the dispersal of droplet nuclei during transportation. Transport equipment should be properly cleaned after patient transport is completed.

7 Communication

Infection Prevention and Control staff should inform clinical staff of patients on Droplet Precautions. Patients should be identified as per hospital protocol, e.g. by using coloured stickers in the patient case sheet, 'O slot' vision outside the patient room, or electronic tagging to inform all HCPs on the precautions to be taken.

8 Recommendations

- a) In acute care setting and community hospitals, place patients who require Droplet Precautions in a single room with dedicated toilet and patient sink, when available. [AII]
- b) In ambulatory settings, offer a surgical mask and hand hygiene advice to clients/patients at triage. Triage client/patient away from waiting area to a single room as soon as possible, and maintain ≥ 1.5 metre spatial separation. [AII]
- c) Wear a surgical mask and eye protection (when splashes to the eye /mucous membrane is anticipated) within 1.5 metre of a client/patient on Droplet Precautions. [BII]
- d) Provide a surgical mask to clients/patients on Droplet Precautions for transport out of the room, if tolerated. [BIII]

9 Glossary

Blood borne pathogen: Pathogenic microorganisms that are transmitted via human blood and cause disease in humans. They include, but are not limited to, hepatitis B virus (HBV) and human immunodeficiency virus (HIV).

Cough etiquette: infection prevention measures to decrease the transmission of respiratory illness (e.g. influenza and cold viruses). These include:

- Covering mouth and nose when coughing or sneezing with a tissue
- Offering a surgical mask to patients or visitors who are coughing

- Using tissue to contain respiratory secretions and dispose them in a non-touch disposal bin (e.g. bin with foot pedal-operated lid)
- Performing hand hygiene after contact with respiratory secretions

Hand hygiene: A general term referring to any action of hand cleaning. Hand hygiene relates to the removal of visible soil and removal or killing of transient microorganisms from the hands. Hand hygiene may be accomplished using soap and running water or an alcohol-based hand rub (ABHR).

Micro-organisms: Microscopic organisms which include bacteria, viruses, fungi, algae and protozoa.

Personal Protective Equipment: Clothing or equipment worn by staff for protection against hazards

10 **References**

Provincial Infectious Diseases Advisory Committee (PIDAC), Routine Practices and Additional Precautions In All Health Care Settings, 3rd edition, November 2012

Siegel JD, Rhinehart E, Jackson M, Chiarello L, and the Healthcare Infection Control Practices Advisory Committee, 2007 Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings. Accessible from: <http://www.cdc.gov/ncidod/dhqp/pdf/isolation2007.pdf> Accessed on 16 December 2013

Chapter 3. Contact Precautions

Contact transmission is the most common route of transmission of infectious agents. It may involve:

- a) **Direct contact**, through touching e.g. a person may transmit microorganisms to others by touching them; or
- b) **Indirect contact**, when microorganisms are transferred via contaminated objects e.g. *C. difficile* can be transmitted from an infected patient to another patient via a contaminated commode.

Contact Precautions should be taken for clients/patients with:

- a) *Clostridium difficile* diarrhoea;
- b) Gastroenteritis;
- c) Undiagnosed diarrhoea;
- d) Scabies;
- e) Pediculosis (Head Lice);
- f) Zoster-limited (Shingles);
- g) Undiagnosed rash; and
- h) Multiple drug resistant organisms e.g. MRSA, VRE, CP-CRE.

1 **Patient Placement**

Acute care clients/patients on Contact Precautions should ideally be accommodated in a single room with a dedicated toilet and patient sink. If single rooms are unavailable, clients/patients should be cohorted with other clients/patients that are infected with the same microorganism in a multi-patient room.

2 **Personal Protective Equipment**

Where patients or residents are placed in isolation rooms, a disposable gown and gloves must be worn before entering the patient's room. Thereafter, hands must be cleaned after glove removal, after gown removal and after exiting the room.

When caring for MDRO carriers in a multi-bedded cubicle:

- a) Wear gloves and gown/ apron only when there is body contact (i.e. close direct contact with the patient) or close contact with potentially contaminated environmental surfaces or equipment.
- b) Clean hands after removing each PPE.
- c) Where there is no bodily contact, hand hygiene should still be practised according to WHO 5 moments.
- d) Remove gown before leaving the patient-care environment and perform hand hygiene immediately.

3 Environmental Control

Clients'/patients' care items, bedside equipment and frequently touched surfaces should be cleaned in between patient use. All patient contact surfaces should be decontaminated with sodium hypochlorite disinfectant with minimum concentration of 1000 ppm available chlorine.

4 Patient – care equipment and linen

Where possible, dedicate the use of non-critical patient-care equipment and items such stethoscope, sphygmomanometer or bedside commode to a single patient. If sharing of common equipment or items is unavoidable, ensure adequate cleaning and disinfection in between patient use. Contaminated linen should be handled as little as possible to prevent gross microbial contamination of the air. All linen from the patient's isolation room should be handled as per hospital protocol.

5 Patient Transport

Clients'/patients' movement and transport from the room should be avoided unless absolutely necessary. If clients/patients need to be transported out of the room, inform the receiving department of the need for Contact Precautions. Staff who accompany the client/patient during the transportation should discard gown and gloves and perform hand hygiene before leaving the room. There is no need to put on gown/apron and gloves when transferring patients. This is to prevent environmental

contamination that could occur through contaminated gloves and gowns/ apron. Clients/patients who are also on droplet precautions should wear a surgical mask en-route. Transport equipment should be properly cleaned after patient transport is completed.

6 Communication

Infection Prevention and Control staff should inform clinical staff of patients who on contact precautions. Patients should be identified as per hospital protocol, e.g. by using coloured stickers in the patient case sheet, 'O slot' vision outside the patient room, or electronic tagging to inform all HCPs on the precautions to be taken.

7 Recommendations

- a) In acute care settings and community hospitals, place patients who require Contact Precautions in a single room with dedicated toilet and patient sink when available. Where isolation rooms are not available, patients who require Contact Precautions may be cohorted in multi-patients rooms. [All]
- b) Do not wear the same gowns and gloves when going from patient-to-patient within the cohort and do not share patient care equipment. [All]
- c) In ambulatory settings, place patients who require Contact Precautions in an isolation room (e.g. examination room) or cohort cubicle as soon as possible. [BII]
- d) In acute care settings and community hospitals where patients are in isolation rooms, wear gloves for all activities in the patient's room. Remove gloves and perform hand hygiene immediately upon leaving the room or bed space. [All]
- e) In acute care settings and community hospital, if there is significant direct contact (where skin or clothing will come in contact with the patient or patient's environment), a gown should be worn. If there is minimal direct contact, hand hygiene alone is adequate. When indicated, put on a gown before entry into the patient's room or bed space. Remove gown and perform hand hygiene immediately after leaving the room or bed space. [BIII]

8 **Glossary**

Hand hygiene: A general term referring to any action of hand cleaning. Hand hygiene relates to the removal of visible soil and removal or killing of transient microorganisms from the hands. Hand hygiene may be accomplished using soap and running water or an alcohol-based hand rub (ABHR).

Micro-organisms: Microscopic organisms which include bacteria, viruses, fungi, algae and protozoa.

Personal Protective Equipment: Clothing or equipment worn by staff for protection against hazards

9 **References**

Healthcare Infection Control Practices Advisory Committee. Guidelines for isolation precautions: Preventing transmission of infectious agent in healthcare settings, 2007; Accessible from: <http://www.cdc.gov/hicpac/2007IP/2007isolationPrecaution.html>, accessed on 15 Jul 11.

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Chapter 4. Airborne Infection Isolation Precautions

Airborne Precautions are used in addition to Standard Precautions to reduce the risk of airborne transmission of infectious agents (< 5 µm in size). Minute droplets may be generated by an infectious person during coughing, sneezing, talking or performing of procedures (e.g. Intubation). These droplets remain suspended in air for long periods of time.

Airborne transmission is further classified into obligate or preferential airborne transmission:

- a) **Obligate airborne transmission** occurs with pathogens that are transmitted only by deposition of droplet nuclei under natural conditions (e.g. pulmonary tuberculosis).
- b) **Preferential airborne transmission** occurs with pathogens that can initiate infection by multiple routes, but are predominantly transmitted by droplet nuclei (e.g. measles and chickenpox).

1 **Patient Placement**

Place patient in an Airborne Infection Isolation (All) Room (AIIR) that has special air handling and ventilation system to contain and safely remove the infectious agents. The room should meet the following ventilation standards:

- a) Minimum 12 air changes per hour (ACH)
- b) Inward directional airflow from adjacent spaces to the room with negative pressure differentials of more negative than - 2.5 Pascal.
- c) The air should flow from room entry door, across the bed area, and exit (exhaust) from the en-suite toilet or the furthest part of the room.
- d) New or renovated AIIR facility should come with an anteroom. The most contaminated area should have the most negative relative air pressure. For example, relative air pressure should be most negative in the patient's room, less negative in the anteroom, and neutral at the common corridor.
- e) All room exhaust air must be HEPA-filtered (at least H14 grade or equivalent)

- f) The HEPA housing must come with 1 set of decontamination port for the safe removal of contaminated HEPA filter, the port size should be at least 5cm in diameter
- g) Exhaust air directed to outside or HEPA-filter, if recirculated
- h) Room pressure must be checked before entering the room and pressure reading monitored daily when in use
- i) The doors in anteroom must have an emergency bypass (both common corridor side and patient room side) for medical emergencies
- j) Doors must be kept closed at all times when not required for entry and exit
- k) Room walls should covered with all penetration points sealed
- l) Architectural furnishings must be smooth without sharp edges. All cracks, gaps and wall stipples must be properly sealed.
- m) All surfaces and fabrics (e.g. curtains, chairs) should be impervious to liquid
- n) No carpeting in patient rooms or hallways
- o) A waste treatment system should be available

If AIIR is not available, place patient in an adequately ventilated single room or transfer patient to a facility that has an AIIR available.

2 Aerosol-generating procedures

Aerosol-generating procedures associated with risk of pathogen transmission (e.g. intubation, bronchoscopy) should be performed using appropriate PPE in an AIIR.

3 Personal Protective Equipment (PPE)

Airborne Precautions are used in addition to Standard Precautions for patients known or suspected of having airborne transmission illness.

NIOSH-approved N95 or higher level respirators are used to prevent inhalation of small particles that may contain infectious agents transmitted via the airborne route. Healthcare Professionals (HCPs) must wear a fit-tested NIOSH-approved N95 or

higher level respirator for respiratory protection before entering the room of a patient on airborne precautions. A seal check of N95 mask or respirator must be performed each time to check leakage around the face piece. Avoid touching or fiddling with the mask once the mask is properly applied. Change the respirator if wet or soiled. Remove N95 mask or respirator after exiting the patient's room or in an anteroom after ensuring that the door of the patient room is closed. Discard the respirator into the appropriate waste bin and perform hand hygiene immediately.

4 Equipment /Consumables

Where possible, dedicate the use of non-critical patient-care equipment and items such stethoscope, sphygmomanometer or bedside commode to a single patient. If sharing of common equipment or items is unavoidable, ensure adequate cleaning and disinfection in between patient use. Contaminated linen should be handled as little as possible to prevent gross microbial contamination of the air. All linen from the patient's isolation room should be handled as per hospital protocol.

5 Dishware and eating utensils

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

6 Environment cleaning

Clients'/patients' care items, bedside equipment, linen and frequently touched surfaces should be cleaned in between patient use. Environmental and surface cleaning of the isolation room with hospital approved disinfectant should be performed daily with special attention given to frequently touched surfaces.

7 Personnel Restriction

Whenever possible, HCP and visitors with lowered immunity should not enter the rooms of patients known or suspected to have measles (rubeola), varicella (chickenpox), disseminated zoster, or smallpox.

8 Visitors

It is necessary to screen visitors before allowing them into patient rooms. Visitors with previous exposure to the disease may have immunity. Active screening may include the completion of a screening tool or questionnaire which elicits information related to recent exposures or current symptoms.

Visitors who have immunity to the disease (e.g. tuberculosis, varicella, smallpox, severe acute respiratory syndrome [SARS]) should wear surgical masks. If immunity cannot be confirmed, visitation should be restricted to only those who have been N95 fit-tested, visitors should be educated about the rationale, and this communication should be documented in the patient's record.

8.1 Patient with TB:

- a) Household contacts have already been exposed and so do not need to wear an N95 respirator but should wear surgical mask.
- b) Visitors who are non-household contacts should be discouraged from visiting. They should be counselled about their risk and taught how to use an N95 respirator appropriately if they do visit.
- c) Family and household members visiting paediatric patients with pertussis and tuberculosis may need to be screened for a history of exposure as well as signs and symptoms of current infection.
- d) Potentially infectious visitors are excluded until they receive appropriate medical screening, diagnosis, or treatment.

8.2 Patient with varicella and measles:

- a) Household contacts have already been exposed and so do not need to wear N95 respirator but should wear surgical mask. They should be assessed for presence of active infections before visiting.
- b) Visitors who are known to be immune or vaccinated do not need to wear an N95 respirator but should wear surgical mask.
- c) Visitors who are non-household contacts, not immune or vaccinated, and have no history of varicella and measles should not visit.

9 Patient transport

Patient movement and transport from the room should be avoided unless absolutely necessary. If a patient needs to be transported out of the room, inform the receiving department of the need for airborne precautions. Healthcare professional should wear an N95 mask or respirator during transportation of patients. Patients should wear a surgical mask if tolerable and follow Respiratory Hygiene /Cough Etiquette in order to minimise the dispersal of droplet nuclei during transportation.

10 Communication

Infection Prevention and Control staff should inform clinical staff of patients on the Contact Precautions. Patients should be identified as per hospital protocol such as:

- a) Display an airborne precaution sign outside the isolation room to alert and guide healthcare professional on the wearing of appropriate PPE.
- b) Indicate on investigation or procedure request forms (e.g. Radiology, Physiotherapy, operation etc.) that the patient is on airborne infection isolation precautions to alert staff on the infection risk.
- c) Notify the receiving department or healthcare facility before transporting or transferring the patient to allow adequate preparation of infection prevention and control measures.

11 Recommendations

- a) Wear an N95 respirator when entering an airborne infection isolation room. [AII]
- b) Do not enter the room of a patient with measles, varicella or zoster unless immune. [AIII]
- c) Provide a surgical mask to clients/patients on Airborne Precautions during transport or activities outside their room, if tolerated. [BIII]
- d) Wear an N95 respirator during transport of clients/patients on Airborne Precautions. [CIII]

12 **Glossary**

Adequately ventilated single room: A single room with ≥ 12 air changes per hour (ACH) without controlled direction of air flow.

Air changes per hour (ACH): Refer to volume of air moved in one hour. One air change per hour in a room, home, or building means that all the air in that environment will be replaced in one hour

Airborne infection isolation room (AIIR): AIIR is also known as negative pressure isolation room. An AIIR is a single-occupancy patient-care room used to isolate persons with a suspected or confirmed airborne infection. It is a room with ≥ 12 air changes per hour (ACH) and controlled direction of air flow with negative differential pressure of more negative than -2.5 Pascal.

Anteroom: A small room leading from a corridor into patient or isolation room. Anteroom is used to further support the appropriate air-balance relative to the corridor. It is designed to provide an “air-lock” between the adjacent area and the patient or isolation room.

13 **References**

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Chapter 5. Protective Environment

Protective Environment (PE) is designed to accommodate patients with severely compromised immune system to minimize the risk of exposure to fungal spores in the air and reduce the risk of invasive environmental fungal infections.

1 Patient Placement

Place allogeneic hematopoietic stem cell transplant (HSCT) patients in a PE room. No recommendation for placing patients undergoing solid organ transplantation or other immunocompromised patients in a PE.

2 Ventilation/Environmental Control

PE room should meet the following Design Features standards:

- a) HEPA (high efficiency particulate air) filtration of incoming air, capable of removing 99.97% of particles ≥ 0.3 microns in diameter
- b) Directed room airflow with the filtered air supply on one side of the room. The air flows across the patient's bed and exhausts on the opposite side of the room.
- c) Minimum 12 air changes per hour (ACH)
- d) Positive room air pressure in relation to the corridor with pressure differentials of $> +2.5$ Pascal.
- e) Self-closing doors on all room exits
- f) Well-sealed room that prevent infiltration of outside air
- g) Proper construction of windows, doors, intake ports and exhaust ports
- h) Ceilings are smooth, free of fissures, open joints and crevices
- i) Walls sealed above and below the ceiling (to specify how)
- j) Monitor room differential pressure every time before entering the room and at least daily during when in use
- k) Door kept closed at all times when not required for entry and exit
- l) For patients who require both PE and airborne precautions (e.g. pulmonary or laryngeal tuberculosis, acute varicella-zoster), use an anteroom to ensure proper air-balance relative to the corridor and the PE

room. Provide an independent exhaust of contaminated air to the outside. Place a HEPA filter in the exhaust duct if recirculated air.

- m) If anteroom is not available, place patient in an AIIR and use portable industrial-grade HEPA filters to enhance filtration of spores in the air.
- n) No carpeting in patient rooms or hallways.
- o) No upholstered furniture and furnishings. Use smooth and non-porous surfaces and finishes that can be scrubbed or easily cleaned.
- p) No fresh or dried flowers or potted plants.

3 Personal Protective Equipment (PPE)

Implement Standard Precautions for patients who are on Protective Environment precautions. Gown, gloves and mask are NOT required for Healthcare Professionals (HCPs) and visitors for routine entry into the room. Practice good hand hygiene according to WHO 5 moments for hand hygiene. Use appropriate PPE as indicated accordingly to standard precautions or for suspected or proven infections for which transmission-based (contact, droplet, airborne) precautions are required.

4 Equipment /Consumable

Where possible, dedicate the use of non-critical patient-care equipment and items such stethoscope, sphygmomanometer or bedside commode to a single patient. If sharing of common equipment or items is unavoidable, ensure adequate cleaning and disinfection in between patient use. Check wound-dressing supplies (e.g. adhesive bandages, elastic adhesive tape) for mold contamination before using on patients to prevent subsequent cutaneous transmission.

5 Environment cleaning

- a) Avoid dusting methods that disperse dust.
- b) Daily wet-mopping of all horizontal surfaces including exhaust vent and windows sill using cloths moistened with hospital approved detergent or disinfectant.

- c) Prohibit exposures of patients to vacuum cleaning that could cause aerosolisation of fungal spores. Use vacuum cleaner equipped with HEPA filters when vacuum cleaning is necessary. Close doors to patient rooms when vacuuming the corridors.

6 Staff Restriction

HCPs with diseases transmissible by air, droplet and direct contact (e.g. Varicella Zoster Virus, infectious gastroenteritis, Herpes lesions of lips or fingers, and Upper Respiratory Infections) should be restricted from patient contact and temporarily reassigned to other duties. Healthcare facilities should have a policy regarding the immunizations of HCPs to prevent transmission of vaccine-preventable diseases to severely immunocompromised patients.

7 Visitors

All visitors must perform appropriate hand hygiene before and after patient contact. Visitors with communicable diseases (e.g. Upper Respiratory Infections, flu-like illnesses) or recent exposure to communicable diseases should be restricted from visiting severely immunocompromised patients.

8 Patient transport

Patient movement and transport from the room should be restricted unless for diagnostic or therapeutic procedures that cannot be done in the room. If severely immunocompromised patients (e.g. Hematopoietic Stem Cell Transplants patients) are required to leave the Protective Environment, they are advised to wear a high-efficiency respirator (e.g. N95 mask) if tolerated, to prevent inhalation of fungal spores, especially when there is construction, renovation or other dust-generating activities in and around the healthcare facility. There is no recommendation for fit-testing of patients who are using respirators. The use of masks or respirators by severely immunocompromised patients when they are outside of the PE for prevention of environmental fungal infections in the absence of construction or renovation has not

been evaluated. The length of time that patients spend outside their rooms should be minimised.

9 Communication

- a) Display a protective precaution signage outside the isolation room to alert healthcare professional.
- b) Notify receiving department or healthcare facility before transporting or transferring patient to allow minimizing the length of time patients are outside the PE.

10 Recommendations

- a) Place allogeneic hematopoietic stem cell transplant patients in a PE to reduce exposure to environmental fungi (e.g. *Aspergillus* sp), (BI)
- b) No published reports support the benefit of placing patients undergoing solid organ transplantation or other immunocompromised patients in a PE. (C)
- c) Use Standard Precautions as recommended for all patient interactions (AI)
- d) Implement transmission-based, droplet or contact precautions together with standard precautions when indicated (BI).
- e) Ensure that the Protective Environment is designed to maintain positive pressure (BI)
- f) Implement Airborne Precautions for patients who require a PE room and who also have an airborne infectious disease (e.g. pulmonary or laryngeal tuberculosis, acute varicella-zoster). (AI)
- g) For patients who require both PE and airborne precautions, use an anteroom to ensure proper air-balance relative to the corridor and the PE room. Provide an independent exhaust of contaminated air to the outside. Place a HEPA filter in the exhaust duct if recirculated air (BI).
- h) If anteroom is not available, place patient in an AIIR and use portable industrial-grade HEPA filters to enhance filtration of spores in the air (BII).

- i) Avoid carpeting in hallways and patient rooms or areas (BI)
- j) HCPs with diseases transmissible by air, droplet and direct contact (e.g. e.g. Varicella Zoster Virus, infectious gastroenteritis, Herpes lesions of lips or fingers, and Upper Respiratory Infections) should be restricted from patient contact and temporarily reassigned to other duties (AI).
- k) Minimize the length of time that patients who require a Protective Environment spend outside their rooms for diagnostic or therapeutic procedures that cannot be done in the room (BI)

PART II.

STANDARD INFECTION PREVENTION AND CONTROL PRACTICES

Chapter 6. Hand Hygiene

Chapter 7. Sterilization and Disinfection

Chapter 8. Management of Blood and Body Fluids Exposure

Chapter 9. Environmental Cleaning

Chapter 10. Waste Management

Chapter 11. Construction and Renovation

Chapter 6. Hand Hygiene

Hand Hygiene is the most important and effective procedure to prevent and control the spread of hospital associated infections (HAIs). It is the responsibility of all Healthcare Professionals (HCPs) to carry this out at the right moments during patient care. Effective hand hygiene removes transient bacteria (c.f. resident flora) on the skin via either of the following two methods:

- a) When the hands are not visibly soiled, use a 70% to 90% alcohol-based hand rub (ABHR). ABHR takes less time than traditional hand washing and is more effective than washing with soap (even using an antimicrobial soap) and water when hands are not visibly soiled. ABHR should be easily accessible in healthcare settings.
- b) When the hands are visibly soiled, hand washing with soap and water should be done. In this situation, mechanical action (by washing, rinsing and drying) is the most important contributor to the removal of transient bacteria. If hands are visibly soiled and running water is not available, use a moistened towelette to remove the visible soil, followed by ABHR.

1 Concept of hand hygiene for inpatients and outpatient

1.1 Concept of 'My 5 moments for hand hygiene in inpatients' setting

The concept of 'My 5 moments for hand hygiene' aims to:

- a) Foster positive outcome evaluation by linking specific hand hygiene actions to specific infectious outcomes in patients and HCPs (positive outcome beliefs); and
- b) Increase the sense of self-efficacy by giving HCPs clear advice on how to integrate hand hygiene in the complex task of care (positive control beliefs).

Since its development in the context of the Swiss National Hand Hygiene Campaign and its integration in the WHO Multimodal Hand Hygiene Improvement Strategy, the concept of "My 5 moments for hand hygiene" has been widely adopted in more than 400 hospitals worldwide in 2006–2008, of which about 70 have been closely monitored to evaluate impact and lessons learnt.

Requirement specifications for a user-centred hand hygiene application concept
Consistent with evidence-based risk assessment of HCAI and spread of multi-resistant microorganisms
Integrated into a natural care workflow
Easy-to-learn
Logical clarity of the concept
Applicable in a wide range of health-care settings
Minimising the density of the need for hand hygiene
Maximal know-how congruence between trainers, observers, and HCWs

"My five moments for hand hygiene": explanations and link to evidence-based recommendations		
Moment	Endpoints of hand transmission	Prevented negative outcome
1. Before touching a patient	Donor surface: any surface in the <i>health-care area</i> Receptor surface: any surface in the <i>patient zone</i>	Patient colonization with health-care microorganisms; exceptionally, exogenous infection
2. Before clean/aseptic procedure	Donor surface: any other surface Receptor surface: <i>critical site with infectious risk for the patient or critical site with combined infectious risk</i>	Patient endogenous infection; exceptionally exogenous infection
3. After body fluid exposure risk	Donor surface: <i>critical site with body fluid exposure risk or critical site with combined infectious risk</i> Receptor surface: any other surface	HCW infection
4. After touching a patient	Donor surface: any surface in the <i>patient zone</i> <u>with</u> touching a patient Receptor surface: any surface in the <i>health-care area</i>	HCW colonization; environment contamination
5. After touching patient surroundings	Donor surface: any surface in the <i>patient zone</i> without touching the patient Receptor surface: any surface in the <i>health-care area</i>	HCW cross-colonization; environment contamination

1.2 The concept of “hand hygiene moments” in outpatient

The concept of patient zone, healthcare area and critical sites:

- a) The **patient zone** includes the patient and some surfaces/items in his/her surroundings that are temporarily and exclusively dedicated to him/her (i.e. all inanimate surfaces touched by or in direct physical contact with the patient and touched by the HCP while providing care), including the patient’s personal belongings.
- b) The **healthcare area** corresponds to all physical surfaces outside the patient zone, including other patients and their patient zones, and the wider healthcare environment. In most settings, the healthcare area is characterized by the presence of many different microorganisms, including multi-resistant pathogens, even if appropriate cleaning is performed.

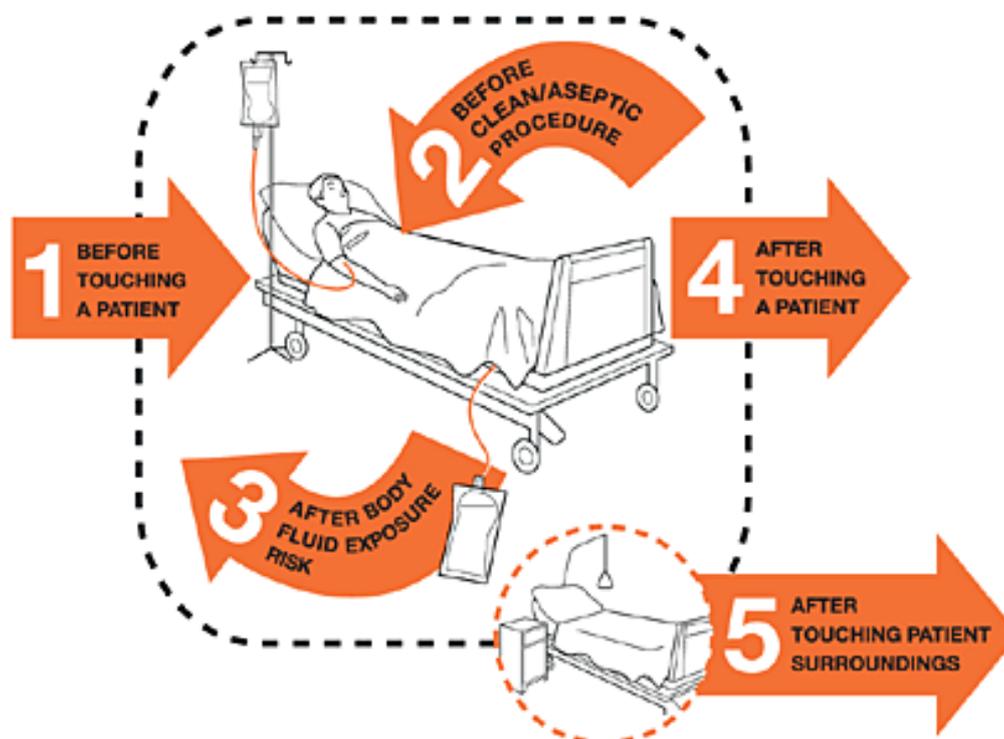
- c) Within the patient zone, specific sites, so-called **critical sites**, are associated with increased risk of infection.

In outpatient settings, HCPs need to understand the concept of patient zone, healthcare area and critical sites. For instance, regarding the **patient zone** concept explained above, in several cases no specific space and items are temporarily (over a conceivable time period) dedicated to a patient exclusively in outpatient settings. In these situations, the patient's access to healthcare is usually limited to a short period of time and the space allocated to care delivery accommodates numerous successive patients. In addition, the time required for actual contamination of the surroundings by the patient's flora remains almost unknown. Under these conditions, the patient zone concept coincides just with the patient him/herself. However, the concept of the **patient zone as a geographical area**, according to the above definition and including the patient surroundings, applies in some outpatient settings where the patient is placed for a **certain time in a dedicated space with dedicated equipment** (e.g. dialysis settings, rooms for chemotherapy administration, labour and delivery rooms). To help focus on hand hygiene when critically needed, the HCP should identify the point of care within the patient zone as the focus for hand hygiene and where it must be performed, especially at 5 specific moments.

2 Indications for hand hygiene

This is simplified as the 'moments' for hand hygiene by WHO, as these are considered the most fundamental times requiring hand hygiene to be observed during care delivery and daily routine.

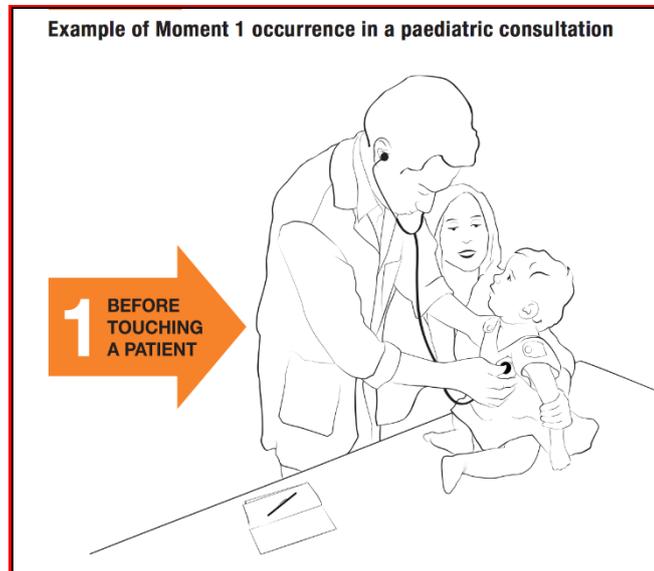
2.1 Acute care and community hospital



Moment 1	Before touching a patient	WHEN? Clean your hands before touching a patient when approaching him/her EXAMPLES: shaking hands, helping a patient to move around, clinical examination
Moment 2	Before clean/aseptic procedure	WHEN? Clean your hands immediately before any aseptic task EXAMPLES: oral/dental care, secretion aspiration, wound dressing, catheter insertion, preparation of food, medications
Moment 3	After body fluid exposure risk	WHEN? Clean your hands immediately after an exposure risk to body fluids (and after glove removal) EXAMPLES: oral/dental care, secretion aspiration, drawing and manipulating blood, clearing up urine, faeces, handling waste.
Moment 4	After touching a patient	WHEN? Clean your hands after touching a patient and her/his immediate surroundings, when leaving the patient's side EXAMPLES: shaking hands, helping a patient to move around, and clinical examination.
Moment 5	After touching patient surroundings	WHEN? Clean your hands after touching any object or furniture in the patient's immediate surroundings, when leaving - even if the patient has not been touched EXAMPLES: changing bed linen, perfusion speed adjustment

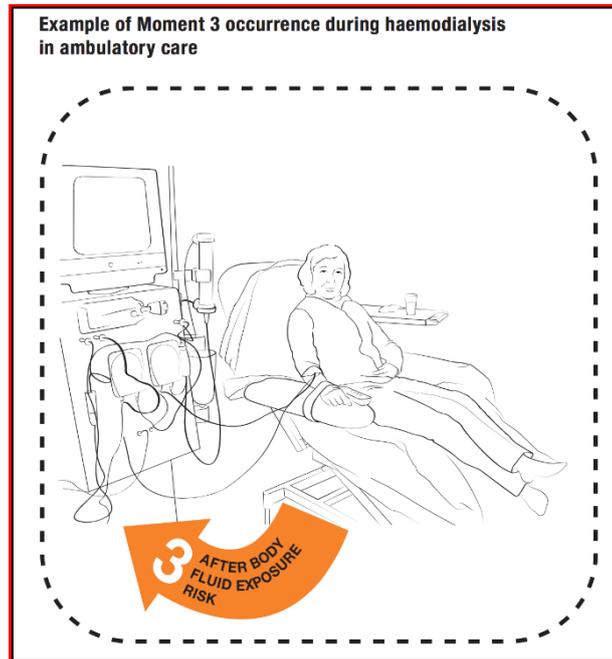
2.2 Outpatient setting

In outpatient settings, it is important for HCPs to understand that the healthcare environment is contaminated by germs brought by patients, HCPs and others. Below are examples of different scenarios:

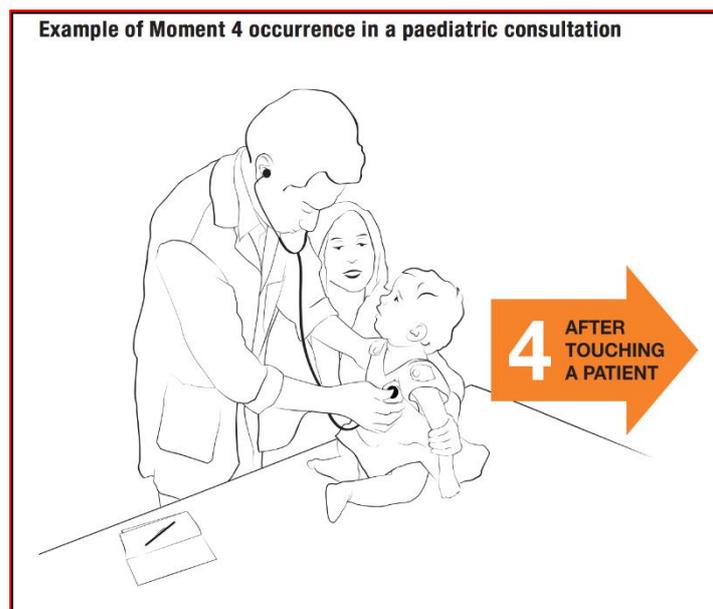


Note: If gloves are indicated for performing a clean/aseptic procedure, they should be donned following hand hygiene performance immediately before the procedure. Subsequently, hand hygiene should be performed again according to opportunities occurring during the sequence of care activities; gloves should be changed if the need for gloves continues. This indication (Moment 2) is not defined by

a sequence of healthcare actions, but by direct or indirect contact with mucous membrane, damaged skin, or an invasive medical device.



Note: If the HCPs is wearing gloves at the time of exposure to a body fluid, they must be removed immediately after and hand hygiene must be performed. If the procedure is repeated on different patients in a sequence and glove use is indicated, gloves should be changed between patients and hand hygiene performed. In some cases, gloves should be changed between sites while tending to the same patient (e.g. two different wounds at two different body sites or between oral and wound care).



3 Sequence of care

It is recommended that the HCP organises his work for better compliance to hand hygiene.

The following scenario is an example to help highlight the importance of work organisation and its influence in hand hygiene compliance.

Example 1

- a) The HCP enters the patient's room and verbally greets him. **The HCP performs hand hygiene** (Moment 1)
- b) He explains to the patient that he wants to change his diaper.
- c) The HCP takes the necessary material from the cabinet and dons disposable gloves.
- d) He rolls down the bed linen to uncover the patient and removes and folds the used diaper and puts it in the waste bin.
- e) The HCP cleans the patient using cellulose and a cleaning foam before putting on a clean diaper.
- f) He puts the used cellulose in the waste bin and then removes and discards his gloves in the waste bin. **The HCP performs hand hygiene** (Moment 3)
- g) The HCP installs the patient in a comfortable position in his bed and pulls up the bed covers. **The HCP performs hand hygiene** (Moment 4)
- h) The HCP leaves the room.

Example 2

- a) The patient arrives, places his belongings on the bedside table, and goes to wash his arm and to be weighed. The patient returns and lies down on the bed or sits in the armchair while the HCP arrives with the machine ready for use. She wears a gown, mask and goggles. **The HCP performs hand hygiene** (Moment 1)
- b) The HCP measures the vital signs and temperature, asks for the weight result, checks the thrill of the fistula, helps to hook the patient to the machine, and places a protection under the patient's arm.

- c) The HCP records the data in the patient chart and puts it on top of the dialysis machine.
- d) The nurse sets the machine. **The HCP performs hand hygiene** (Moment 2).
- e) The HCP opens the administration set for puncture on the top of the bedside table, pours antiseptic, prepares the needle and some tubes for blood sampling, if necessary, then fills syringes and adds compresses. **The HCP performs hand hygiene** (Moment 2).
- f) The HCP dons sterile gloves and applies antiseptic on the puncture site (arterial-venous fistula site) using instruments.
- g) The HCP inserts the first needle, rinses and fixes it to the port, connects the dialysis circuit, and repeats the procedure with the second needle.
- h) The HCP adjusts the output of the machine.
- i) The HCP clears the puncture set and removes and discards gloves in the waste bin. **The HCP performs hand hygiene** (Moment 3).
- j) The HCP checks again the vital signs and records them, and gives a book to the patient from his bag on the bedside table. **The HCP performs hand hygiene** (Moment 4).

4 Methods of hand hygiene

4.1 Routine patient care

Hand rubs using alcohol based hand rub and hand washing using medicated soap removes transient bacteria which can cause infection. Standard hygienic hand antisepsis can be done using:

- Alcohol-based hand rubs (ABHRs): ABHRs are the first choice for hand hygiene when hands are not visibly soiled. Using ABHRs is less time-consuming hand washing with soap and water. It takes 20-30 seconds for the entire procedure (Refer to [Appendix 6.1](#)).
- Hand washing using medicated soap: This method takes about 40-60 seconds. It is an essential technique to ensure every part of the hands gets washed. Wet the hands with warm water under a running tap and apply soap (preferably liquid soap from a pump dispenser). (Refer to [Appendix 6.2](#)).

4.2 Surgical hand preparation

In contrast to the standard hand rub/ hand wash, surgical hand preparation must eliminate transient and resident flora on the hands. The WHO approach for surgical hand preparation requires the six basic steps for the hands as for hygienic hand antisepsis, but requires additional steps for rubbing the forearm (Refer to [Appendix 6.3](#)). The time required for the surgical hand antisepsis depends on the product used, although most products recommend a 3 minute exposure.

Surgical hand-scrub with medicated soap, and surgical hand rub using alcohol based hand rubs, are both suitable for prevention of surgical site infection. Although medical soaps are still used by many surgical teams worldwide for pre-surgical preparation, it is important to note that products with high concentration of alcohol has higher antibacterial efficacy than any medicated soap available now. It is not necessary to wash hands before hand rub unless hands are visibly soiled or dirty. .

Other key points:

- a) Keep nails short (≤ 2 mm from the nails bed) and pay attention to them when washing your hands - most microbes on hands come from beneath the fingernails.
- b) Do not wear artificial nails or nail polish.
- c) Remove all jewellery (rings, watches, bracelets) before entering the operating theatre.
- d) Wash hands and arms with soap before entering the operating theatre area or if hands are visibly soiled.

5 Hand Care

- a) Intact skin is a natural defense against infection
- b) HCPs should cover all cuts and abrasions with a water-resistant dressing
- c) The use of hand cream (moisturizer) is recommended as hands may become dry with constant hand washing
- d) Do not use personal hand creams at work as it may counteract the antiseptic properties in the antiseptic preparation

- e) Hand cream containing oil should be avoided as they may cause latex gloves to split.
- f) Provide alternative hand hygiene products for HCPs with confirmed allergies or adverse reactions to standard hand hygiene products used in the healthcare setting.

6 Evaluation of hand hygiene products

Every new formulation for hand hygiene products, with the exception of non-medicated soaps, should be tested for its antimicrobial efficacy to demonstrate that:

- a) It has superior efficacy over normal soap
- b) It meets an agreed performance standard

The formulation with all its ingredients should be evaluated to ensure that humectants or rehydrating chemicals added to ensure better skin tolerance do not in any way compromise its antimicrobial action.

6.1 Methods to test activity of hygienic hand wash and hand rub agents

6.2.1 CEN (European Committee for Standardization) standards: EN 1499 and EN 1500

In Europe, the most common methods for testing hygienic hand antiseptic agents are EN 1499 and EN1500. EN 1499 requires 12-15 subjects, and EN 1500 18-22 subjects and a culture of *E.coli*. Subjects are assigned randomly to 2 groups when one applies the test formulation and the other a standardized reference solution. In a consecutive run, the 2 groups reverse roles (cross-over design). If an antiseptic soap has been tested according to EN 1499, the mean log₁₀ reduction by the formulation must be significantly higher than that obtained with the control (soap soap). For hand rubs (EN 1500), the mean acceptable reduction with a test formulation shall not be significantly inferior to that with the reference alcohol-based hand rub (isopropyl alcohol or isopropanol 60% volume).

6.2.2 ASTM (Food and Drug Administration (FDA) and Health Canada; refer to standards ASTM International)

a) **ASTM E-1174**

Currently, hand wash or hand rub agents are evaluated using this method in North America. The efficacy criteria of the FDA's Tentative Final Monograph (TFM) are a 2- \log_{10} reduction of the indicator organism on each hand within 5 minutes after the first use, and a 3- \log_{10} reduction of the indicator organism on each hand within 5 minutes after the tenth use. [Note: The performance criteria in EN 1500 and in the TFM for alcohol-based hand rubs are not the same, whereby a formulation may pass the TFM criterion, but may not meet that of the EN 1500 or vice versa.] It should be emphasized here that the level of reduction in microbial counts needed to produce a meaningful drop in the hand-borne spread of nosocomial pathogens remains unknown.

b) **ASTM E-1838 (fingerpad method for viruses)**

The fingerpad method can be applied to hand wash or hand rub agents. When testing hand wash agents, it can also measure reductions in the levels of viable virus after exposure to the test formulation alone, after post-treatment water rinsing and post-rinse drying of hands. This method also presents a lower risk to subjects because it entails contamination of smaller and well-defined areas on the skin in contrast to using whole hands (as above). The method can be applied to traditional as well as more recently discovered viruses such as caliciviruses.

c) **ASTM E-2276 (fingerpad method for bacteria)**

This method is for testing hand wash or hand rub against bacteria. It is similar in design and application to the method E-1838 described above for working with viruses.

d) **ASTM E-2613 (fingerpad method for fungi)**

This method is for testing hand wash or hand rub against fungi. It is similar in design and application to the methods described above for working with viruses (E-1838) and bacteria (E-2276).

e) **ASTM E2011 (whole hand method for viruses)**

In this method, the entire surface of both hands is contaminated with the test virus, and the test hand wash or hand rub formulation is rubbed on

them. The surface of both hands is eluted and the eluted assayed for viable virus.

6.2 Methods to test activity of Surgical hand preparation

Surgical hand preparation is directed against the resident hand flora. No contamination of hands is used in any existing methods.

6.2.2 CEN standard: EN 12791 (surgical hand preparation)

EN 12791 is comparable with that described in EN 1500, except that the bactericidal effect of a product is tested:

- a) On clean, not experimentally contaminated hands;
- b) With 18-22 subjects;
- c) Using the split-hands model by Michaud, McGrath & Gross to assess the immediate effect on one hand and a 3-hour effect (to detect a possible sustained effect) on the other;
- d) In addition, a cross-over design is used but, contrary to hygienic hand antisepsis, the 2 experimental runs are separated by one week to enable regrowth of the resident flora;
- e) The reference antisepsis procedure uses as many 3-ml portions of n-propanol 60% (v/v) as are necessary to keep hands wet for 3 minutes; thus, the total quantity used may vary according to the size and temperature of the hands and other factors;
- f) The product is used according to manufacturer's instructions with a maximum allowed contact time of 5 minutes;
- g) The requirements are that the immediate and 3-hours effects of a product must not be significantly inferior to those of the reference hand antisepsis; and
- h) If there is a claim for sustained activity, the product must demonstrate a significantly lower bacterial count than the reference at 3 hours.

6.2.3 ASTM standard: ASTM E-1115 (surgical hand scrub)

This test method is designed to measure the reduction in bacterial flora on the skin. It is intended for determining immediate and persistent microbial reductions, after

single or repetitive treatments, or both. It may also be used to measure cumulative antimicrobial activity after repetitive treatments.

In North America, this method is required to assess the activity of surgical scrubs. The TFM requires that formulations:

- a) Reduce the number of bacteria 1- \log_{10} on each hand within a minute of product use and that the bacterial colony count on each hand does not subsequently exceed baseline within 6 hours on each day;
- b) Produce a 2- \log_{10} reduction in bacterial in bacterial counts on each hand within 1 minute of product use by the end of the second day of enumeration; and
- c) Accomplish a 3- \log_{10} reduction of bacterial counts on each hand within 1 minute of product use by the end of the 5th day when compared to the established baseline.

Basic experimental design of current methods to test the efficacy of hand hygiene and surgical hand preparation formulations

Method	Test organism(s)	Basic procedure
EN 1499 (hygienic handwash)	<i>E. coli</i> (K12)	Hands washed with a soft soap, dried, immersed in broth culture for 5 seconds, excess fluid drained off, and air-dried for 3 minutes. Bacteria recovered for the initial values by kneading the fingertips of each hand separately for 60 seconds in 10 ml of broth without neutralizers. Hands removed from the broth and treated with the product following the manufacturer's instructions (but for no longer than 1 minute) or the reference solution (a 20% solution of soft soap). Recovery of bacteria for final values (see EN 1500).
EN 1500 (hygienic handrub)	<i>E. coli</i> (K12)	Basic procedure for hand contamination and initial recovery of test bacteria same as in EN 1499. Hands rubbed for 30 seconds with 3 ml of isopropanol 60% v/v; same operation repeated with a total application time not exceeding 60 seconds. The fingertips of both hands rinsed in water for 5 seconds and excess water drained off. Fingertips of each hand kneaded separately in 10 ml of broth with added neutralizers. These broths are used to obtain the final (post-treatment) values. Log ₁₀ dilutions of recovery medium containing neutralizer are prepared and plated out. Within 3 hours, the same subjects tested with the reference formulation or the test product. Colony counts obtained and log reductions calculated.
ASTM E-1174 (efficacy of HCW or consumer handwash formulation)	<i>S. marcescens</i> and <i>E. coli</i>	To test the efficacy of handwash or handrub agents on the reduction of transient microbial flora. Before baseline bacterial sampling and prior to each wash with the test material, 5 ml of a suspension of test organism are applied to and rubbed over hands. Test material put onto hands and spread over hands and lower third of forearms with lathering. Hands and forearms rinsed with water. Elutions are performed after required number of washes using 75 ml of eluent for each hand in glove. The eluates are tested for viable bacteria.
ASTM E-1838 (fingerpad method for viruses)	Adenovirus, rotavirus, rhinovirus and hepatitis A virus	10 µl of the test virus suspension in soil load placed at the centre of each thumb- and fingerpad, the inoculum dried and exposed for 10–30 seconds to 1 ml of test formulation or control. The fingerpads then eluted and eluates assayed for viable virus. Controls included to assess input titre, loss on drying of inoculum, and mechanical removal of virus. The method applicable to testing both handwash and handrub agents.
ASTM E-2276 (fingerpad method for bacteria)	<i>E. coli</i> , <i>S. marcescens</i> , <i>S. aureus</i> , and <i>S. epidermidis</i>	Similar to ASTM E-1838.
ASTM E-2613 (fingerpad method for fungi)	<i>Candida albicans</i> and <i>Aspergillus niger</i>	Similar to ASTM E-1838.
ASTM E-2011 (whole hand method for viruses)	Rotavirus and rhinovirus	This method is designed to confirm the findings of the fingerpad method (E-1838), if necessary. Both hands are contaminated with the test virus, and test formulation is used to wash or rub on them. The entire surface of both hands eluted and the eluates assayed for infectious virus.
EN 12791 (surgical hand preparation)	Resident skin flora (no artificial contamination)	Same as for EN 1500 with the following exceptions: no artificial contamination; reference hand antiseptics 3-minute rub with n-propanol 60% v/v; longest allowed treatment with product 5 minutes; 1 week between tests with reference and product. Test for persistence (3 hours) with split hands model is optional (product shall be significantly superior to reference).
ASTM E-1115 (test method for evaluation of surgical handscrub formulations)	Resident skin flora (no artificial contamination)	The method is designed to assess immediate or persistent activity against the resident flora. Subjects perform simulated surgical scrub and hands sampled by kneading them in loose-fitting gloves with an eluent. The eluates are assayed for viable bacteria.

Source from: WHO Guidelines on Hand Hygiene in Health Care,

7 Factors to consider when selecting hand hygiene products

The selection of hand hygiene products is a key component of hand hygiene program promotion. The selection strategy requires multidisciplinary team (including infection prevention and control professionals, representation from different categories of healthcare professionals, occupational disease professionals, administrative staff, pharmacists, and behavioural scientists) to evaluate factors

related to hand hygiene products and to conduct clinical pilot projects to test these factors.

7.1 Pilot testing

Pilot testing to assess acceptability is strongly recommended before final selection. It aims to foster systemic change by involving users in selecting the product they like most and therefore are most likely to use. A standardized and validated survey to evaluate acceptability and tolerability among HCPs is available within the Implementation Toolkit (<http://www.who.int/gpsc/en/>). The tool should be adapted to the local settings.

7.2 Factors to consider:

- a) relative efficacy of antiseptic agents, whether for hygienic hand antisepsis or surgical hand preparation,
- b) dermal tolerance and skin reactions,
- c) cost
- d) aesthetic preferences of HCPs and patients such as fragrance, colour, texture, “stickiness”, and ease of use;
- e) practical considerations such as availability, convenience and functioning of dispenser, and ability to prevent contamination;
- f) time for drying (different products have different drying times; products that require longer drying times may impact compliance to hand hygiene);
- g) freedom of choice by HCPs at an institutional level after consideration of the above-mentioned factors.

7.3 Dermal tolerance and skin reactions

Dermal tolerance affects product acceptability by HCPs, and directly influences compliance with hand hygiene. It was demonstrated that dermal tolerance of alcohol-based hand rubs is related to the addition and the quality of emollient in the product. Alcohols in alcohol-based hand rubs, generate a minor skin irritant effect, while soap and water are less irritating.

7.4 Aesthetic preferences

- a) Fragrance: products with mild or no added fragrances are preferable. Products with strong fragrance may lead to discomfort or respiratory symptoms in some HCPs allergic to perfume or fragrance. Many patients may complain about perfumed or fragrance products.
- b) Consistency: hand rubs are available in gels, solutions or foams. Considerations should be given for the HCPs preferences.

7.5 Practical considerations

- a) Product accessibility: frequency of hand cleaning is affected by the accessibility of hand hygiene facilities. A reliable supplier is essential to ensure continuous supply of products. Considerations should be given to infrastructure to ensure access to the hand hygiene products.
- b) Risk of contamination: alcohol-based hand rubs have low risk of contamination. Avoid use of multi-use bar soap. Liquid soaps is generally preferred although there is still risk for either intrinsic or extrinsic microbial contamination.

7.6 Cost

The introduction of alcohol based hand rubs for hand hygiene is highly cost-effective. The acceptance of products by HCPs is important in achieving a better hand hygiene compliance. A cheaper product with undesirable characteristics may discourage hand hygiene and result in more costly outcomes, such as the increase in healthcare associated infections.

8 Hand hygiene program

All healthcare facilities should allocate resources to plan and implement an ongoing program promoting excellent hand hygiene practices by staff, patients and visitors. A self-assessment on current hand hygiene activities is recommended using the WHO Hand Hygiene Self-Assessment Framework. The WHO multimodal strategy is recommended. The strategy includes the following:

8.1 System change

System change is a vital component of the World Health organization (WHO) Multimodal Hand Hygiene Improvement Strategy for all healthcare facilities. It refers to ensuring that the healthcare facility has the necessary infrastructure in place to allow HCPs to practice hand hygiene. Compliance with hand hygiene is only possible if the healthcare setting ensures an adequate infrastructure and if a reliable and permanent supply of hand hygiene products at the right time and location is provided.

Tools for system change:

- a) Ward infrastructure survey
- b) Alcohol-based hand rub planning and costing tool
- c) Guide to local production: WHO-recommended hand rub formulations
- d) Soap/hand rub consumption survey
- e) Protocol for evaluation of tolerability and acceptability of alcohol-based hand rub in use or planned to be introduced
- f) Protocol for evaluation and comparison of tolerability and acceptability of different alcohol-based hand rubs

Note: Tools can be obtained from World Health Organization website at www.who.int/gpsc/en

8.2 Training / Education

Education is an important and critical factor and represents one of the cornerstones for improvement of hand hygiene practices. All healthcare professionals require training and education on the importance of hand hygiene, the indication on the 5 Moments of hand hygiene and the correct steps of hand hygiene. Clear and standardized message need to be conveyed to all healthcare professionals to ensure consistency in hand hygiene. In addition, this is also to encourage behavioural and cultural change.

Tools for education and training:

- a) Slides for the hand hygiene coordinator
- b) Slides for education sessions for trainers, observers and healthcare professionals
- c) Hand hygiene training films

- d) Slides accompanying the training films
- e) Hand hygiene technical reference manual
- f) Observation form
- g) Hand hygiene – why, how and when brochure
- h) Glove use information leaflet
- i) ‘Your 5 moments for hand hygiene’ poster
- j) Frequently asked questions
- k) Key scientific publications
- l) Sustaining improvement – additional activities for consideration by healthcare facilities

Note: Tools can be obtained from World Health Organization website at www.who.int/gpsc/en

8.3 Evaluation and feedback

Evaluation and repeated monitoring of a range of indicators indicating hand hygiene practices and infrastructure including knowledge and perception of the problem of healthcare-associated infection and the importance of hand hygiene is an important aspect in improving hand hygiene. Continuous monitoring of any implementation that had been introduced is essential to assess the effectiveness of the strategy in improving hand hygiene in the institution.

Tools for evaluation and feedback:

- a) Hand hygiene technical reference manual
- b) Observation tools: observation form and compliance calculation form
- c) Ward infrastructure survey
- d) Soap/hand rub consumption survey
- e) Perception survey for healthcare professionals
- f) Perception survey for senior managers
- g) Hand hygiene knowledge questionnaire for healthcare professionals
- h) Protocol for evaluation of tolerability and acceptability of alcohol-based hand rub in use or planned to be introduced
- i) Protocol for evaluation and comparison of tolerability and acceptability of different alcohol-based hand rubs
- j) Data entry analysis tool

- k) Instructions for data entry and analysis
- l) Data summary report framework

Note: Tools can be obtained from World Health Organization website at www.who.int/gpsc/en

8.4 Reminders in the workplace

Reminders are important to remind and prompt all healthcare professionals on the importance of hand hygiene and the WHO 5 Moments to hand hygiene. Patients and visitors are also informed of the standard of care that they should expect from their healthcare professionals with regards to hand hygiene through these reminders. Reminders can be visual such as posters or audio such as via public announcements. Other initiatives can be in the form of patient' educational leaflets, badges etc.

Tools for reminders in the workplace

- a) 'Your 5 Moments for hand hygiene' poster
- b) How to hand rub poster
- c) How to hand wash poster
- d) Hand hygiene: when and how leaflet
- e) Save lives: clean your hands screensaver

Note: Tools can be obtained from World Health Organization website at www.who.int/gpsc/en

8.5 Institutional safety climate

This refers to creating an environment and perceptions that facilitate awareness about patient safety issues while guaranteeing consideration of hand hygiene improvement as a high priority at all levels:

- a) Active participation at both the institutional and individual levels
- b) Awareness of individual and institutional capacity to change and improve
- c) Partnering with patients and patient organizations

Tools for institutional safety climate:

- a) Template to advocate hand hygiene for managers
- b) Template letter to communicate hand hygiene initiatives for managers
- c) Guidance on engaging patients and relatives

d) Sustaining improvement – additional activities for consideration by healthcare facilities

e) Save lives: clean your hands promotional video

Note: Tools can be obtained from World Health Organization website at www.who.int/gpsc/en

8.6 Infrastructure considerations in facility design

The healthcare setting needs to ensure adequate infrastructure and a reliable supply of hand hygiene products at the right time and at the right location to achieve compliance with hand hygiene. Thus, facility design considerations are important in the initial implementation phase. A baseline survey needs to be carried out to identify any deficiencies in hand hygiene facilities and products. There is a need to look at the availability of a clean water supply, sink: bed ratio, soap, towel and alcohol-based hand rubs. In a study carried out by Kaplan and McGuckin, they showed a statistical difference in hand washing rates in the medical ICU (76%) with a sink to bed ratio of 1:1, compared to the surgical ICU (51%) where the ratio was 4:1.

9 Evaluation of hand hygiene program

It is of utmost importance to evaluate the effectiveness of the institution's hand hygiene program in order to drive improvement and compliance. WHO 'Hand Hygiene Self-Assessment Framework' tool provides a set of indicators that can be scored to give a situation analysis of hand hygiene promotion and practices within a healthcare facility. Repeated use of the Framework will allow documentation of progress with time.

Note: Tools can be obtained from World Health Organization website at:

a) www.who.int/gpsc/en and

b) http://www.who.int/gpsc/country_work/hhsa_framework_October_2010.pdf?ua=1

10 Recommendations

a) A multidisciplinary, multifaceted hand hygiene program must be developed and implemented in all healthcare settings [BI].

- b) Hand hygiene agents are to be made available at point-of-care in all healthcare settings. [AI].
- c) Each healthcare setting must have written hand hygiene policies and procedures. [BIII]
- d) Provide staff with hand moisturizing skin-care products (and encourage frequent use) to minimize the occurrence of irritant contact dermatitis associated with hand hygiene. [AI]
- e) Wash hands with soap and water if there is visible soiling with dirt, blood, body fluids or other body substances. [AI] If hands are visibly soiled and running water is not available, use moistened towelettes to remove the visible soil, followed by alcohol- based hand rub.
- f) Hand hygiene products must not interfere with glove integrity or with the action of other hand hygiene or hand care products. [AII]
- g) Before aseptic procedure, perform surgical hand preparation using either an antimicrobial soap or an alcohol- based surgical hand rub that ensures sustained antimicrobial activity, before donning sterile gloves. [BI]
- h) The use of gloves does not replace the need for hand hygiene. [BI]
- i) Hand hygiene should be performed after removal of gloves. [AII]
- j) Educate healthcare professionals about [AII]:
 - i. indications for hand hygiene
 - ii. factors that influence hand hygiene
 - iii. hand hygiene agents
 - iv. hand hygiene techniques
 - v. hand care to promote skin integrity
- k) Routinely monitor hand hygiene compliance with the provision of timely feedback by using a reliable, validated observer audit tool and training process. [AII]
- l) Monitoring should assess compliance with each of the WHO moments to direct education and provide reliability. [BIII]
- m) Results of hand hygiene compliance should be regularly reviewed by the Infection Prevention and Control Committee [BIII]

11 **References**

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- World Health Organization (WHO), Hand Hygiene in Outpatient and Home-Based Care and Long Term Care Facilities 2011

Appendix 6.1. Hand Hygiene Technique with Alcohol-Based Formulation

Hand Hygiene Technique with Alcohol-Based Formulation

⌚ Duration of the entire procedure: 20-30 seconds

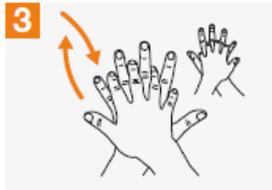
1a  **1b** 

Apply a palmful of the product in a cupped hand, covering all surfaces;

Rub hands palm to palm;

2 

Rub hands palm to palm;

3 

Right palm over left dorsum with interlaced fingers and vice versa;

4 

Palm to palm with fingers interlaced;

5 

Backs of fingers to opposing palms with fingers interlocked;

6 

Rotational rubbing of left thumb clasped in right palm and vice versa;

7 

Rotational rubbing, backwards and forwards with clasped fingers of right hand in left palm and vice versa;

8 

Once dry, your hands are safe.

Appendix 6.2. Hand Hygiene Technique with Soap and Water

Hand Hygiene Technique with Soap and Water

⌚ Duration of the entire procedure: 40-60 seconds

0  Wet hands with water;	1  Apply enough soap to cover all hand surfaces;	2  Rub hands palm to palm;
3  Right palm over left dorsum with interlaced fingers and vice versa;	4  Palm to palm with fingers interlaced;	5  Backs of fingers to opposing palms with fingers interlocked;
6  Rotational rubbing of left thumb clasped in right palm and vice versa;	7  Rotational rubbing, backwards and forwards with clasped fingers of right hand in left palm and vice versa;	8  Rinse hands with water;
9  Dry hands thoroughly with a single use towel;	10  Use towel to turn off faucet;	11  Your hands are now safe.

Appendix 6.3. Surgical hand preparation - Hand rubbing Technique

The handrubbing technique for surgical hand preparation must be performed on perfectly clean, dry hands. On arrival in the operating theatre and after having donned theatre clothing (cap/hat/bonnet and mask), hands must be washed with soap and water. After the operation when removing gloves, hands must be rubbed with an alcohol-based formulation or washed with soap and water if any residual talc or biological fluids are present (e.g. the glove is punctured).

Surgical procedures may be carried out one after the other without the need for handwashing, provided that the handrubbing technique for surgical hand preparation is followed (Images 1 to 17).



1 Put approximately 5ml (3 doses) of alcohol-based handrub in the palm of your left hand, using the elbow of your other arm to operate the dispenser



2 Dip the fingertips of your right hand in the handrub to decontaminate under the nails (5 seconds)



3 Images 3–7: Smear the handrub on the right forearm up to the elbow. Ensure that the whole skin area is covered by using circular movements around the forearm until the handrub has fully evaporated (10-15 seconds)



4 See legend for Image 3



5 See legend for Image 3



6 See legend for Image 3



7 See legend for Image 3



8 Put approximately 5ml (3 doses) of alcohol-based handrub in the palm of your right hand, using the elbow of your other arm to operate the dispenser



9 Dip the fingertips of your left hand in the handrub to decontaminate under the nails (5 seconds)



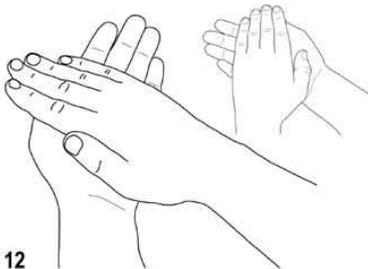
10

Smear the handrub on the left forearm up to the elbow. Ensure that the whole skin area is covered by using circular movements around the forearm until the handrub has fully evaporated (10-15 seconds)



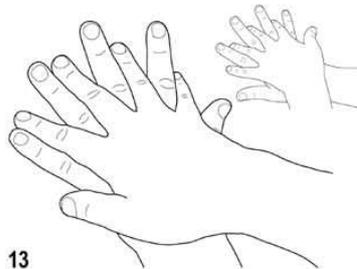
11

Put approximately 5ml (3 doses) of alcohol-based handrub in the palm of your left hand, using the elbow of your other arm to operate the distributor. Rub both hands at the same time up to the wrists, and ensure that all the steps represented in Images 12-17 are followed (20-30 seconds)



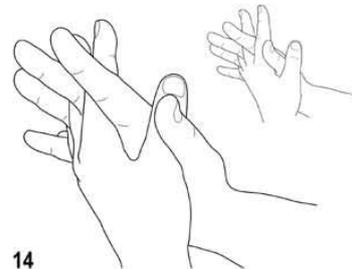
12

Cover the whole surface of the hands up to the wrist with alcohol-based handrub, rubbing palm against palm with a rotating movement



13

Rub the back of the left hand, including the wrist, moving the right palm back and forth, and vice-versa



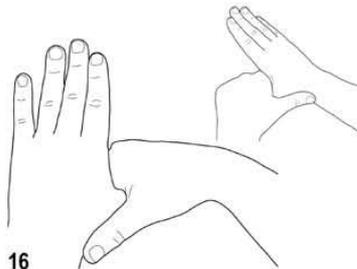
14

Rub palm against palm back and forth with fingers interlinked



15

Rub the back of the fingers by holding them in the palm of the other hand with a sideways back and forth movement



16

Rub the thumb of the left hand by rotating it in the clasped palm of the right hand and vice versa



17

When the hands are dry, sterile surgical clothing and gloves can be donned

Repeat the above-illustrated sequence (average duration, 60 sec) according to the number of times corresponding to the total duration recommended by the manufacturer for surgical hand preparation with an alcohol-based handrub.

Chapter 7. Sterilization and Disinfection

1 General Principles

The goals of safe reprocessing of medical equipment/devices include:

- a) Preventing transmission of microorganisms to staff and clients/patients; and
- b) Minimizing damage to medical equipment/devices from foreign material (e.g. blood, body fluids, saline and medications) or inappropriate handling.

Best practices in reprocessing medical equipment/devices must include the following:

- a) Adequate review by a multi-disciplinary team whenever new sterilisation and disinfection equipment/devices are being considered for purchase;
- b) A centralized area for reprocessing or an area that complies with the requirements for reprocessing;
- c) Written policies and procedures for reprocessing each type of medical equipment/device;
- d) Training of all staff who performs reprocessing;
- e) Validation of cleanliness, sterility and function of the reprocessed equipment/device;
- f) Continual monitoring of reprocessing procedures to ensure their quality;
- g) A corporate strategy for dealing with single-use medical equipment/devices;
- h) Management and reporting of medical incidents;
- i) Management and reporting of safety-related accidents;
- j) Recall of improperly reprocessed devices; and
- k) Written procedures for emergency situations (e.g. utilities shutdowns, compromised packaging, and biological indicator (BI) testing failures).

Decisions related to reprocessing medical equipment/devices should be made by a multi-disciplinary team that includes the individuals involved in: purchasing the equipment/device; reprocessing the equipment/device; maintaining the

equipment/device; infection prevention and control; occupational health and safety; and using the reprocessed equipment/device.

It is strongly recommended that, wherever possible, reprocessing should be performed in a centralized area that complies with the physical and human resource requirements for reprocessing.

When formulating written policies and procedures, the following steps in reprocessing must be included:

- a) Collection at point of use, containment and transport;
- b) Disassembly (if required);
- c) Inspection;
- d) Cleaning;
- e) Disinfection/sterilization (including establishment of the level of reprocessing required for items, based on Spaulding's classification and manufacturer's instructions);
- f) Rinsing (following disinfection);
- g) Drying/aeration;
- h) Reassembly and functional testing;
- i) Clean transportation; and
- j) Storage.

It is essential that an overall inventory of all reprocessing practices within the healthcare setting is done. There should be documentation as to where, how and by whom all equipment/devices are being reprocessed and whether current standards are being met, as set out in this document. All processes must continue to be audited on a regular basis (e.g. annually), with clear and known consequences resulting from non-compliance.

As new reprocessing technologies and processes become available, they must be evaluated against the same criteria as current methodologies. Verify that:

- a) The process is compatible with the equipment/device being reprocessed;
- b) The process is compatible with the cleaning products being used;
- c) Environmental issues with the process have been considered (e.g.

- odours, toxic waste products, toxic vapours);
- d) Occupational health issues with the process have been considered (e.g. is PPE or special ventilation required);
 - e) Staff education and training is available (provided by the manufacturer);
 - f) The facility is able to provide the required preventive maintenance;
 - g) The process can be monitored (e.g. there are physical, chemical and biologic monitors and indicators available);
 - h) Quarantine of non-implantable items in processed loads pending results of biological indicator testing (if load quarantine is not possible, evaluation of a class 5 or 6 chemical indicator (ci) and specific cycle physical parameters may be used to justify the release of loads);
 - i) Quarantine of each load containing implantable devices pending results of biological indicator testing.

2 Factors Affecting the Efficacy of the Reprocessing Procedure

Policies and procedures for disinfection and sterilization must include statements and information relating to factors that might affect the effectiveness of reprocessing. These procedures must be readily accessible to staff doing the reprocessing.

Many factors affect the efficacy of reprocessing, particularly when chemical reprocessing is used. These factors include:

2.1 Cleanliness of the surface of the equipment/device:

- a) Many chemical disinfectants/sterilants are inactivated by organic material; cleaning must always precede decontamination;
- b) The greater the bioburden, the more difficult it is to disinfect or sterilize the equipment/device.

2.2 Characteristics of equipment/device:

- a) Long, narrow lumens and channels are difficult to clean;
- b) Materials such as rubber and plastic may require special treatment;

- c) Rough or porous surfaces may trap microorganisms (e.g. ridges, ribbing, grooves, and articulations);
- d) Hinges, cracks, coils, valves, joints, clamps and crevices on the equipment/device may impede successful disinfection/sterilization.

2.3 Type and concentration of the product:

- a) Products used for disinfection and/or sterilization must be mixed according to the manufacturer's recommendations in order to achieve the correct dilution; if the concentration of the disinfectant is too low, the efficacy will be decreased; if the concentration is too high, the risk of damage to the instrument or toxic effects on the user increases;
- b) Dry equipment/devices after cleaning, before immersing in disinfectant, to prevent dilution of the disinfectant;
- c) Discard expired solutions; diluted products are inherently unstable once mixed and should be discarded after a certain duration as recommended by the manufacturer;
- d) Use chemical test strips for all high-level liquid disinfectants to assess their efficacy; during reuse, the concentration of active ingredients may decrease as dilution of the product occurs and organic impurities accumulate;
- e) Use the appropriate disinfectant/sporicide for the task; the infection prevention and control team must approve disinfectants and their application; and
- f) Some microorganisms are more resistant to disinfectants/sporicides, and this must be taken into consideration when choosing the product/process.

2.4 Duration and temperature of exposure to the product:

- a) Use Spaulding's Classification (see [Table 7.1](#)) for the level of disinfection/sterilization required for the intended use of the equipment/device and minimum exposure time to disinfectants/sterilants to achieve this level ;
- b) Use manufacturer's recommendations for temperature and for exposure time required to achieve the desired level of disinfection/sterilization; do

not exceed the manufacturer's maximum exposure time, as some chemicals may cause damage to the medical equipment/device if used for extended periods of time;

- c) All surfaces of the article must be in direct contact with the disinfectant/sterilant; and
- d) Contact may be compromised by the complexity of the article and the ability of the disinfectant to penetrate lumens.

2.5 Physical and chemical properties affecting the reprocessing environment:

- a) Water hardness can affect some disinfectants;
- b) Excessive humidity may compromise sterile wrappings; and
- c) The pH of the solution may be an important consideration, as extremes of acidity or alkalinity affect growth of microorganisms or alter the activity of disinfectants and sterilants.

3 Policies and Procedures

Every healthcare facility must establish its own policies and procedures to ensure appropriate sterilization and disinfection processes. These policies and procedures should be reviewed by the infection prevention and control team/department at least annually.

Reprocessing policies and procedures shall include the following:

- a) Responsibilities of management and staff;
- b) Qualifications, education and training for staff involved in reprocessing;
- c) Infection prevention and control activities;
- d) HCPs' health and safety activities;
- e) Preventive maintenance requirements with documentation of actions;
- f) Written protocols for each component of the cleaning, disinfection and/or sterilization processes that are based on the manufacturer's recommendations and established guidelines for the intended use of the product;
- g) Provision for annual review of policies and procedures with updating as

required;

- h) Documentation and maintenance of records for each process;
- i) Ongoing audits of competency and procedures (who, when, how);
- j) Management and reporting to administration or appropriate regulatory body of incidents where healthcare professionals and patient safety may have been compromised;
- k) Procedures for the recall and reprocessing of improperly reprocessed medical requirements for internal or external subcontractors; and if applicable, a written protocol that prevents the release of loads containing implantable devices pending results of biological indicator testing equipment/devices.

4 Education and Training

The manager and all supervisors involved in reprocessing must, as a minimum, have completed a recognized qualification course in reprocessing practices. A plan must be in place for each staff involved in reprocessing to obtain this qualification.

It is the supervisor's responsibility to ensure that:

- a) Any individual involved in the cleaning, disinfection and/or sterilization of medical equipment/devices is properly trained and their practice is audited on a regular basis to verify that standards are met;
- b) Training includes information on cleaning, disinfection and sterilization, occupational health and safety issues, and infection prevention and control;
- c) Orientation and continuing education is provided and documented for all staff involved in reprocessing of medical equipment/devices; and
- d) Feedback is provided to reprocessing staff in a timely manner.

The policies of the healthcare setting should specify the requirements for, and frequency of, education and training with competency assessment for all staff involved in the reprocessing of medical equipment/devices. The healthcare facility should ensure that:

- a) All staff who are primarily involved in reprocessing obtain and maintain

- certification;
- b) Any individual involved in any aspect of reprocessing obtains education, orientation and training specific to the medical equipment/device to be reprocessed (e.g. dental hygienists, radiation technologists, nurses in long- term care, nurses in physician offices);
 - c) There is a process in place to ensure continued competency, including continuing education;
 - d) Supervisory staff must be competent through education, training and experience in the reprocessing of reusable medical equipment/devices.

All staff involved in reprocessing of medical equipment/devices must be supervised and shall be qualified through formally recognized courses for sterilization technology. Refresher training shall be provided at regular intervals. Orientation, training, continuing education and periodic competency assessment should be documented.

5 Environmental Requirements for Reprocessing Areas

5.1 Physical Space

There must be a centralized area for reprocessing medical equipment/devices. Reprocessing performed outside the centralized area must be kept to a minimum and must be approved by the Infection Prevention and Control Committee or those accountable for safe reprocessing practices. Decentralised reprocessing areas must conform to the requirements for reprocessing space (See **Table 7.3** in Appendix 7.1 for recommended design parameters). In smaller settings, such as clinics or offices in the community, this refers to any segregated area where reprocessing of equipment/devices takes place, away from clients/patients and clean areas.

The central processing area(s) should be divided into at least three areas, respectively for decontamination, packaging, and sterilization and storage. Physical barriers should separate the decontamination area from the other sections to prevent cross-contamination.

5.1.1 Decontamination area

In the decontamination area, contaminated supplies are received, sorted, and decontaminated. The recommended airflow pattern should contain contaminants within the decontamination area and minimize the flow of contaminants to the clean areas. The American Institute of Architects recommends negative pressure and no fewer than six air exchanges per hour in the decontamination area (AAMI recommends 10 air changes per hour) and 10 air changes per hour with positive pressure in the sterilizer equipment room.

The environment where cleaning/decontamination is performed must:

- a) Have adequate space for the cleaning process and storage of necessary equipment and supplies;
- b) Be distinctly separate from areas where clean/disinfected/sterile equipment/devices are handled or stored;
- c) Have easy access to hand hygiene facilities;
- d) Have surfaces that can be easily cleaned and disinfected;
- e) Have slip-proof flooring that can withstand wet mopping and hospital-grade cleaning and disinfecting products;
- f) Have restricted access from other areas in the setting; and
- g) Ensure one-way movement by staff.

Decontamination work areas shall be physically separated from clean and other work areas by walls or partitions to control traffic flow and contain contaminants generated during cleaning. Walls or partitions should be cleaned regularly, hence they should be made of materials that can withstand frequent cleaning and disinfection. The floors and walls should be made of materials capable of withstanding chemical agents used for cleaning or disinfecting. Ceilings and wall surfaces should be made of non-shedding materials.

5.1.2 Decontamination sinks

Decontamination sinks:

- a) Shall be designed and arranged to facilitate soaking, washing and rinsing of equipment/devices with minimal movement or delay between steps;
- b) Should be adjacent to waterproof counter tops and a backsplash;

- c) Shall not have an overflow;
- d) Should be at a height that allows HCPs to use them without bending or straining;
- e) Should be large enough to accommodate trays or baskets of instruments;
- f) Should be deep enough to allow complete immersion of larger devices and instruments so that aerosols are not generated during cleaning; and
- g) Should be equipped with water ports for the flushing of instruments with lumens, if appropriate.

5.1.3 Packaging area

The packaging area is for inspecting, assembling, and packaging clean, but non-sterile, material.

5.1.4 Sterile storage area

The sterile storage area should be a limited access area with a controlled temperature (may be as high as 24°C) and relative humidity (between 30-60% in all work areas except sterile storage, where the relative humidity should not exceed 70%).

5.1.5 Hand hygiene facilities

Hand hygiene facilities should be located in all staff support areas and at all entrances to, and exits from, the decontamination area. Hand hygiene facilities should include:

- a) Accessible hand washing sinks with hands-free controls, soap dispensers and paper towels; and/or
- b) Alcohol-based hand-rub (ABHR).

5.2 Air Quality

Occupational exposure limits such as ceiling exposure value (CEV) for chemical agents (e.g. glutaraldehyde, ethylene oxide) should comply with the local environmental law. A CEV is the maximum airborne concentration of a chemical agent to which a HCP may be exposed at any time. If control measures are not available during reprocessing of an equipment involving a chemical agent, air sampling should be performed to ensure that the CEV does not exceed the regulated limit.

Air changes, temperature and humidity of the reprocessing area should be appropriate to the process/product being used. In healthcare settings where there are dedicated central reprocessing areas, negative pressure airflow must be maintained in soiled areas and positive pressure airflow must be maintained in clean areas and be monitored.

5.3 Water Quality

The healthcare setting should have policies to ensure the quality of its water supply. In case of compromises in the quality of the water supply, there should be written contingency plans for reprocessing equipment.

5.4 Environmental Cleaning in Sterile Processing Departments

There should be established policies for cleaning practices and cleaning frequency. As a minimum:

- a) The facility shall have written cleaning procedures with clearly defined responsibilities for all areas in the facility where decontamination is performed;
- b) All work areas, stands, tables, countertops, sinks and equipment surfaces shall be cleaned with hospital approved cleaning agents and disinfected at least daily;
- c) Floors shall be cleaned at least daily;
- d) If a spill occurs, the affected area shall be cleaned immediately;
- e) Sinks shall be cleaned at least each shift and more frequently as necessary;
- f) Sinks used for cleaning endoscopes and respiratory equipment shall be cleaned between each use;
- g) The sequence of cleaning shall be from clean areas to soiled areas, from high areas to low areas (i.e. top of walls to floor) and from least contaminated to most contaminated;
- h) Staff shall not move back and forth between clean and soiled areas; and
- i) Cleaning equipment used in the decontamination area shall not be used in any other area.

6 Occupational Health and Safety for Reprocessing

An Occupational Health and Safety review is recommended for all protocols for reprocessing medical equipment/devices, to verify that staff safety measures are followed and are in compliance with the Workplace Safety and Health Act. The safety measures should ensure that:

- a) Sharps are handled appropriately;
- b) Local exhaust ventilation systems adequately protect staff from toxic vapours;
- c) Chemicals are labelled, stored and handled appropriately, and safety data sheets (SDS) are readily available;
- d) An eyewash fountain is installed to prevent a potential hazard to the eye due to contact with a biological or chemical agent;
- e) Personal protective equipment, such as elbow length impervious gloves (insulated if using a steam autoclave) for unloading the autoclave, is present and complies with regulatory requirements;
- f) Procedures must be in place for immediate response to staff exposure to blood and body fluids or injury from sharp objects; and
- g) All staff working in reprocessing must be immune to Hepatitis B or receive Hepatitis B immunization.

6.1 Routine Practices (Standard precaution)

All staff should receive education and training in routine practices to prevent exposure to body substances. Routine practices in reprocessing areas include:

- a) A policy that prohibits eating, drinking, storage of food and drink, smoking, application of cosmetics and handling contact lenses in the reprocessing area;
- b) No storage of personal items in the reprocessing area;
- c) Hand hygiene facilities located at all entrances to, and exits from, reprocessing areas and faucets;
- d) Reprocessing areas should be supplied with foot-, wrist- or knee-operated handles or electronic sensors to prevent contact;
- e) Proper hand hygiene is performed;
- f) Hand and arm jewellery or artificial nails are not worn;

- g) Provision for, and wearing of, appropriate PPE for all reprocessing activities; and
- h) Dedicated staff for the decontamination area.

6.2 Personal Protective Equipment (PPE)

All staff involved in reprocessing must be trained in the correct use, wearing, limitations and indications for PPE. Staff should ensure that:

- a) PPE that is worn for cleaning and handling contaminated equipment/devices includes gloves appropriate to the task, face protection (full face shield/fluid-impervious face mask/protective eyewear) and impermeable gown or waterproof apron;
- b) When choosing gloves, the following points need to be considered:
 - i. Gloves must be long enough to cover wrists and forearms;
 - ii. Gloves must be of sufficient weight to be highly tear-resistant;
 - iii. Gloves must allow adequate dexterity of the fingers;
 - iv. The use of disposable gloves are recommended; if reusable gloves are used, they must be decontaminated and inspected for tears and holes daily.
- c) PPE is removed on completion of the task for which it was indicated and before leaving the reprocessing area;

6.3 Safe Handling of Sharps

Procedures shall be in place to prevent injuries from sharp objects. When working with sharps, staff shall:

- a) Place disposable sharp objects in puncture-resistant containers;
- b) Take extra care when handling glass and other fragile objects;
- c) Remove devices with chipped or broken glass from work area and arrange for repair or disposal;
- d) Not recap used needles or other sharps unless using a recapping device; and
- e) Not manually bend or break needles.

6.4 Work Restrictions

Reprocessing staff are subject to some work restrictions to protect themselves and patients.

- a) Staff who have respiratory problems (e.g. asthma) should be assessed by occupational health and safety staff prior to working with chemical disinfectants or cleaning agents; and
- b) Staff who have exudative lesions or weeping dermatitis shall refrain from handling client/patient care equipment until the condition is resolved.

7 Transportation and Handling of Contaminated Medical Equipment / Devices

Soiled medical equipment/devices must be handled in a manner that reduces the risk of exposure and/or injury to staff and clients/patients, or contamination of environmental surfaces. When transporting and handling contaminated medical equipment, staff should:

- a) Use closed carts or covered containers designed to prevent the spill of liquids, with easily cleanable surfaces;
- b) Use direct routes to avoid high-traffic, clean/sterile storage and client/patient care areas;
- c) Clean containers or carts used in transport of soiled medical equipment/devices after each use; and
- d) Ensure that sharps are disposed in appropriate puncture-resistant sharps containers at point-of-use, prior to transportation.

8 Selection of Product/Process for Reprocessing

The reprocessing method and products required for medical equipment/devices will depend on the intended use of the equipment/device and the potential risk of infection involved in the use of the equipment/device. The process and products used for cleaning, disinfection and/or sterilization of medical equipment/devices must be compatible with the equipment/devices:

- a) Compatibility of the equipment/device to be reprocessed to detergents, cleaning agents and disinfection/sterilization processes is determined by the manufacturer of the equipment/device; and

- b) The manufacturer must provide written information regarding the safe and appropriate reprocessing of the medical equipment/device.

8.1 Reprocessing Process

The classification system developed by Spaulding divides medical equipment/devices into three categories, based on the potential risk of infection involved in their use:

Table 7.1. Spaulding's Classification of Medical Equipment/Devices and Required Level of Processing/Reprocessing

Classification	Definition	Level of Processing/Reprocessing	Examples
Critical	Equipment/device that enters sterile tissues, including vascular system	Cleaning followed by sterilization	Surgical instruments, biopsy instruments
Semi-critical	Equipment/device that comes into contact with non-intact skin or mucous membranes but do not penetrate them	Cleaning followed by Sterilization or high-level disinfection	Respiratory therapy equipment, anaesthesia equipment, tonometer
Non-critical	Equipment/device that touches only intact skin and not mucous membranes, or does not directly touch the patient	Cleaning followed by low-level disinfection	ECG machines, oximetry, bedpans, urinals, commodes, blood pressure cuffs, crutches, computers, bed rails, bedside tables, patient furniture and floors

All medical equipment/devices that will be purchased and/or will be reprocessed must have written device-specific manufacturer's cleaning, disinfection and sterilization instruction. If disassembly or reassembly is required, detailed instructions with pictures must be included. It is recommended that hospitals or healthcare facilities follow the written, updated instruction (e.g. Instructions for Use [IFU], Product Insert) provided by the device manufacturers on how their devices

should be cleaned, disinfected or sterilized. To achieve this, staff training must be provided on these processes before the medical equipment/device is placed into circulation.

8.2 Reprocessing Products

Tools used for any/all stages in reprocessing (i.e. cleaning, disinfection, sterilization) must be:

- a) Appropriate for the level of reprocessing that is required for the medical equipment/device; and
- b) Approved by:
 - i. The committee responsible for product selection;
 - ii. Reprocessing expertise team; and
 - iii. The infection prevention and control team.

9 Disassembly, Inspection and Cleaning of Reusable Medical Equipment/ Devices

Reusable medical equipment/devices must be thoroughly cleaned before disinfection or sterilization. The process of cleaning physically removes contaminants from the equipment/device, rather than killing microorganisms. If an item is not cleaned, soil (e.g. blood, body fluids, dirt) can (i) block the microorganisms from the action of the disinfection or sterilization process, and (ii) inactivate the disinfectant or sterilants, and result in sterilisation and disinfection failure. Disinfectants that become overloaded with soil can become contaminated and may become a source for transmission of microorganisms. Cleaning is always essential prior to disinfection or sterilization. An item that has not been cleaned cannot be adequately disinfected or sterilized.

9.1 Pre-Cleaning

Gross soil (e.g. faeces, sputum, and blood) shall be removed immediately at point-of-use. If cleaning cannot be done immediately, the medical equipment/device must be submerged in tepid water and detergent or enzymatic cleaner to prevent organic matter from drying on it. This does not eliminate the chance of transmission of infectious agents to healthcare professionals. Staff who perform such task should

wear appropriate protective equipment and follow safe work practice according to Standard Precautions.

Factors that affect the ability to effectively clean medical equipment/devices must be considered prior to cleaning. Policies and procedures for cleaning medical equipment/devices shall be based on the manufacturer's instructions and must be developed in consultation with the Infection Prevention and Control, Occupational Health and Safety, Biomedical Engineering and Environmental Services teams/departments. Appropriate PPE shall be worn for handling and cleaning contaminated equipment/devices. Once medical equipment/devices have been received in the reprocessing area/department, they must be disassembled, sorted and soaked.

9.1.1 Disassembly – facilitates access of the cleaning agent, disinfectant and/or sterilant to device surfaces. Equipment/devices shall be disassembled following the manufacturer's instruction prior to cleaning if there is one or more removable part, unless otherwise recommended by the manufacturer

9.1.2 Sorting – keeps medical equipment/devices that belong to a set together and streamlines the cleaning process.

- a) Sort equipment/devices into groups of like products requiring the same processes;
- b) Segregate sharps and/or delicate equipment/devices to prevent injury to staff and damage to the equipment/device.

9.1.3 Soaking – prevents soil from drying on equipment/devices and makes them easier to clean.

- a) Soak equipment/device in a hospital-approved instrument soaking solution;
- b) Do not use saline as a soaking solution as it can damage some medical equipment/devices;
- c) Use detergent-based products, including those containing enzymes, as part of the soaking process;

- d) Ensure that detergents (including enzymatic cleaners) are appropriate for the equipment/device being cleaned (products used must be approved by the equipment/device's manufacturer); and
- e) Avoid prolonged soaking (e.g. overnight) of equipment/devices.

9.2 Cleaning

Cleaning may be done manually or using mechanical cleaning machines (e.g. washer-disinfector, ultrasonic washer, washer-sterilizer) after gross soil has been removed. Automated machines may increase productivity, improve cleaning effectiveness and decrease staff exposure to blood and body fluids. Manual cleaning may be required for delicate or intricate items. Follow the manufacturer's cleaning instructions, including specifications for detergent type, water temperature and cleaning methods. The following procedures are included in the cleaning process:

9.2.1 Physical Removal of Soil

- a) Completely submerge immiscible items during the cleaning process to minimize aerosolisation of microorganisms and assist in cleaning;
- b) Minimize the production of aerosols when cleaning non-immiscible equipment/devices;
- c) Remove gross soil using tools such as brushes and cloths;

9.2.2 Manual Cleaning

- a) Any brushing required should be done under water
- b) Clean equipment/devices that have lumens with a brush, according to the manufacturer's instructions, then manually or mechanically flush with a detergent solution and rinse;
- c) Check equipment/devices with lumens for obstructions and leakage;

9.2.3 Mechanical Cleaning

Whenever possible, clean equipment/devices by mechanical means:

- a) Any brushing required should be done underwater;
- b) Use mechanical washers in accordance with the manufacturer's instructions;

- c) Manually clean heavily soiled equipment/devices before mechanical cleaning;
- d) Ensure that the equipment/device to be cleaned is compatible with the mechanical cleaning equipment and chemical solutions that are being used;
- e) Ultrasonic washers are strongly recommended for any semi-critical or critical medical equipment/device that has joints, crevices, lumens or other areas that are difficult to clean. Note:
 - i. The manufacturer's instructions must be followed for use and routine cleaning and maintenance of the ultrasonic washer.
 - ii. Equipment/devices shall be completely immersed in the washing solution.
 - iii. After cleaning, equipment/devices shall be rinsed thoroughly prior to further reprocessing.
 - iv. The ultrasonic washing solution should be changed at least daily or more frequently if it becomes visibly soiled or if the manufacturer's instructions specify more frequent changes.
- f) Washer-disinfectors are strongly recommended for medical equipment/devices that can withstand mechanical cleaning, to achieve the required exposure for cleaning and to reduce potential risk to staff. Note:
 - i. The manufacturer's instructions must be followed for the use and routine maintenance, cleaning and calibration of the washer-disinfector.
 - ii. Washer-disinfectors may be used for low-level disinfection.
 - iii. Washer-disinfectors are not to be used for high-level disinfection.

9.2.4 Care of Cleaning Tools

- a) Inspect brushes and other cleaning equipment for damage after each use, and discard if necessary; and
- b) Clean, disinfect, dry and store tools used to assist in cleaning (e.g. brushes, cloths) as recommended by the manufacturer.

9.3 Rinsing

Rinsing following cleaning is necessary, as residual detergent may neutralize the disinfectant.

- a) Rinse all equipment/devices thoroughly after cleaning with water to remove residues which might react with the disinfectant/sterilant;
- b) Perform the final rinse for equipment/devices containing lumens with commercially prepared sterile, pyrogen-free water (note: distilled water is not necessarily sterile or pyrogen-free).

9.4 Drying

Drying is an important step that prevents dilution of chemical disinfectants which may result in ineffective cleaning and promote microbial growth.

- a) Follow the manufacturer's instructions for drying of the equipment/device;
- b) Equipment/devices may be air-dried or dried by hand with a clean, lint-free towel;
- c) Dry lumens with compressed air that has been filtered and dried;
- d) Dry stainless steel equipment/devices immediately after rinsing to prevent spotting.

9.5 Post-Cleaning

Once medical equipment/devices have been reprocessed, they should be differentiated from equipment/devices which have not been reprocessed. Sterilized items may be identified using external chemical indicators (CIs), such as autoclave tape which changes colour during sterilization. Equipment/devices which receive high-level disinfection should also be labelled, tagged or color-coded to indicate that they have been reprocessed.

9.5.1 Reassembly and Inspection

- a) Visually inspect all equipment/devices once the cleaning process has been completed and prior to terminal disinfection/sterilization to ensure cleanliness and integrity of the equipment/device (e.g. cracks, defects, adhesive failures, missing parts);
- b) Repeat the cleaning on any item that is not clean;

- c) Do not reassemble equipment/device prior to disinfection/sterilization; if the equipment/device manufacturer's instructions specify reassembly in the reprocessing stage, reassembly shall take place in a clean area and performed in accordance with the manufacturer's instructions.

9.5.2 Lubrication

- a) Follow the manufacturer's guidelines for lubrication;
- b) Equipment/devices requiring lubrication shall be lubricated prior to sterilization;
- c) Lubricants shall be compatible with the device and with the sterilization process;
- d) Discard expired lubricants or when visibly soiled or contaminated.

9.5.3 Wrapping

- a) Equipment/devices that are to be sterilized require wrapping prior to sterilization (except for IUSS);
- b) Container and materials used for wrapping shall be prepared in a manner that will allow adequate air removal, steam penetration and evacuation to all surfaces.

9.5.4 Practice audits

- a) Cleaning processes must be audited on a regular basis;
- b) A quality improvement process must be in place to deal with any irregularities/concerns resulting from the audit.

10 Disinfection of Reusable Medical Equipment/Devices

Disinfection is the inactivation of certain disease-producing microorganisms. It is used for non-critical devices and semi-critical devices that cannot withstand sterilisation. Disinfection does not destroy bacterial spores or prions (Figure 7.1). Disinfection of medical equipment/devices falls into two major categories – low-level disinfection and high-level disinfection.

Figure 7.1. Decreasing order of resistance of microorganisms to disinfection and sterilization and the level of disinfection or sterilization (Reference: CDC Guideline for Disinfection and Sterilization in Healthcare Facilities, 2008)

Resistance Level	Micro-organism	Level / method of disinfection & sterilization
<p>Resistant</p>  <p>Susceptible</p>	Prions (Creutzfeldt-Jakob Disease)	Prion reprocessing
	Bacterial spores (<i>Bacillus atrophaeus</i>)	Sterilization
	Coccidia (<i>Cryptosporidium</i>)	
	Mycobacteria (<i>M. tuberculosis</i> , <i>M. terrae</i>)	High disinfection
	Nonlipid or small viruses (polio, coxsackie)	
	Fungi (<i>Aspergillus</i> , <i>Candida</i>)	
	Vegetative bacteria (<i>S. aureus</i> , <i>P. aeruginosa</i>)	Low disinfection
Lipid or medium-sized viruses (HIV, herpes, hepatitis B)		

10.1 Low-Level Disinfection (LLD)

Low-level disinfection eliminates vegetative ('live') bacteria, some fungi and enveloped viruses. LLD is used for non-critical medical equipment/devices and some environmental surfaces. Low-level disinfectants include 3% hydrogen peroxide, 0.5% accelerated hydrogen peroxide, some quaternary ammonium compounds (QUATS), phenolics and diluted sodium hypochlorite (e.g. bleach) solutions.

LLD is performed after the equipment/device is thoroughly cleaned; rinsed and excess rinse water is removed. The container used for disinfection must be washed, rinsed and dried when the solution is changed.

10.2 High-Level Disinfection (HLD)

High-level disinfection eliminates vegetative bacteria, enveloped viruses, fungi, mycobacteria (e.g. Tuberculosis) and non-enveloped viruses by the use of high-level liquid disinfectants or pasteurisation. HLD is used for semi-critical medical equipment/devices that cannot be sterilised. Whenever possible, semi-critical medical equipment/devices should be sterilized. Only when sterilization is not possible, semi-critical equipment/devices shall be cleaned, followed by high-level disinfection.

High-level disinfectants include 2% glutaraldehyde, 6% hydrogen peroxide, 0.2% peracetic acid, 7% accelerated hydrogen peroxide and 0.55% ortho-phthalaldehyde (OPA). The contact time required for high-level disinfection for each equipment differs (Refer to Table 7.4 in Appendix 7.1). HLD is performed after the equipment/device is thoroughly cleaned, rinsed and excess rinse water is removed.

10.3 Methods of Disinfection for Semi-critical Medical Equipment/Devices

There are two major methods of disinfection used in healthcare settings – liquid chemicals and pasteurization.

10.3.1 Liquid Chemical Disinfection

When selecting a disinfectant for reprocessing medical equipment/devices in the healthcare setting, consider:

- a) Efficacy for the intended use;
- b) Compatibility with the equipment/device and surfaces to be disinfected;
- c) Compatibility with detergents, cleaning agents and disinfection and/or sterilization processes;
- d) The intended end use of the equipment/devices to be disinfected;
- e) The method for monitoring the product concentration;
- f) Recommendations for rinsing (e.g. water quality, volume, time);
- g) Safety for use, with minimal toxic and irritating effects to/for staff; and
- h) Environmental safety and biodegradability.

The healthcare facility should follow the manufacturer's recommendations for chemical disinfectants pertaining to:

- a) Usage - disinfectant manufacturers must supply recommended usage for the disinfectant to ensure that it is compatible with the medical equipment/devices on which it will be used;
- b) Contact time (note: where the manufacturer recommends a shorter contact time with a particular product than is required to achieve the desired level of disinfection/sterilization, an infection prevention and control professional must be consulted for advice);
- c) Shelf life;
- d) Storage;
- e) Appropriate dilution; and
- f) Required PPE.

The process of high-level disinfection requires monitoring and auditing. Monitoring and audit should check that:

- a) Chemical test strips should be used to determine whether an effective concentration of active ingredients is present, despite repeated use and dilution:
 - i. The frequency of testing should be based on how frequently the solutions are used (i.e. test daily if used daily);
 - ii. Chemical test strips must be checked each time a new package/bottle is opened to verify they are accurate, using positive (e.g. full strength disinfectant solution) and negative (e.g. tap water) controls; see manufacturer's recommendations for appropriate controls;
 - iii. Test strips must not be considered a way of extending the use of a disinfectant solution beyond the expiration date;
- b) A permanent record of processing shall be completed and retained according to the policy of the facility; this record shall include, but not be limited to:
 - i. The identification of the equipment/device to be disinfected;
 - ii. Date and time of the clinical procedure;
 - iii. Concentration and contact time of the disinfectant used in each process;
 - iv. Results of each inspection (and, for endoscopes, each leak test);

- v. Result of each testing of the disinfectant; and
 - vi. The name of the staff completing the reprocessing.
- c) Disinfection practices shall be audited on a regular basis and a quality improvement process must be in place to deal with any irregularities/concerns resulting from the audit;
 - d) Prepared solutions shall not be topped up with fresh solution;
 - e) If manual disinfection is performed, the container used for disinfection shall be kept covered during use and washed, rinsed and dried when the solution is changed; and
 - f) Rinsing of medical equipment/devices following chemical disinfection requires three separate rinses, using sterile water, and the rinse solutions must be changed after each process.

10.3.2 Pasteurization

Pasteurization is a process of hot water disinfection (minimum 71°C for 30 minutes), which is accomplished through the use of automated pasteurizers or washer disinfectors. Semi-critical medical equipment/devices suitable for pasteurization include equipment for respiratory therapy and anaesthesia.

Advantages of pasteurization include:

- a) No toxicity;
- b) Rapid disinfection cycle; and
- c) Moderate cost of machinery and upkeep.

Disadvantages of pasteurization include:

- a) May cause splash burns;
- b) Difficulty validating the effectiveness of the process; and
- c) Pasteurizers and related equipment can become contaminated without a good preventive maintenance program and careful monitoring of processes.

The manufacturer's instructions for installation, operation and ongoing maintenance of pasteurizing equipment must be followed to ensure that the machine does not become contaminated.

- a) The process must be monitored with mechanical temperature gauges and timing mechanisms for each load, with a paper printout record; pasteurizing equipment must have, or be retrofitted for, mechanical paper printout;
- b) Water temperature within the pasteurizer should be verified weekly by manually measuring the cycle water temperature;
- c) Cycle time should be verified manually and recorded daily;
- d) Calibration of pasteurization equipment will be performed according to the manufacturer's recommendations;
- e) Daily cleaning of pasteurizing equipment is required following the manufacturer's recommendations; and
- f) Following pasteurization, medical equipment/devices should be inspected for wear, cracks or soil:
 - i. Damaged equipment/devices shall be handled according to facility procedures; and
 - ii. Soiled equipment/devices shall be reprocessed.

Following pasteurization, medical equipment/devices shall be handled in a manner that prevents contamination. Equipment/devices shall be transported directly from the pasteurizer to a clean area for drying, assembly and packaging. Medical equipment/devices shall be thoroughly dried in a drying cabinet that is equipped with a high efficiency particulate air (HEPA) filter and is used exclusively for the drying of pasteurized equipment/devices. A preventive maintenance program for drying cabinets must be implemented and documented. Printed records of each cycle (i.e. temperature, time) shall be retained in accordance with the healthcare setting's requirements.

11 Sterilization of Reusable Medical Equipment/Devices

Sterilization is the elimination of all disease-producing microorganisms, including spores (e.g. *Clostridium* and *Bacillus* species). [Note: Prions are not susceptible to routine sterilization.] Sterilization shall be used for critical medical equipment/devices and semi-critical medical equipment/devices whenever possible.

For equipment/devices that cannot withstand heat sterilization, sterilisation may use sterilants which include:

- a) 6% hydrogen peroxide;
- b) 2% glutaraldehyde (> 10 hours);
- c) hydrogen peroxide gas plasma;
- d) 0.2% peracetic acid;
- e) 7% accelerated hydrogen peroxide; and
- f) 100% ethylene oxide.

Refer to Table 7.4 in Appendix 7.1 for contact time for sterilization.

11.1 Sterilization Process

All critical medical equipment/devices must be sterilized, because microbial contamination can result in disease transmission. Medical equipment/devices that have contact with sterile body tissues or fluids are considered critical items. Critical items include surgical instruments, implants, foot care equipment, endoscopes that enter sterile cavities and spaces, colposcopy equipment, biopsy forceps and brushes, eye equipment and dental equipment.

Semi-critical medical equipment/devices have contact with broken skin or mucous membranes but do not penetrate them. Whenever possible, semi-critical medical equipment/devices should be sterilized. When sterilization is not possible, semi-critical equipment/devices shall be cleaned, followed by high-level disinfection. Healthcare settings shall have written policies and procedures for sterilization of medical equipment/devices processes that:

- a) Ensure that the sterilization processes follow the principles of infection prevention and control;
- b) Ensure that manufacturer's instructions for installation, operation, cleaning and preventive maintenance of the equipment are followed;
- c) Include clearly defined responsibilities;
- d) Include cleaning, decontamination, drying, inspection, lubrication, disassembly, wrapping, sealing and labelling;
- e) Include a thorough evaluation of all sterilization processes before being put into service, and at regular intervals thereafter.

The floors and walls of sterilisation facilities should be made of materials capable of withstanding chemical agents used for cleaning or disinfecting. Ceilings and wall surfaces should be made of non-shedding materials. Physical arrangements of processing areas are presented schematically in four references.

11.2 New Sterilizers

Input from a professional with infection prevention and control expertise must be obtained prior to the purchase of a new sterilizer. There must be good communication between the healthcare setting and the manufacturer of the sterilizer to ensure that:

- a) Manufacturers of sterilizers provide specific, written instructions on installation and use of their equipment;
- b) Storage and transportation practices maintain sterility to the point of use; and
- c) Manufacturers of sterilizers are specific as to which medical equipment/devices can be sterilized in their machines and the recommended sterilization methods.

Sterilizers must be subjected to rigorous testing and monitoring on installation and following disruptions to their normal activity.

- a) Autoclaves must be installed according to the manufacturer's instructions;
- b) Table-top steam sterilizers are recommended for office settings;
- c) Following installation of a new sterilizer, the sterilizer must pass at least three consecutive cycles with the appropriate challenges (i.e. biological, chemical) placed in an empty sterilizer, as well as at least one cycle challenged with a full test load, before the sterilizer can be put into routine service;
- d) For sterilizers of the dynamic air removal type (vacuum), three consecutive air removal tests shall be conducted in an empty sterilizer with the air detection test pack (e.g. bowie-dick);
- e) A sterilizer shall not be approved for use if the biological indicator yields a positive result on any of the tests;

- f) Sterilizers must be monitored with a test load and be fully re-qualified in the following circumstances:
- i. After major repairs to an existing sterilizer;
 - ii. When there has been construction, relocation or other environmental changes in the area;
 - iii. After unexplained sterility failures;
 - iv. After changes in steam and/or ethylene oxide supply or delivery;
and
 - v. After repairs or modification to the emission control system.

11.3 Monitors and Indicators

Physical, biological and chemical monitoring is done to verify the effectiveness of sterilizers and the sterilization process. Monitoring is done when a sterilizer is first installed, before it is put into general use, and when assessing routine performance thereafter. Performance monitoring using all three types of indicators/monitors must be completed in all sterilizers to ensure that effective sterilization has been achieved.

11.3.1 Physical Monitors

A physical monitor is a device that monitors the physical parameters of a sterilizer, such as time, temperature and pressure that are measured during the sterilization cycle and recorded (as a printout or electronic record) on completion of each cycle.

11.3.2 Biological Indicators (BI)

A biological indicator is a test system containing viable microorganisms (e.g. spore-laden strips or vials) providing a defined resistance to a specified sterilization process. The BI is generally contained inside a process challenge device (PCD) that simulates the in-use challenges presented by packaged devices. Once sterilized, a BI is incubated to see if the microorganism will grow, which indicates a failure of the sterilizer.

The manufacturer's instructions regarding the type of BI to be used in a particular sterilizer should be followed. The recommended test microorganisms generally used as BIs are:

- a) *Geobacillus stearothermophilus* (formerly *Bacillus stearothermophilus*) spores for sterilizers that use steam, hydrogen peroxide gas plasma or peracetic acid, as well as IUSS sterilizers; and
- b) *Bacillus atrophaeus* (formerly *Bacillus subtilis*) spores for sterilizers that use dry heat or ethylene oxide.

The BI is incubated according to the manufacturer’s instructions. Most BIs require up to 48 hours of incubation before the test is complete. Recently, however, rapid readout biological indicators have become available that provide BI results in one hour. These indicators detect enzymes of *Geobacillus stearothermophilus* (the test organism for steam sterilizers) by reading a fluorescent product produced by the enzymatic breakdown of a non-fluorescent substrate. Studies have shown that the sensitivity of rapid-readout tests for steam sterilization (1 hour for 132°C gravity sterilizers, 3 hours for 121°C gravity and 132°C vacuum sterilizers) parallels that of the conventional sterilization-specific BIs.

11.3.3 Chemical Indicators (CI)

A chemical indicator is a system that responds to a change in one or more predefined process variables with a chemical or physical change. There are six types of chemical indicators (see [Table 7.2](#), ‘International Classes of Steam Chemical Indicators’).

Chemical indicators do not necessarily indicate that a device is sterile and do not replace the need to use a BI, but do indicate that the package has been processed through a sterilization cycle.

Table 7.2. International Classes of Steam Chemical Indicators

Type	Category	Description	Intended use
1	e1	Exposure or process indicator	Indicates exposure to a process, allows differentiation between unprocessed and processed, i.e. indicator tapes or labels
2	s2	Special indicator	Indicators for use in special applications, i.e. Bowie-Dick test

Type	Category	Description	Intended use
3	i3	Internal single variable indicator to indicate when 1 critical variable	For pack control - but not as useful as Class IV or V indicators; for exposure control monitoring, i.e. temperature tubes for dry heat sterilizing
4	i4	Internal multi-variable indicator that reacts to more than 1 critical variable in sterilization cycle	For pack control, i.e. chemical impregnated paper strips
5	i5	Internal integrating indicator that reacts to all critical variables in the sterilization process (i.e. for steam sterilization - time, temperature, presence of steam) and has stated values that correlate to a BI at 3 time/temperature relationships	For pack control or as additional monitoring for loads that contain implants, i.e. PCD containing a type 5 CI
6	i6	Internal emulating indicator that reacts to all critical variables (i.e. for steam sterilization - time, temperature, presence of steam) for specified sterilization cycle	For pack control, i.e. chemical impregnated paper strip

Source: APSIC Guidelines for Disinfection and Sterilization of Instruments in Health Care Facilities

11.3.4 Process Challenge Device (PCD)

A process challenge device is a test device intended to provide a challenge to the sterilization process that is equal to, or greater than, the challenge posed by the most difficult item routinely processed. Examples include BI test packs, which also contain a chemical indicator, or CI test packs, which contain a Class 5 integrating indicator or an enzyme-only indicator. During routine monitoring of sterilizers, the BI and/or CI is usually placed within a PCD and placed in the sterilizer. A PCD can be commercially manufactured or prepared in-house.

11.4 Routine Monitoring of Sterilizers

Routine monitoring verifies that the sterilization process is working as expected and that medical equipment/devices achieve sterility. Routine monitoring of sterilizers involves the assessment of physical parameters of the sterilizer cycle, chemical

indicators and biological indicators. All monitoring must comply with the manufacturer's instructions.

The following are included in routine monitoring:

- a) Record results of physical, chemical and biological parameters;
- b) Document daily operation of the sterilizer:
 - i. Review physical monitoring parameters for each operation (e.g. printed or electronic records);
 - ii. Note any malfunction and take appropriate action to ensure that the product either has been properly treated or is returned for reprocessing;
- c) Test filter systems for leakage;
- d) Validate gas sterilization units for such factors as gas concentration, temperature, and relative humidity;
- e) Conduct three consecutive tests with the air detection test pack (bowie-dick) for sterilizers of the dynamic air removal type; and
- f) Monitor dry heat sterilization with each cycle due to differences in penetration with different items.

When using sterilization indicators, staff must ensure that:

- a) Indicator shall be used according to the indicator manufacturer's instructions;
- b) Indicator shall be used only for the sterilizer type and cycle for which it was designed and validated;
- c) Indicator shall be interpreted only by qualified staff who have been trained to do so;
- d) Indicator shall not be used beyond the expiration date; and
- e) Indicator shall be stored in accordance with the manufacturer's instructions.

The following requirements apply to chemical monitoring:

- a) An internal chemical indicator shall be placed inside each package, container or bundle that is undergoing sterilization in the area judged to be least accessible to steam penetration or to the sterilizing agent; this may not necessarily be at the centre of the package; the class of indicator

chosen is based on the parameters being measured and the degree of precision that is needed;

- b) Each package or container to be sterilized shall have an externally visible class I chemical indicator, which is examined immediately after sterilization to make sure that the item has been exposed to the sterilization process; and
- c) For dynamic air removal-type sterilizers, an air removal test with a Class II chemical indicator shall be performed every day the sterilizer is used.

The following requirements apply to biological monitoring:

- a) A biological indicator (BI) shall be used to test the sterilizer each day that it is used and with each type of cycle that is used that day; except for steam sterilizer which should be done weekly;
- b) A biological indicator shall be included in every load that is to be sterilized with ethylene oxide;
- c) A biological indicator shall be included in every load containing implantable devices;
- d) Items in the processed load should not be released until the results of the BI test are available; if quarantine pending BI results is not possible, evaluation of a class 5 or 6 chemical indicator and the specific cycle physical parameters may be used to justify the release of routine loads; and
- e) Implantable devices should be quarantined until the results of the BI test are available.

12 Immediate Use Steam Sterilization (IUSS)

IUSS shall only be used in emergency situations and not be used for implantable equipment/devices and complete sets or trays of instruments. Operative scheduling and lack of instrumentation do not qualify as reasons to use IUSS.

To ensure effective sterilization using IUSS, staff must check that:

- a) Decontamination and sterilization areas must meet the requirements for processing space and shall not be located in the operative procedure

- room or near any potential source of contamination, such as sinks, hoppers, linen or trash disposal areas;
- b) A record is made for each piece of equipment/device for IUSS, that includes the name of the client/patient, procedure, physician/practitioner and equipment/device used; the client/patient record should also reflect this information;
 - c) If, in an emergency situation, a IUSS sterilizer is used, a biological monitor must be included at least once daily and with each type of cycle and every load configuration (i.e. open tray, rigid IUSS container, single wrapper) that will be used that day;
 - d) The load printout must be signed to verify that the required time, temperature and pressure have been achieved;
 - e) Records must be retained according to the facility's policy;
 - f) There must be a procedure for notification of the client/patient in the event of a recall (e.g. positive biological indicator); and
 - g) Records should be reviewed on a regular basis to correct issues relating to overuse of IUSS.

13 Reprocessing Endoscopy Equipment/Devices

Critical Endoscope (e.g. arthroscopes and laparoscopes): Endoscopes used in the examination of critical spaces, such as joints and sterile cavities. Many of these endoscopes are rigid with no lumen.

Semi-critical Endoscope (e.g. laryngoscopes, nasopharyngeal endoscopes, and colonoscopes): Fibre optic or video endoscopes used in the examination of the hollow viscera. These endoscopes generally invade only semi-critical spaces, although some of their components might enter tissues or other critical spaces. Due to the complexity of their design, flexible fibre optic and video endoscopes require special cleaning and handling.

13.1 Education and Training

Individuals responsible for reprocessing endoscopes require training and must meet the healthcare setting's written endoscope processing competency requirements, which include ongoing education and training:

- a) Staff assigned to reprocess endoscopes must receive device-specific reprocessing instructions to ensure proper cleaning and high-level disinfection or sterilization;
- b) Competency testing of staff reprocessing endoscopes shall be performed at least annually; and
- c) Temporary staff shall not be allowed to reprocess endoscopes until competency has been established.

13.2 Physical Space

The area used to reprocess endoscopes must include:

- a) Adequate space for the storage and holding of clean and soiled materials that is separate from other activities and controlled to prohibit public contact;
- b) Dedicated processing room(s) for cleaning and decontaminating instruments that are physically separated from clean areas, client/patient care areas and procedure rooms;
- c) Appropriate number of utility sink(s) for the volume of work and method of decontamination;
- d) Dedicated hand hygiene sink(s);
- e) Eye-washing facilities;
- f) Sufficient cleanable counter space to handle the volume of work;
- g) Space and utility connections for automatic endoscope reprocessor(s);
- h) Ventilation system that will remove toxic vapours generated by, or emitted from, cleaning or disinfecting agents;
 - i. The vapour concentration of the chemical disinfectant used shall not exceed allowable limits (e.g. 0.05 ppm for glutaraldehyde);
 - ii. Air-exchange equipment (e.g. ventilation system, exhaust hoods) should be used to minimize the exposure of all persons to potentially toxic vapours;

- iii. In-use disinfectant solutions must be maintained in closed, covered, labelled containers at all times; and
- iv. Air quality should be monitored on a scheduled basis to ensure control of vapours;
- i) Negative pressure ventilation and a minimum air exchange rate to 10 per hour for processing/decontamination area
- j) Adequate space for the storage and holding of materials/equipment that is separate from other activities, has adequate positive pressure ventilation and is controlled to prohibit public contact.

13.3 Cleaning Procedures

Each healthcare facility in which endoscopic procedures are performed shall have written detailed procedures for the cleaning and handling of endoscopes. Endoscopic cleaning shall take place immediately following completion of the clinical procedure, as soil residue in endoscope lumens dries rapidly, becoming very difficult to remove.

Immediately following completion of the endoscopy procedure:

- a) Flush and wipe the endoscope at point-of-use;
- b) Use a freshly prepared enzymatic cleaning solution; and
- c) Place the endoscope and accessories in a covered, leak proof container and transport to the designated decontamination area.

Following manufacturer's instructions for cleaning and use of cleaning products.

This includes the following steps:

- a) Perform leak testing after each use, prior to cleaning:
 - i. Verify the integrity of the endoscope sheath through leak testing, performed prior to, and during, immersion of the endoscope;
 - ii. Perform the leak test according to the manufacturer's instructions;
 - iii. An endoscope that fails the dry leak test should not undergo the immersion leak test;
- b) Soak and manually clean all immiscible endoscope components with water and a recommended cleaning agent prior to automated or further manual disinfection or sterilization;

- c) Disconnect and disassemble endoscope components (e.g. air/water and suction valves) as far as possible and completely immerse the endoscope and components in enzymatic cleaner;
- d) Flush and brush all channels and lumens of the endoscope while submerged to remove debris and minimize aerosols;
- e) Ensure that brushes used for cleaning lumens are of an appropriate size, inspected before and after use, and discarded or cleaned, high-level disinfected and dried following use;
- f) Consider irrigation adaptors or manifolds that may be recommended by the manufacturer to facilitate cleaning;
- g) Thoroughly rinse endoscope and all components with clean filtered water prior to disinfection/sterilization and remove excess rinse water;
- h) Identify damaged endoscopes and immediately remove from service;
- i) Discard enzymatic cleaner after each use; and
- j) Discard disposable cleaning items or thoroughly clean and high-level disinfect/sterilize non-disposable items between uses.

13.4 Special disinfection and sterilisation processes for duodenoscope

The duodenoscope is a complex endoscopic instrument for Endoscopic Retrograde Cholangiopancreatograph (ERCP) that features a specific channel, which allows the manipulation of a guide wire at the terminal end of this channel. This separate channel is the elevator channel that is complex in design and has crevices that are difficult to access with a cleaning brush. Outbreaks related to duodenoscopes involving Carbapenemase-Resistant *Enterobacteriaceae* (CRE) and other Multiple Drug Resistant Organisms (MDROs) have been reported.

Meticulously cleaning duodenoscopes prior to high level disinfection can reduce the risk of transmitting pathogens but may not entirely eliminate it. It is therefore important to follow manufacturer's instruction to clean the elevator parts. Using appropriate connectors and brushes are also critical to achieve thorough cleaning. Regular review of staff in the endoscopy unit on the competency of cleaning the duodenoscope is important.

To minimise the immediate risk, it is recommended to adhere to current endoscope reprocessing guidelines with any one of the following methods for reprocessing duodenoscopes (priority ranked):

- 1) Ethylene oxide sterilization after HLD with periodic microbiologic surveillance
- 2) HLD done twice with periodic microbiologic surveillance
- 3) HLD with scope quarantine until negative culture
- 4) Liquid chemical sterilant processing system using peracetic acid (rinsed with extensively treated potable water) with periodic microbiologic surveillance
- 5) Other FDA-cleared low-temperature sterilization technology (provided material compatibility and sterilization validation testing performed using the sterilizer and endoscope) after HLD, with periodic microbiologic surveillance
- 6) HLD with periodic microbiologic surveillance

Follow CDC interim protocol regarding surveillance for bacterial contamination of duodenoscopes after reprocessing using a special culture method and test. It is recommended to test each duodenoscope either once a month or after 60 ERCP procedures.

13.5 Endoscope Disinfection and Sterilization

A minimum of high-level disinfection should be used for all endoscopes and their accessories, except for biopsy forceps and brushes (which require sterilization). The following steps must be included in the disinfection/sterilization procedure:

- a) Choose a disinfectant that is compatible with the endoscope;
- b) Monitor the efficacy of the disinfectant before each use with test strips available from the product manufacturer;
- c) Maintain a written log of monitoring test results;
- d) Do not use disinfectants past their expiry date;
- e) Carefully follow the manufacturer's directions regarding the ambient temperature and duration of contact for the disinfectant (e.g. 2% glutaraldehyde for 20 minutes at 20°C);

- f) Completely immerse the endoscope and endoscope components in the high-level disinfectant/sterilant and ensure all channels are perfused; and
- g) Following disinfection, rinse the endoscope and flush the channels with bacteria-free or sterile water.

13.6 Drying and Storage of Endoscopes

Steps in the final drying of semi-critical endoscopes must include:

- a) Initial flushing of all channels with medical or filtered air;
- b) Flushing all channels with 70% isopropyl alcohol to aid in the drying process; and
- c) Second flushing of the channels with medical or filtered air.

Storage procedures must include the following:

- a) Remove caps, valves and other detachable components during storage and reassemble just before use; store close to the endoscope in a manner that minimizes contamination;
- b) Store semi-critical endoscopes by hanging vertically in a well-ventilated area in a manner that minimizes contamination or damage;
- c) Store endoscopes that have been sterilized in their sterilization containers;
- d) Do not allow endoscopes to coil, touch the floor or bottom of the cabinet while handling, or be stored in their cases;
- e) Ensure that endoscope storage cabinets are made of non-porous material that can be cleaned; and
- f) Clean and disinfect endoscope storage cabinets at least weekly.

Note: Colonoscopes have a maximum shelf life of 7 days, if stored dry. There are no recommendations regarding shelf life of other types of endoscopes.

13.7 Accessories

Endoscopic accessories (e.g. biopsy forceps and brushes) that break the mucosal barrier must be sterilized after each use.

- a) Because of the difficulty cleaning biopsy forceps/brushes, it is strongly recommended that disposable items be used; and
- b) If reusable biopsy forceps/brushes are used, they must be meticulously cleaned prior to sterilization.

13.8 Automated Endoscope Reprocessor (AER)

To achieve consistency in endoscope reprocessing, it is recommended that automated endoscope reprocessor (AER) be used. Follow the manufacturer's instructions for use of the AER which should include the following:

- a) Ensure that the endoscope and endoscope components to be reprocessed are compatible with the AER used;
- b) Ensure that channel connectors and caps for both the AER and the endoscope are compatible;
- c) Place brushes and instruments used to clean the endoscope in the AER for disinfection;
- d) Do not open or stop the AER once started; if an AER cycle is interrupted, high-level disinfection cannot be assured; and
- e) Implement and document preventive maintenance program(s) for the AER(s).

13.9 Equipment Used for Cleaning

The water bottle and its connecting tube, used for cleaning the endoscope lens and irrigation during the procedure, should receive high-level disinfection or sterilization at least daily. Sterile water shall be used to fill the water bottle.

13.10 Record-keeping

An accurate, permanent record of endoscope use and reprocessing will assist in tracking endoscopes and clients/patients in the event of a recall or follow-up. To assist in outbreak investigation:

- a) Document the client/patient's name and record number, the date and time of the procedure, the type of procedure, name of endoscopist, and the serial number or other identifier of both the endoscope and the AER (if used) for each procedure;
- b) Record the endoscope number in the patient record; and

- c) Retain records according to the policy of the facility.

14 Unacceptable Methods of Disinfection/Sterilization

The following methods of disinfection/sterilization are **NOT** recommended:

14.1 Boiling

The use of boiling water to clean instruments and utensils is not an effective means of sterilization. Boiling water is inadequate for the destruction of bacterial spores and some viruses.

14.2 Ultraviolet Irradiation

The germicidal effectiveness of ultraviolet (UV) radiation is influenced by organic matter, wavelength, type of suspension, temperature, type of microorganism and UV intensity, which is affected by distance and dirty tubes. The application of UV light in the healthcare setting is limited to the destruction of airborne organisms (e.g. ventilation ducts) or inactivation of microorganisms located on surfaces (e.g. laboratory hoods). It is not an acceptable method of disinfection/sterilization for medical equipment/devices.

14.3 Glass Bead Sterilization

Glass bead sterilizers use small glass beads and high temperature for brief exposure times to inactivate microorganisms. Glass bead sterilizers are difficult to monitor for effectiveness, have inconsistent heating resulting in cold spots, and often have trapped air which affects the sterilization process. The US Food and Drug Administration (FDA) has determined that a risk of infection exists with this equipment because of their potential failure to sterilize dental instruments and has required their commercial distribution cease until the device has received FDA clearance.

14.4 Chemiclave

Unsaturated chemical-vapour sterilization ('chemiclave') involves heating a chemical solution of primarily alcohol with 0.23% formaldehyde in a closed pressurized chamber. Because of the environmental risks associated with formaldehyde, this method of sterilization is discouraged. If used, it must be closely monitored and local

regulations for hazardous waste disposal must be followed and air sampling for toxic vapours may be indicated.

14.5 Microwave Oven Sterilization

Microwave ovens are unreliable and difficult to monitor for effective sterilization. Home microwaves have been shown to inactivate bacteria, viruses, mycobacteria and some spores. However there may not be even distribution of microwave energy over the entire device. More research and testing is required to validate the use of microwave ovens for sterilization. The use of microwave ovens for sterilization of medical equipment/devices is currently unacceptable.

15 Continued Monitoring and System Failures Recalls

A written procedure must be established for the recall and reprocessing of improperly reprocessed medical equipment/devices. Improper reprocessing includes, but is not limited to, the following situations:

- a) The load contains a positive biological indicator;
- b) An incorrect reprocessing method used on the equipment/device;
- c) Print-outs on reprocessing equipment indicate failure to reach correct parameters (e.g. temperature, pressure, exposure time);
- d) Chemical Indicator or monitoring tape has not changed colour; and
- e) There is doubt about the sterility of medical equipment/devices.

All equipment/devices in each processed load must be recorded to enable tracking in the event of a recall. The recall procedure should include:

- a) Designation of department and staff responsible for executing the recall;
- b) Identification of the medical equipment/devices to be recalled; if recall is due to a failed BI, the recall shall include the medical devices in the failed load as well as all other devices processed in the sterilizer since the last successfully sterilized load;
- c) Assessment of client/patient risk;
- d) Procedure for subsequent notification of physicians, patients, other facilities and/or regulatory bodies, if indicated; and
- e) Involvement of the facility's risk manager, if applicable.

The healthcare facility shall have a process for receiving and disseminating medical device alerts and recalls originating from manufacturers or government agencies.

16 Single-Use Medical Equipment/Devices

Healthcare settings must have written policies regarding single-use medical equipment and devices. Critical and semi-critical medical equipment/devices labelled as single-use must not be reprocessed and re-used unless the reprocessing is done according to institutional policy.

Healthcare settings that wish to have their single-use medical equipment/devices reprocessed should ensure that facilities and procedures have been certified by a regulatory authority or an accredited quality system auditor to ensure the cleanliness, sterility, safety and functionality of the reprocessed equipment/devices. In order to have critical or semi-critical medical equipment/devices reprocessed by one of these facilities, there must be processes for:

- a) Tracking and labelling equipment/devices;
- b) Recalling improperly reprocessed medical equipment/devices;
- c) Assuring proof of sterility or high-level disinfection;
- d) Testing for pyrogens;
- e) Maintenance of equipment/device functionality and integrity;
- f) Quality assurance and quality control;
- g) Reporting adverse events; and
- h) Provision of good manufacturing procedures.

Whereas reusable medical equipment/devices are sold with instructions for proper cleaning and sterilization, no such instructions exist for single-use medical equipment/devices. Manufacturers often do not provide evidence that the equipment/device can be thoroughly cleaned, and/or withstand heat or chemical sterilization, and/or that delicate mechanical and electrical components can continue to function after one or more reprocessing cycles. In circumstances where the manufacturer does not approve of reuse, the facility will bear the legal responsibility in

establishing the conditions that the reuse of medical equipment/devices are acceptable, with no increased risk to patients and adherence to a reasonable standard of care in the reuse of the equipment/device. This would involve written policies, extensive testing of reprocessing protocols and strict adherence to quality assurance investigations. This is a detailed and expensive process and should only be undertaken if there is a compelling reason to do so.

17 Equipment/Devices with Small Lumens

Reusable equipment/devices with small lumens or other characteristics are difficult to clean effectively and can put patients at risk, as they cannot be cleaned effectively or be adequately checked for cleanliness during reprocessing. This includes items such as catheters, drains and fine cannulae (excluding endoscopy equipment). These items should be designated single-use and should not be reprocessed and re-used, even if designated as reusable by the manufacturer.

18 Prion-Contaminated Medical Instruments and Environment (excluding variant Creutzfeldt-Jakob Disease)

Prions in dried films of tissue are more resistant to inactivation by steam sterilization than prions in tissues that have been kept moist. Instruments should be kept moist (either wet by immersion in water or a detergent with prionocidal activity or, if not possible, by use of a wet cloth draped over the instruments or use of a transport gel or foam) after use and during storage or transport prior to decontamination in central processing departments. Instruments should be decontaminated as soon as possible after use. Decontaminate instruments in a mechanical washer (e.g. washer-disinfector) with a detergent (preferably a detergent that has been shown to have prionocidal activity).

After the device is clean, it should be sterilized by either autoclaving (i.e. steam sterilization) or using a combination of sodium hydroxide and autoclaving, using one of the four options below:

- a) Autoclave at 134°C for 18 minutes in a prevacuum sterilizer.
- b) Autoclave at 132°C for 1 hour in a gravity displacement sterilizer.

- c) Immerse in 1 N NaOH (1 N NaOH is a solution of 40 g NaOH in 1 L water) for 1 hour; remove and rinse in water, then transfer to an open pan and autoclave (121°C gravity displacement sterilizer or 134°C porous or pre-vacuum sterilizer) for 1 hour.
- d) Immerse in 1 N NaOH for 1 hour and heat in a gravity displacement sterilizer at 121°C for 30 minutes, then clean and subject to routine sterilization.

IUSS should not be used for reprocessing instruments. Devices that are impossible to clean are to be discarded. Items that permit only low-temperature sterilization (e.g. sterilization with ethylene oxide) are to be discarded. There is no current evidence for the use of low-temperature technologies that have shown prionocidal activity, such as a specific type of hydrogen peroxide gas plasma and vaporized hydrogen peroxide.

Contaminated items (e.g. medical devices used for brain biopsy) that have not been processed according to these recommendations are to be recalled and appropriately reprocessed. To minimize patient exposure to Creutzfeldt-Jakob Disease (CJD), neurosurgical instruments should be sterilised as prion contaminated for patients undergoing diagnostic brain biopsy. Alternatively, disposable neurosurgical instruments may be used.

Non-critical environmental surfaces contaminated with high-risk tissues (e.g. a laboratory surface in contact with CJD-infected samples) should be cleaned with a detergent and then spot decontaminated with a 1:10 dilution of sodium hypochlorite (i.e. bleach; a 1:10 dilution of 5.25%–6.15% sodium hypochlorite provides 5250–6150 ppm chlorine), ideally for a contact time of at least 15 minutes. To minimize environmental contamination, disposable plastic-backed cover sheets on work surfaces should be used.

Non-critical equipment that has been contaminated with high-risk tissue should be cleaned and then disinfected using a 1:10 dilution of sodium hypochlorite or 1N NaOH, depending on material compatibility. All contaminated surfaces should be thoroughly disinfected.

19 Storage and Use of Reprocessed Medical Equipment/Devices

The shelf life of a sterile package is event-related rather than time-related. Event-related shelf life is based on the concept that items that have been properly decontaminated, wrapped, sterilized, stored and handled will remain sterile indefinitely, unless the integrity of the package is compromised (i.e. open, wet, dirty).

19.1 Sterile Storage Areas

The sterile storage area should be located adjacent to the sterilization area, preferably in a separate, enclosed, limited-access area. See Table 7.3 in Appendix 7.1 for recommended design parameters. Requirements for this area include:

- a) Containers used for storage of clean equipment/devices should be moisture-resistant and cleanable (i.e. cardboard boxes must not be used);
- b) Equipment/devices are stored in a clean, dry, dust-free area (closed shelves), not at floor level, and at least one meter away from debris, drains, moisture and vermin to prevent contamination;
- c) Equipment/devices are stored in an area where they are not subject to tampering by unauthorized persons;
- d) Equipment/devices are transported in a manner that avoids contamination or damage to the equipment/device; and
- e) Supplies and materials not used for reprocessing will not be stored in sterile processing areas.

19.2 Maintaining Sterility

Healthcare settings must have procedures for storage and handling of clean and sterile medical equipment/devices that include:

- a) Medical equipment/devices purchased as sterile must be used before the expiration date, if one is given;
- b) Reprocessed medical equipment/devices shall be stored in a clean, dry location in a manner that minimizes contamination or damage;
- c) Sterility must be maintained until used;

- d) Sterile packages that lose their integrity shall be re-sterilized prior to use; and
- e) Equipment/devices must be handled in a manner that prevents recontamination of the item.

19.3 Using Sterile Equipment/Devices

At point-of-use, upon opening the reprocessed medical equipment/device, a check must be made for integrity of the packaging and the equipment/device. Those performing this inspection must be provided with education that includes:

- a) Validating results of chemical tape and internal monitors, if present;
- b) Visually inspecting the equipment/device for discoloration or soil; if present, the item is removed from service and reprocessed;
- c) Checking for defective equipment/devices and removing them from use;
- d) Checking for dampness or wetness (e.g. high humidity); if present, reprocessing may be required;
- e) Reassembly of equipment/device if required.

20 Recommendations

- a) It is strongly recommended that, wherever possible, reprocessing should be performed in a centralized area that complies with the physical and human resource requirements for reprocessing. [BIII]
- b) The chemical disinfectant used for disinfecting medical equipment/devices must be compatible with both the equipment/device manufacturer's instructions for disinfection and the cleaning products involved in the reprocessing of the equipment/device. [BIII]
- c) The healthcare setting must have written policies regarding single-use medical equipment/devices. [AIII]
- d) Critical and semi-critical medical equipment/devices labelled as single-use must not be reprocessed and re-used unless the reprocessing is done by a licensed reprocessor. [AII]
- e) It is strongly recommended that catheters, drains and other medical equipment/devices with small lumens (excluding endoscopy equipment)

be designated single-use and not be reprocessed and re-used, even if designated as reusable by the manufacturer. [All]

- f) Home healthcare agencies may consider re-using single-use semi critical medical equipment/devices for a single client in their home when reuse is safe and the cost of replacing the equipment/device is prohibitive for the client. [All]
- g) After a CJD contaminated device has been cleaned, it should be sterilized by either autoclaving (i.e. steam sterilization) or using a combination of sodium hydroxide and autoclaving, using one of the four options below [B1]:
 - i. Autoclave at 134⁰C for 18 minutes in a prevacuum sterilizer.
 - ii. Autoclave at 132⁰C for 1 hour in a gravity displacement sterilizer.
 - iii. Immerse in 1 N NaOH (1 N NaOH is a solution of 40 g NaOH in 1 L water) for 1 hour; remove and rinse in water, then transfer to an open pan and autoclave (121⁰C gravity displacement sterilizer or 134⁰C porous or prevacuum sterilizer) for 1 hour.
 - iv. Immerse in 1 N NaOH for 1 hour and heat in a gravity displacement sterilizer at 121⁰C for 30 minutes, then clean and subject to routine sterilization.
- h) The following methods are not acceptable for achieving disinfection/sterilization: [BIII]
 - i. Boiling
 - ii. Ultraviolet light
 - iii. Glass bead sterilization
 - iv. Microwave ovens
 - v. Chemiclave sterilization
- i) Individuals responsible for reprocessing endoscopes shall be specially trained and shall meet the facility's written endoscope processing competency requirements, including ongoing education and training and annual competency testing (AI)
- j) Each healthcare setting in which endoscopic procedures are performed shall have written, detailed procedures for the cleaning and handling of endoscopes. (All)
- k) Critical endoscopes shall be sterilized prior to use. (AI)

- l) Semi-critical endoscopes require a minimum of high-level disinfection prior to use. (IA)
- m) Adequate ventilation is required to remove toxic vapours generated by, or emitted from, cleaning or disinfecting agents. (AI)
- n) Endoscope cleaning shall commence immediately following completion of the clinical procedure. (AI)
- o) Patency and integrity of the endoscope sheath shall be verified through leak testing, performed after each use. (AI)
- p) Endoscopic equipment/devices shall be rinsed and excess water removed prior to disinfection or sterilization. (All)
- q) Endoscopic accessories (e.g. biopsy forceps and brushes) that enter sterile tissue or the vascular system shall be disposable or sterilized after each use. (AI)
- r) Final drying of semi critical endoscopes shall be facilitated by flushing all channels with filtered air, followed by 70% isopropyl alcohol, followed by forced air purging of the channels. (AI)
- s) Semi critical endoscopes shall be stored in a dedicated, closed, ventilated cabinet outside of the reprocessing area and procedure room. (All)
- t) The water bottle and its connecting tube, used for cleaning the endoscope lens and irrigation during Endoscopic retrograde cholangiopancreatography (ERCP) procedures, shall be cleaned and sterilized following manufacturer's instructions. (AIII)
- u) A preventive maintenance program for automated endoscope reprocessor (AER) shall be implemented and documented. (AIII)
- v) Healthcare settings shall have policies in place providing a permanent record of endoscope use and reprocessing, as well as a system to track endoscopes and clients/patients that includes recording the endoscope number in the client/patient record. (AIII)
- w) Enhancement in methods for reprocessing duodenoscopes should be followed and documented. (All)
- x) Regular surveillance for bacterial contamination of duodenoscopes after reprocessing using a special culture method and test is recommended. (All)

21 Glossary

Action level: concentration of a regulated substance (e.g. ethylene oxide, formaldehyde) within the employee breathing zone

Antiseptic: substance that prevents or arrests the growth or action of microorganisms by inhibiting their activity or by destroying them. The term is used especially for preparations applied topically to living tissue.

Asepsis: prevention of contact with microorganisms.

Autoclave: device that sterilizes instruments or other objects using steam under pressure. The length of time required for sterilization depends on temperature, vacuum, and pressure.

Bactericide: agent that kills bacteria.

Bioburden: number and types of viable microorganisms with which an item is contaminated; also called *bioload* or *microbial load*.

Biofilm: accumulated mass of bacteria and extracellular material that is tightly adhered to a surface and cannot be easily removed.

Biologic indicator: device for monitoring the sterilization process. The device consists of a standardized, viable population of microorganisms (usually bacterial spores) known to be resistant to the sterilization process being monitored. Biologic indicators are intended to demonstrate whether conditions were adequate to achieve sterilization. A negative biologic indicator does not prove that all items in the load are sterile or that they were all exposed to adequate sterilization conditions.

Bleach: Household bleach (5.25% or 6.00%–6.15% sodium hypochlorite depending on manufacturer) usually diluted in water at 1:10 or 1:100. Approximate dilutions are 1.5 cups of bleach in a gallon of water for a 1:10 dilution (~6,000 ppm) and 0.25 cup of bleach in a gallon of water for a 1:100 dilution (~600 ppm).

Bleach Solution	Dilution	Chlorine (ppm)
5.25 - 6.15%	None	52,500 - 61,500
	1:10	5,250 - 6,150
	1:100	525 - 615
	1:1000	53 - 62

Bowie-Dick test: diagnostic test of a sterilizer's ability to remove air from the chamber of a prevacuum steam sterilizer. The air-removal or Bowie-Dick test is not a test for sterilization.

Ceiling limit: concentration of an airborne chemical contaminant that should not be exceeded during any part of the workday. If instantaneous monitoring is not feasible, the ceiling must be assessed as a 15-minute time-weighted average exposure.

Central processing or Central service department: the department within a healthcare facility that processes, issues, and controls professional supplies and equipment, both sterile and non-sterile, for some or all patient-care areas of the facility.

Challenge test pack: pack used in installation, qualification, and ongoing quality assurance testing of healthcare facility sterilizers.

Chemical indicator: device for monitoring a sterilization process. The device is designed to respond with a characteristic chemical or physical change to one or more of the physical conditions within the sterilizing chamber. Chemical indicators are intended to detect potential sterilization failures that could result from incorrect packaging, incorrect loading of the sterilizer, or malfunctions of the sterilizer. The "pass" response of a chemical indicator does not prove the item accompanied by the indicator is necessarily sterile. The Association for the Advancement of Medical Instrumentation has defined 6 types and categories of chemical indicators.

Contact time: time a disinfectant is in direct contact with the surface or item to be disinfected. For surface disinfection, this period is framed by the application to the surface until complete drying has occurred.

Container system, rigid container: sterilization containment device designed to hold medical devices for sterilization, storage, transportation, and aseptic presentation of contents.

Contaminated: state of having actual or potential contact with microorganisms. As used in healthcare, the term generally refers to the presence of microorganisms that could produce disease or infection.

Cleaning: removal, usually with detergent and water or enzyme cleaner and water, of adherent visible soil, blood, protein substances, microorganisms and other debris from the surfaces, crevices, serrations, joints, and lumens of instruments, devices, and equipment by a manual or mechanical process that prepares the items for safe handling and/or further decontamination.

Decontamination: “the use of physical or chemical means to remove, inactivate, or destroy blood-borne pathogens on a surface or item to the point where they are no longer capable of transmitting infectious particles and the surface or item is rendered safe for handling, use, or disposal” In healthcare facilities, the term generally refers to all pathogenic organisms.

Decontamination area: area of a healthcare facility designated for collection, retention, and cleaning of soiled and/or contaminated items.

Detergent: cleaning agent that makes no antimicrobial claims on the label. They comprise a hydrophilic component and a lipo-philic component and can be divided into four types: anionic, cationic, amphoteric, and non-ionic detergents.

Disinfectant: usually a chemical agent (but sometimes a physical agent) that destroys disease-causing pathogens or other harmful microorganisms but might not kill bacterial spores. It refers to substances applied to inanimate objects.

Disinfection: thermal or chemical destruction of pathogenic and other types of microorganisms. Disinfection is less lethal than sterilization because it destroys most recognized pathogenic microorganisms but not necessarily all microbial forms (e.g. bacterial spores).

D value: time or radiation dose required to inactivate 90% of a population of the test microorganism under stated exposure conditions.

Endoscope: an instrument that allows examination and treatment of the interior of the body canals and hollow organs.

Enzyme cleaner: a solution used before disinfecting instruments to improve removal of organic material (e.g. proteases to assist in removing protein).

Exposure time: period in a sterilization process during which items are exposed to the sterilant at the specified sterilization parameters. For example, in a steam sterilization process, exposure time is the period

during which items are exposed to saturated steam at the specified temperature.

Immediate use steam sterilization (IUSS): process designed for the steam sterilization of unwrapped patient-care items for immediate use (or placed in a specially designed, covered, rigid container to allow for rapid penetration of steam).

Fungicide: agent that destroys fungi (including yeasts) and/or fungal spores pathogenic to humans or other animals in the inanimate environment.

Germicide: agent that destroys microorganisms, especially pathogenic organisms.

High-level disinfectant: agent capable of killing bacterial spores when used in sufficient concentration under suitable conditions. It therefore is expected to kill all other microorganisms.

Hospital disinfectant: disinfectant registered for use in hospitals, clinics, dental offices, and any other medical-related facility.

Implantable device: “device that is placed into a surgically or naturally formed cavity of the human body if it is intended to remain there for a period of 30 days or more”

Intermediate-level disinfectant: agent that destroys all vegetative bacteria, including tubercle bacilli, lipid and some nonlipid viruses, and fungi, but not bacterial spores.

Limited disinfectant: disinfectant registered for use against a specific major group of organisms (gram-negative or gram-positive bacteria). Efficacy has been demonstrated in laboratory tests against either *Salmonella choleraesuis* or *Staphylococcus aureus* bacteria.

Low-level disinfectant: agent that destroys all vegetative bacteria (except tubercle bacilli), lipid viruses, some nonlipid viruses, and some fungi, but not bacterial spores.

Mechanical indicator: devices that monitor the sterilization process (e.g. graphs, gauges, printouts).

Medical device: instrument, apparatus, material, or other article, whether used alone or in combination, including software necessary for its application, intended by the manufacturer to be used for human beings for diagnosis, prevention, monitoring treatment, or alleviation of disease.

Microorganisms: animals or plants of microscopic size. As used in healthcare, generally refers to bacteria, fungi, viruses, and bacterial spores.

Minimum effective concentration (MEC): the minimum concentration of a liquid chemical germicide needed to achieve the claimed microbicidal activity as determined by dose-response testing. Sometimes used interchangeably with *minimum recommended concentration*.

Mycobacteria: bacteria with a thick, waxy coat that makes them more resistant to chemical germicides than other types of vegetative bacteria.

One-step disinfection process: simultaneous cleaning and disinfection of a noncritical surface or item.

Pasteurization: process developed by Louis Pasteur of heating milk, wine, or other liquids to 65–77°C (or the equivalent) for approximately 30 minutes to kill or markedly reduce the number of pathogenic and spoilage organisms other than bacterial spores.

Parametric release: declaration that a product is sterile on the basis of physical and/or chemical process data rather than on sample testing or biologic indicator results.

Permissible exposure limit (PEL): time-weighted average maximum concentration of an air contaminant to which a HCP can be exposed, according to OSHA standards. Usually calculated over 8 hours, with exposure considered over a 40-hour work week.

Personal protective equipment (PPE): specialized clothing or equipment worn by an employee for protection against a hazard. General work clothes (e.g. uniforms, pants, shirts) not intended to function as protection against a hazard are not considered to be PPE.

Parts per million (ppm): common measurement for concentrations by volume of trace contaminant gases in the air (or chemicals in a liquid); 1 volume of contaminated gas per 1 million volumes of contaminated air equal 1 ppm.

Prions: transmissible pathogenic agents that cause a variety of neurodegenerative diseases of humans and animals, including sheep and goats, bovine spongiform encephalopathy in cattle, and Creutzfeldt-Jakob Disease (CJD) in humans. They are unlike any other infectious pathogens because they are composed of an abnormal conformational

isoform of a normal cellular protein, the prion protein (PrP). Prions are extremely resistant to inactivation by sterilization processes and disinfecting agents.

Process challenge device (PCD): item designed to simulate product to be sterilized and to constitute a defined challenge to the sterilization process and used to assess the effective performance of the process. A PCD is a challenge test pack or test tray that contains a biologic indicator, a Class 5 integrating indicator, or an enzyme-only indicator.

Recommended exposure limit (REL): occupational exposure limit recommended by NIOSH as being protective of HCP health and safety over a working lifetime. It is frequently expressed as a 40-hour time-weighted-average exposure for up to 10 hours per day during a 40-work week.

Reprocess: method to ensure proper disinfection or sterilization; can include: cleaning, inspection, wrapping, sterilizing, and storing.

Shelf life: length of time an undiluted or use dilution of a product can remain active and effective. Also refers to the length of time a sterilized product (e.g. sterile instrument set) is expected to remain sterile.

Spaulding classification: strategy for reprocessing contaminated medical devices. The system classifies a medical device as critical, semi-critical, or non-critical on the basis of risk to patient safety from contamination on a device. The system also established three levels of germicidal activity (sterilization, high-level disinfection, and low-level disinfection) for strategies with the three classes of medical devices (critical, semi-critical, and non-critical).

Spore: relatively water-poor round or elliptical resting cell consisting of condensed cytoplasm and nucleus surrounded by an impervious cell wall or coat. Spores are relatively resistant to disinfectant and sterilant activity and drying conditions (specifically in the genera *Bacillus* and *Clostridium*).

Spore strip: paper strip impregnated with a known population of spores that meets the definition of biological indicators.

Steam quality: steam characteristic reflecting the dryness fraction (weight of dry steam in a mixture of dry saturated steam and entrained water) and

the level of noncondensable gas (air or other gas that will not condense under the conditions of temperature and pressure used during the sterilization process). The dryness fraction (i.e. the proportion of completely dry steam in the steam being considered) should not fall below 97%.

Steam sterilization: sterilization process that uses saturated steam under pressure for a specified exposure time and at a specified temperature, as the sterilizing agent.

Steam sterilization, dynamic air removal type: one of two types of sterilization cycles in which air is removed from the chamber and the load by a series of pressure and vacuum excursions (prevacuum cycle) or by a series of steam flushes and pressure pulses above atmospheric pressure (steam-flush-pressure-pulse cycle).

Sterile or **Sterility:** state of being free from all living microorganisms. In practice, usually described as a probability function, e.g. as the probability of a microorganism surviving sterilization being one in one million.

Sterility assurance level (SAL): probability of a viable microorganism being present on a product unit after sterilization. Usually expressed as 10^{-6} ; a SAL of 10^{-6} means $\leq 1/1$ million chance that a single viable microorganism is present on a sterilized item. A SAL of 10^{-6} generally is accepted as appropriate for items intended to contact compromised tissue (i.e. tissue that has lost the integrity of the natural body barriers). The sterilizer manufacturer is responsible for ensuring the sterilizer can achieve the desired SAL. The user is responsible for monitoring the performance of the sterilizer to ensure it is operating in conformance to the manufacturer's recommendations.

Sterilization: validated process used to render a product free of all forms of viable microorganisms. In a sterilization process, the presence of microorganisms on any individual item can be expressed in terms of probability. Although this probability can be reduced to a very low number, it can never be reduced to zero.

Sterilization area: area of a healthcare facility designed to house sterilization equipment, such as steam ethylene oxide, hydrogen peroxide gas plasma, or ozone sterilizers.

Sterilizer: apparatus used to sterilize medical devices, equipment, or supplies by direct exposure to the sterilizing agent.

Sterilizer, gravity-displacement type: type of steam sterilizer in which incoming steam displaces residual air through a port or drain in or near the bottom (usually) of the sterilizer chamber. Typical operating temperatures are 121–123°C and 132–135°C.

Sterilizer, prevacuum type: type of steam sterilizer that depends on one or more pressure and vacuum excursions at the beginning of the cycle to remove air. This method of operation results in shorter cycle times for wrapped items because of the rapid removal of air from the chamber and the load by the vacuum system and because of the usually higher operating temperature (132–135°C; 141–144°C). This type of sterilizer generally provides for shorter exposure time and accelerated drying of fabric loads by pulling a further vacuum at the end of the sterilizing cycle.

Sterilizer, steam-flush pressure-pulse type: type of sterilizer in which a repeated sequence consisting of a steam flush and a pressure pulse removes air from the sterilizing chamber and processed materials using steam at above atmospheric pressure (no vacuum is required). Like a prevacuum sterilizer, a steam-flush pressure-pulse sterilizer rapidly removes air from the sterilizing chamber and wrapped items; however, the system is not susceptible to air leaks because air is removed with the sterilizing chamber pressure at above atmospheric pressure. Typical operating temperatures are 121–123°C, 132–135°C, and 141–144°C).

Table top steam sterilizer: a compact gravity-displacement steam sterilizer that has a chamber volume of not more than 0.06 cubic meter and that generates its own steam when distilled or deionized water is added.

Vegetative bacteria: bacteria that are devoid of spores and usually can be readily inactivated by many types of germicides.

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Appendix 7.1. Recommended Design Parameters and Contact Time for High-Level Disinfection and Sterilisation

Table 7.3. Design parameters (ANSI/ASHRAE/ASHE standard 170-2008)

Location	Pressure relations hip to adjacent areas	Minimum outdoor ACH	Minimu m total ACH	All room air exhausted directly to outdoors	Air recirculated by means of room units	Relative humidity (%)	Temper ature (°C)
Decontaminati on room	Negative	2	6	Yes	No	No requirement	22-26
Clean workroom	Positive	2	4	No requirement	No	No requirement	22-26
Sterile storage	Positive	2	4	No requirement	No requirement	Maximum 60	22-26
Sterilizer equipment room	Negative	No requirement	10	Yes	No	No requirement	No requireme nt

Table 7.4 High-level chemical disinfectants or sterilants

Chemical Disinfectant or Sterilant	High level disinfection claim	Sterilization claim
Hydrogen peroxide 7.5%	30 mins at 20°C	6 hours at 20°C
Peracetic acid 0.2%	NA	12 mins at 50-56°C
Glutaraldehyde ≥2%	20-90 mins at 20-25°C	10 hours at 20-25°C
Ortho-phthalaldehyde 0.55% (OPA)	5 mins at 20°C, 5 mins at 25°C in AER	None
Hydrogen peroxide / peracetic acid (7.35% / 0.23%)	15 mins at 20°C	3 hours at 20°C

Reference: CDC Guideline for Disinfection and Sterilization in Healthcare Facilities, 2008

Chapter 8. Management of Blood and Body Fluids Exposure

1 Sharps injuries & Blood and Body Fluid

Accidental needle-stick injuries are a common occupational hazard in healthcare. The estimated annual incidences of Needle-stick Injuries (NIs) is 384,000 in the United States, 100,000 in the United Kingdom, 700,000 in Germany, 29,719 in France, 28,200 in Italy, and 21,815 in Spain. The data from the EPINet system suggested that at an average hospital, there will be 30 NIs injuries per 100 beds per year. The reporting rate varies among job categories and disciplines and surgeons had the lowest reporting rate (<30%) in the United States. On the other hand, more than 25% of the exposures occurred in operating rooms and within inpatient units, approximately one-third of exposures occurred in ICUs.

NIs carry a huge impact to healthcare industries in both aspects of safety and economic burden. The United Kingdom reported a rate of 1.43 known hepatitis C virus or human immunodeficiency virus (HIV) transmissions to healthcare professionals per annum. Among susceptible healthcare professionals, in the absence of post-exposure prophylaxis, the risk of Hepatitis B virus (HBV) infection after a NI is 37% to 62% if the source patient is hepatitis B e antigen (HBeAg) positive, and 23% to 37% if the patient is HBeAg negative. The economic burden of NIs varies from country to country; for instance, annual costs are estimated at €7 million in Italy and \$118 million to \$591 million in the United States.

The majority of reported NIs involved hollow-bore needles (55-62%), and recapping was the most common behaviour associated with NI. Overall, more than half of percutaneous injuries involving hollow-bore needles were potentially preventable through safer work practices or technologies. The US General Accounting Office estimates that 29% of NIs that occur in hospitals could be prevented through the adoption of safety-engineered needles or needle-free devices. A report from UK reported that the greatest reduction in NIs was achieved by blunt suture needles and safety cannulae. In conclusion, findings on the incidence and economic burden of NIs indicate the need for safety-engineered needles or needle-free technology, along with increased education regarding safer practices in the work environment.

2 Sharps prevention program

2.1 Develop Organizational Capacity

Each healthcare institution should have staff responsible for the Sharps Prevention Program. It is recommended that the Infection Prevention and Control Team/Department work in close collaboration with the following to achieve the goal of injury reduction or elimination:

- a) Occupational Health and Safety
- b) Staff Clinic
- c) Quality Improvement
- d) Materials Management/Product Evaluation

2.2 Assess Program Operation Processes

2.2.1 Assessing the Culture of Safety

A baseline assessment should include:

- a) Organization leadership's commitment to safety
- b) Strategies used to report injuries and to identify and remove injury hazards
- c) Feedback systems to improve safety awareness
- d) Methods to promote individual accountability for safety.

2.2.2 Assessing Procedures for Sharps Injury Reporting

All healthcare facilities will need to have procedures for sharps injury reporting and documenting employee needle-sticks and other percutaneous injuries. These procedures must be assessed to be adequate for data collection and analysis, and appropriate data sources must be used to assess improvements in injury reporting.

2.2.3 Assessing Methods for the Analysis and Use of Sharps Injury Data

Data on sharps injuries need to be analysed and interpreted so they will be meaningful for prevention planning. This part of the assessment determines how these data are compiled and used in the organization.

2.2.4 Assessing the Process for Identifying, Selecting, and Implementing Engineered Sharps Injury Prevention Devices

This baseline assessment considers who is involved and how decisions are made. As with other program functions, it is important to determine the data sources (e.g. product evaluation committee reports, lists of manufacturers contacted, device lists) that can be used to measure process improvement. A similar process assessment of methods for identifying and implementing other prevention interventions (e.g. changes in work practices, policies, and procedures) also could be included in this baseline assessment.

2.2.5 Assessing Programs for the Education and Training of Healthcare Professionals on Sharps Injury Prevention

All healthcare facilities should have a plan for providing employee education and training on blood-borne pathogen prevention at the time of hire, as well as on an annual basis. The implementation of a sharps injury prevention program is an opportune time to reassess the quality of these efforts and to identify other education and training opportunities. As with other processes, it is necessary to identify the data (e.g. staff development reports, curriculum changes, and training) that can be used to assess improvements in educating and training healthcare professional.

2.3 Prepare a Baseline Profile of Sharps Injuries and Prevention Activities

The next step is to develop a baseline profile of injury risks in the institution. This information, along with the information gathered from the baseline assessment, will be used to develop an action plan for better prevention of sharps injuries. The following questions may be asked in the profiling:

- a) What occupational groups most frequently sustain sharps injuries?
- b) Where do sharps injuries most frequently occur?
- c) What devices are most commonly involved in sharps injuries?
- d) What circumstances or procedures contribute to sharps injuries?
- e) What sharps injuries pose an increased risk for blood-borne virus transmission?
- f) Has the organization taken steps to limit the unnecessary use of needles

by healthcare professional? If so, how has this been done?

- g) What devices with engineered sharps injury prevention features have been implemented?
- h) Is there a list of recommended work practices to prevent sharps injuries?
- i) What communication tools have been used to promote safe sharps handling techniques?
- j) Is there a policy/procedure for determining the appropriate location of sharps containers?
- k) Who is responsible for removing/replacing sharps containers?

2.4 Determine Intervention Priorities

Baseline information on sharps injuries, along with the weaknesses identified in the assessment of program operation processes should be used to determine priority areas. The following approaches can be used alone or in combination to create a list of initial priorities for intervention:

- a) Determine priorities based on injuries that pose the greatest risk for blood borne virus transmission (e.g. focus initially on preventing injuries associated with vascular access)
- b) Determine priorities based on the frequency of injury with a particular device (e.g. focus on injuries associated with hypodermic or suture needles)
- c) Determine priorities based on a specific problem contributing to a high frequency of injuries (e.g. focus on sharps handling and/or disposal)

In general, priority is given to those areas that will have the greatest impact on improving the overall operation of the program.

2.5 Develop and Implement Action Plans

Two action plans are recommended:

- a) Establish an action plan for reducing injuries
 - i. Set targets for injury reduction
 - ii. Specify which interventions will be used
 - iii. Identify indicators of performance improvement
 - iv. Establish time lines and define responsibility

- b) Establish an action plan for performance improvement
 - i. List priorities for improvement, as identified in the baseline assessment
 - ii. Specify which interventions will be used
 - iii. Identify performance improvement measures
 - iv. Establish time lines and define responsibilities

2.6 Monitor Program Performance

It is recommended that this be monitored regularly. The following steps may be used:

- a) Develop a checklist of activities
- b) Create and monitor a time line for implementation
- c) Schedule periodic reviews for assessing performance improvements

3 Selection of sharps injury prevention devices

This step gives healthcare facilities a systematic way to determine and document which devices will best meet their needs. In general, the selected devices must be acceptable for clinical care and provide optimal protection against injuries.

Organize a product selection and product evaluation team. The team should comprise the following members:

- a) Users from relevant clinical departments with insight into products used by their staff members and can identify departmental representatives to help with product selection and evaluation
- b) Infection prevention and control staff, who can help identify potential infection risks or protective effects associated with particular devices;
- c) Materials management staff (purchasing agents) who have information about vendors and manufacturers (e.g. reliability, service record, in-service support) and can be involved with product purchasing;
- d) Central service staff who know what devices are used in different settings in a facility and can identify supply and distribution issues; and
- e) Industrial hygiene staff (if available) who can assess ergonomic and environmental use issues.

4 Post-exposure management and prophylaxis for HIV, HBV & HCV

Hepatitis B virus (HBV), hepatitis C virus (HCV) and the human immunodeficiency virus (HIV) constitute well-recognized occupational risks for healthcare professional (HCPs). Avoiding occupational blood exposure by the adherence to principles of standard precautions through the use of appropriate work practices and personal protective equipment is a cornerstone for preventing transmission of these blood-borne pathogens (BBP) in the healthcare setting.

Occupational exposure is serious and every effort should be taken to prevent its occurrence. However, accidents may still happen and if so, risk assessment and counselling constitutes the basis of post exposure management. Appropriate post exposure prophylaxis (PEP) should be provided using a case-by-case evaluation approach.

4.1 What are occupational injuries?

Occupational injuries may be divided into:

- a) Percutaneous exposure (from needles, instruments, bone fragments, human bite which penetrates the skin layer, etc.);
- b) Exposure via broken skin (exposed skin that is chapped, abraded, or afflicted with dermatitis etc.) with blood, tissue, or other body fluids that are potentially infectious; and
- c) Exposure via mucous membranes including the eye.

Transmission of HIV through human bites are reported rarely, but not after an occupational exposure. Human bites, however, are associated with a significant risk for bacterial infection, including *Eikenella corrodens*, *Streptococcus anginosus* and *Staphylococcus aureus*, among many others. Tetanus immunization or booster should be considered after a bite exposure.

4.2 Exposures for which PEP is indicated:

- a) Break in the skin by a sharp object (including hollow-bore, solid-bore, and cutting needles or broken glassware) that is contaminated with blood, visibly bloody fluid, or other potentially infectious material, or sharp objects had been in the source patient's blood vessel.
- b) Bite from a patient with visible bleeding (in the mouth) and which causes bleeding in the exposed HCPs.
- c) Splash of blood, visibly bloody fluid, or other potentially infectious material to a mucosal surface (mouth, nose, or eyes).

4.3 First Aid

- a) Following any exposure, the wound should be washed immediately and thoroughly with soap and water. Alcohol, hydrogen peroxide, Betadine or other chemical cleansers are best avoided. Wound should not be squeezed or sucked.
- b) For mucosal contact e.g. spillage into the conjunctivae, the exposed area should be immediately flushed with plenty of clean running water.
- c) The exposed HCP should then seek immediate medical advice for proper wound care and post-exposure management.
- d) The following information should be recorded in the exposed HCP's confidential medical record:
 - i. details about the source patient (e.g. name, NRIC No, diagnosis and any relevant information)
 - ii. date, time and place of the exposure
 - iii. details of the procedure being performed
 - iv. use of protective equipment at the time of the exposure
 - v. the type, severity, and amount of fluid to which the HCP was exposed
- e) The healthcare professional should be tested for HIV antibody, HCV, HBV antigen and antibody
- f) The source patient's blood (if available) should be tested for HIV, HCV & HBV.

4.4 Reporting

All institutions should have a mechanism in place for reporting and managing of sharp injuries and mucosal exposure in the occupational setting. HCPs must know the reporting process to facilitate quick and smooth flow so as to allow the attending physician to evaluate the risk of exposure and provide prompt appropriate post-exposure treatment. In addition, a surveillance system of exposure events should be available to avoid similar incidents from occurring in the future.

4.5 Evaluation of Risk for Occupational Exposure

The risk of transmission of HBV and HCV from an occupational exposure is significantly greater than the risk of HIV transmission.

Table 8.1. Risk of transmission

Source	Risk
HBV	
HBeAg+	22.0% - 30.0%
HBeAg-	1.0% - 6.0%
HCV+	1.8%
HIV+	0.3%

Table 8.2. Risk in relation to exposure

Type of Exposure (Others)	Risk
Biting	Negligible
Spitting	Negligible
Throwing body fluids (including semen or saliva)	Negligible

After percutaneous exposures, factors that might increase the risk of HIV transmission are:

- a) Source patient was suffering from early or late stages of HIV infection with high viral load.
- b) Visible blood on a device.
- c) Procedure involved placement in a vein or artery.
- d) Injuries were deep.

- e) Injury was with a hollow-bore needle.

4.6 Counselling

Until the risk of infection is ruled out, advice should be given to the exposed staff to refrain from donating blood, plasma, organs, tissue or semen. The use of condom during sexual intercourse should also be advised. A place for psycho-social support is clearly indicated.

5 Management of Post Exposure to HIV

When an occupational exposure to HIV source patient occurs, it should be considered as an urgent medical concern. PEP should be initiated as soon as possible, ideally within 24 hours of the exposure.

A first dose of PEP should be offered to the exposed HCP while the evaluation is underway i.e. the determination of HIV status of the source patient. Initiating PEP should be the first priority and should not be delayed to await expert consultation.

PEP regimens* should include 3 (or more) antiretroviral drugs given for a period of 4 weeks.

Table 8.3. Post-Exposure Prophylaxis (PEP) Against HIV Infection for HCP Exposed to Blood and /or Body Fluids

Exposure	Source patient HIV (+)	Source Patient Unknown	Considerations
Mucous membrane or skin, integrity compromised			
Mucous membrane or skin, integrity compromised	Low titre Source patient asymptomatic and high CD4 counts – may not need PEP, discuss with HCP	No treatment	Skin integrity is compromised if there is evidence of chapped skin, dermatitis, abrasion or open wound
Small (few drops or short duration)	High titre Source patient has advanced AIDS, primary HIV infection, high or increasing viral load or low CD4 count – consider prophylaxis with PEP Regimen		

Large (several drops, major blood splash and/or longer duration i.e. more than several minutes)	Low titre Source patient asymptomatic and high CD4 count – recommend prophylaxis with PEP regimen	If there is a possible risk for HIV exposure, consider prophylaxis with PEP regimen	
	High titre Source patient has advanced AIDS, primary HIV infection, high or increasing viral load or low CD4 count – recommend prophylaxis with PEP regimen		
Intact skin			
Intact skin	PEP not needed unless there is high exposure to blood e.g. extensive area of skin exposed or prolonged contact with blood	No treatment	
Percutaneous exposure			
Percutaneous exposure	Low titre Source patient asymptomatic and high CD4 count – recommend prophylaxis with PEP regimen	If there is a possible risk for HIV exposure, consider prophylaxis with PEP regimen	Combination of factors e.g. large bore hollow needle and deep puncture contribute to an increased risk for transmission if source patient is HIV positive
Less severe e.g. solid needle, superficial scratch	High titre Source patient has advanced AIDS, primary HIV infection, high or increasing viral load or low CD4 count – recommend prophylaxis with PEP regimen		
More severe e.g. large-bore hollow needle, deep puncture, visible blood on device, or needle used in source patient's artery or vein	Low or high titre Recommend prophylaxis with PEP regimen		

5.1 Regimen for HIV PEP Following Occupational Exposure

When there is a significant risk exposure which requires PEP, the following three-drug regimen is recommended as a preferred initial PEP regimen:

- a) Raltegravir (Isentress; RAL) 400 mg PO twice daily
Plus
- b) Truvada (Tenofovir DF [Viread; TDF] 300 mg + Emtricitabine [Emtriva; FTIC] 200 mg) 1 PO once daily

Alternatives can be considered where there is a potential for HIV resistance, toxicity risks, clinician preference, or constraints on the availability of particular agents OR when the initial or subsequent PEP regimen is not well tolerated (see Table 8.4).

Table 8.4. Alternative Regimens for HIV Post-Exposure prophylaxis (Source: US Public Health Service Guideline Infection Control and Hospital Epidemiology 2013; 34(9): 875-92)

May combine 1 drug from left column with 1 pair of nucleoside/nucleotide reverse transcriptase inhibitors from right column	
Raltegravir (Isentress; RAL)	Tenofovir DF (Viread; TDF) + emtricitabine (Emtriva; FTC); available as Truvada
Darunavir (Prezista; DRV) + ritonavir (Norvir; RTV)	Tenofovir DF (Viread; TDF) + lamivudine (Epivir; 3TC)
Etravirine (Intelence; ETR)	Zidovudine (Retrovir; ZDV; AZT) + lamivudine (Epivir; 3TC); available as Combivir
Rilpivirine (Edurant; RPV)	Zidovudine (Retrovir; ZDV; AZT) + emtricitabine (Emtriva; FTC)
Atazanavir (Reyataz; ATV) + ritonavir (Norvir; RTV)	
Lopinavir/ritonavir (Kaletra; LPV/RTV)	
The following alternative is a complete fixed-dose combination regimen, and no additional antiretrovirals are needed: Stribild (elvitegravir, cobicistat, tenofovir DF, emtricitabine)	

5.1.1 Duration of PEP Regimen

When the source patient is confirmed to be HIV-negative, clinicians should discontinue the PEP regimen even before its completion.

5.1.2 Follow-up appointments

- a) Follow-up appointments should begin within 72 hours of HIV exposure and should include follow-up HIV testing, monitoring for drug toxicity, and counseling
- b) HIV testing at baseline and at 6 weeks, 12 weeks, and 6 months after exposure.
- c) HIV testing should generally continue for 6 months after exposure.
- d) The follow-up period for exposed HCP can be shortened to 4 months (from 6) if the clinician is certain that a 4th generation combination HIV p24 antigen/antibody test is used.

5.1.3 Expert Consultation

There are several scenarios where expert consultation is recommended:

- a) Source patient is known to harbour drug-resistant HIV
- b) Pregnant or breast-feeding exposed HCP
- c) Severe illness in exposed HCP
- d) Delayed > 72 hours report of exposure
- e) Severe needle stick injury from unknown source

6 Management of accidental exposure to Hepatitis B Virus (HBV)

The management of an incident of accidental exposure to HBV involves proper risk assessment, counselling and post exposure prophylaxis that is tailored to the needs/status of individual healthcare professional (refer to Table 8.5)

6.1 Recommendation for PEP for HBV exposures:

- Both the source patient's HBsAg status and the exposed HCP's vaccination status should be considered.
- Both HBIG (if required) and the first dose of the hepatitis B vaccine should be ideally administered within 24 hours of exposure.
- Even if the risk of exposure to HBV is not deemed significant, HBV vaccination should still be advised for all non-HBV-immune exposed HCPs.
- The three-dose HBV vaccine series is given at 0, 1 to 2 months, and 6 months.

Table 8.5. Post-Exposure Prophylaxis (PEP) Against Hepatitis B for HCP Exposed to Blood and/or Body Fluids

Immune Status of HCP	Source Patient HBsAg (+)	Source Patient HBsAg (-)	Source Not Tested Or Unknown
Unvaccinated			
Unvaccinated	One dose HBIG and start one series of HB vaccination	Start HB vaccine series	Start HB vaccine series
Previously vaccinated			
Known responder (anti-HBs \geq 10 mIU/ml)	No treatment	No treatment	
Known non-responder	One dose HBIG and start one series of HB vaccine	No treatment	If known high risk source, treat as if source were HBsAg (+)
Antibody response unknown	Check anti-HBs: If \geq 10 mIU/ml, no treatment* If $<$ 10 mIU/ml, one dose HBIG and vaccine booster	No treatment	Check anti-HBs: If \geq 10 mIU/ml, no treatment If $<$ 10 mIU/ml, one dose HBIG and vaccine booster

HBIG - Hepatitis B immunoglobulin
 HB - Hepatitis B
 HBsAg - Anti-hepatitis B surface antigen

7 Hepatitis C Virus Post-Exposure Management

Currently, prophylaxis of HCV is neither available nor recommended although early identification of infection following exposure is recommended to be accompanied by referral to an infectious disease doctor or a specialist experienced in treating HCV.

HCP should be tested for HCV antibody and liver enzyme levels (alanine aminotransferase or ALT) as soon as possible after the exposure (baseline) and at 3-6 months after the exposure.

Table 8.6. Hepatitis C Post-Exposure Management According to Baseline Test Results

Clinical Scenario	Follow-Up
Source patient is HCV-antibody negative	No further testing or follow-up is necessary for source patient or the exposed HCP
Source patient is unavailable or refuses testing	Exposed HCP: Follow-up HCV antibody and at 3 and 6 months
Source patient is HCV-antibody positive and HCV RNA negative	Manage the exposed HCP as if the source patient has chronic hepatitis C
Source patient is positive for both HCV antibody and HCV RNA and Exposed HCP is HCV-antibody negative	Exposed HCP to be referred to specialist experienced in treating HCV infection

7.1 Post-Exposure Follow-Up for HCV

For individuals exposed to hepatitis C-infected source patients, regular follow-up with HCV RNA polymerase chain reaction (PCR) testing is recommended in addition to PCR for HCV antibody testing.

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Chapter 9. Environmental Cleaning

1 Infection Prevention and Control and the Environment

Healthcare-associated infections (HAIs) are infections that occur as a result of healthcare interventions in any healthcare setting where care is delivered. Factors that increase the risk to patients/residents for the development of HAIs include:

- a) Advanced age
- b) Greater acuity
- c) Increasing numbers of immunocompromised clients/patients
- d) Complex treatments
- e) Increasing antimicrobial use in hospitals and institutional healthcare settings, creating a large reservoir of resistant microbial strains
- f) Infrastructure repairs and renovations to aging hospitals and long-term care homes creating the risk of airborne fungal diseases caused by dust and spores released during demolition and construction.

In addition, overcrowding, understaffing and pressures to move more patients through the healthcare system can challenge completion of environmental cleaning.

1.1 Evidence for Cleaning

The potential for contaminated environmental surfaces to contribute to transmission of pathogens depends on the following factors:

- a) Ability of pathogens to remain viable for prolonged periods of time on variety of dry environmental surfaces
- b) Ability of pathogens to remain virulent after environmental exposure
- c) Frequency which the contaminate surfaces is touched by patients and healthcare professionals
- d) Whether or not levels of contamination are sufficiently high to result in transmission to patients
- e) Relative pathogen resistance to disinfectants used on environmental surfaces (*C. difficile*, Norovirus)

Pathogens such as methicillin-resistant *Staphylococcus aureus* (MRSA), Vancomycin-resistant enterococci (VRE) and *C. difficile* have the ability to remain viable on dry surfaces for days, weeks or even months.

The environment of the healthcare setting has been shown to be a reservoir for infectious agents such as bacteria (e.g. MRSA, VRE, *C. difficile*, *Acinetobacter baumannii*, *Bacillus* spp.), viruses (e.g. influenza, Norovirus, Rotavirus) and fungi (e.g. *Aspergillus* spp., *Fusarium* spp., *Penicillium* spp.).

Environmental contamination may contribute to transmission when healthcare professionals contaminate their hands or gloves by touching contaminated surfaces, or when patients come into direct contact with contaminated surfaces. Scientific evidence suggests that environmental contamination plays an important role in the spread of MRSA and VRE, e.g. admitting a new patient to a room previously occupied by a MRSA- or VRE-positive patient significantly increases the risk of acquisition for MRSA or VRE. Outbreaks have been brought under control with infection prevention and control measures that include enhanced cleaning.

Healthcare facilities may be categorized into two components for the purposes of environmental cleaning:

- a) '*Hotel component*' is the area of the facility that is not involved in patient care; this includes public areas such as lobbies and waiting rooms, offices, corridors, elevators, stairwells and service areas. Areas designated in the hotel component are cleaned with a '*Hotel Clean*' regimen.
- b) '*Hospital component*' is the area of the facility that is involved in client/patient care; this includes client/patient units (including nursing stations), procedure rooms, bathrooms, clinic rooms, and diagnostic and treatment areas. Areas designated in the hospital component are cleaned with a '*Hospital Clean*' regimen.

1.2 The Patient Environment and High-touch Surfaces in Healthcare Settings

Housekeeping surfaces can be divided into two groups – those with minimal hand-contact (e.g. floors, and ceilings) and those with frequent hand-contact (“high touch surfaces”). Carling’s work has helped define 14 high touch surfaces / points that

would require cleaning on a more frequent schedule than “minimal touch housekeeping services”. These are:

1.2.1 Patient Area

- a) Tray table
- b) Bedside table
- c) Side rail
- d) Call box
- e) Telephone
- f) Chair
- g) Room door knobs

1.2.2 Toilet Area

- a) Sink
- b) Toilet seat
- c) Toilet handle
- d) Toilet door knobs
- e) Toilet hand hold
- f) Bathroom light switch
- g) Bedpan cleaner

Surfaces closer to the patient/resident pose a greater risk for transmission than those situated further away. Furthermore, frequently touched surfaces are more likely to harbour and transmit microbial pathogens. It would therefore, be cost-effective to concentrate cleaning resources on high risk, high touch surfaces.

1.3 Recommendation

- a) Focus cleaning resources on high risk high touch surfaces as frequently touched surfaces are more likely to harbour and transmit microbial pathogens.
[BII]

2 Selection of Finishes and Surfaces in the Healthcare Setting in Areas Where Care is delivered

Housekeeping surfaces require regular cleaning and removal of soil and dust. Healthcare facilities should have policies that include the criteria to be used when choosing furnishings and equipment for patient care areas. In general, the following factors are to be considered in these criteria:

- a) Choosing finishes, furnishings and equipment that are easily cleaned
- b) Ensuring compatibility of the healthcare setting's cleaning and disinfecting agents with the items and surfaces to be cleaned ^{1,2}

It is highly recommended that Infection Prevention and Control, Occupational Health and Safety and Housekeeping Services work collectively in decision making with respect to choices of furniture and finishing for facilities.

Attention is to be paid to the following when choosing finishes and surfaces:

- a) Easy maintenance and repair e.g. sharp corners on floors are to be avoided, instead, rounded corners are recommended for easy cleaning and maintenance
- b) Fabrics used in upholstered furniture in patient care areas must be fluid-resistant, non-porous and able to withstand cleaning with hospital-grade disinfectants
- c) Choose materials that are less likely to support microbial growth e.g. plastic and metal. Wet organic substrates (e.g. wood) should be avoided in hospital areas with immunocompromised patients
- d) Cloth items such as curtains, pillows, mattresses and soft furnishings should:
 - i. Be seamless where possible or have double-stitched seams;
 - ii. Be easily accessed for cleaning;
 - iii. Have removable covers for cleaning;
 - iv. Have foam cores that are resistant to mould;
 - v. Not be damaged by detergents and disinfectants;
 - vi. Be quick-drying; and
 - vii. Be maintained in good repair.

- e) Carpets are not recommended in areas where there is the likelihood of spills of contaminated liquids or alcohol-based hand rub. These include wards (particularly around sinks), and laboratory areas. Such liquids pose a flammability risk. Carpets should especially not be used in patient care areas housing immunocompromised patients (e.g. burn units, intensive care units, operating rooms, transplant and oncology units) given the risk of infection from dust and particulates containing environmental microorganisms including fungi.
- f) Plastic coverings, including mattress covers and pillow covers, should be cleaned with hospital approved cleaning agents on a regular basis and inspected for damage. Mattresses and pillow covers should be replaced when torn, cracked or have evidence of liquid penetration or are visibly stained.

2.1 Hospital Equipment

Infection Prevention and Control should be consulted when purchasing new equipment. Factors to note include computer keyboards/pads and screen monitors that can be easily cleaned and disinfected. Plastic skins may be effective to cover computer keyboards, allowing ease of cleaning but such plastic skins must be compatible with the healthcare facilities's cleaning and disinfecting products.

2.2 Recommendation

It is highly recommended that Infection Prevention and Control, Occupational Health and Safety and Environmental Services work collectively in decision making with respect to choices of furniture and finishing for facilities.[BIII]

3 Cleaning Agents and Disinfectants

Infection prevention and control aspects in housekeeping practices are important factors contributing to a safe and healthy environment. Although hand hygiene is important to minimize the impact of transmission of infections, cleaning and disinfecting of environmental surfaces is fundamental in reducing their potential contribution to the incidence of healthcare-associated infections

(HAIs). “Routine cleaning is necessary to maintain a standard of cleanliness and the process must be effective and consistent”.

3.1 Detergents and Cleaning Agents

“Detergents” or “soaps” are cleaning agents that make no antimicrobial claims. Their cleaning activity can be attributed to their detergent properties, which result in removal of dirt, soil and various organic substances.

3.2 Disinfectants

The choice of disinfectant, its concentration, and exposure time are based on the risks for infection associated with use of the equipment and other factors discussed in this guideline. Since organic material will inactivate many disinfectants, it must be removed from surfaces before applying the disinfectants. Refer to Table 9.1 which illustrated a list of properties of an ideal disinfectant.

Table 9.1. Properties of an ideal disinfectant

Broad spectrum	Should be active against many antimicrobial types
Fast acting	Should produce a rapid kill
Not affected by environmental factors	Should be active in the presence of organic matter (e.g. blood, sputum, faeces) and compatible with soaps, detergents, and other chemicals
Nontoxic	Should not be harmful to the user or patient
Surface compatibility	Should not corrode instruments and metallic surfaces and Should not cause the deterioration of cloth, rubber, plastics, and other materials
Residual effect on treated surfaces	Should leave an antimicrobial film on the treated surface Easy to use with clear label directions
Odorless	Should have a pleasant odor or no odor to facilitate its routine use
Economical	Should not be prohibitively high in cost
Solubility	Should be soluble in water
Stability	Should be stable in concentrate and use-dilution
Cleaner	Should have good cleaning properties

Environmentally friendly	Should not damage the environment on disposal
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Adopted from CDC, 2008.

There are many commonly-used surface disinfectants listed in Table 9.2 which include alcohols, quaternary ammonium compounds (QATs), phenolics, chlorine compounds as well as two new approaches (refer to Table 9.3) to room decontamination; ultraviolet irradiation and hydrogen peroxide (HP) systems.

Table 9.2. Types of Chemical Disinfectants

Disinfectants	Recommended Use	Precautions
Alcohol e.g. Isopropyl, Ethyl alcohol, methylated spirit.	<ul style="list-style-type: none"> • Rapidly bactericidal, tuberculocidal, fungicidal, and virucidal but do not destroy bacterial spores. • Smooth metal surfaces, table tops and other surfaces on which bleach cannot be used. • Effectively to disinfect non-critical items such as oral and rectal thermometers, hospital mobiles, BP cuffs and stethoscopes etc. 	<ul style="list-style-type: none"> • Flammable, toxic, to be used in cool and well-ventilated area, avoid inhalation. • To be kept away from heat sources. Electrical equipment, flames, hot surfaces.
Quaternary Ammonium Compounds e.g. Alkyl dimethyl benzyl ammonium chloride, Alkyl dimethyl ethylbenzyl ammonium chloride	<ul style="list-style-type: none"> • Commonly used in general environmental cleaning of noncritical surfaces, such as floors, furniture, and walls. 	<ul style="list-style-type: none"> • Relatively non-toxic and less corrosive • Dilutions in use may get contaminated and grow gram negative bacteria
Phenolics e.g. Benzyl-4-chlorophenol, Amylphenol, Phenylphenol	<ul style="list-style-type: none"> • Effective and good for general use on vegetative bacteria, lipid containing viruses and <i>Mycobacterium tuberculosis</i>. • Have limited or no efficacy for use against spores or non-lipid viruses. • Use on environmental surfaces (e.g. locker, bedrails) and on noncritical medical devices. 	<ul style="list-style-type: none"> • Phenolics should not be used to clean infant bassinets and incubators as hyperbilirubinemia in infants were reported. • If phenolics are used for terminal cleaning of infant bassinets and incubators, the surfaces should be rinsed thoroughly with water and dried before reuse of infant bassinets and incubators.
Sodium hypochlorite [e.g. Sodium dichloroisocyanurate (NaDCC)]	<ul style="list-style-type: none"> • Kills fast and has broad spectrum actions against a wide range of gram-negative and gram-positive bacteria and spores. 	<ul style="list-style-type: none"> • PPE are required while handling and using undiluted • Corrosiveness to metals • Flammable, toxic, to be used in cool and well-ventilated area, avoid inhalation.

Table 9.3. New technologies in room decontamination

Type	Advantages	Disadvantages
<p>Ultraviolet (UV) light</p> <ul style="list-style-type: none"> • Uses UV to decontaminate surfaces by reflecting UV from walls, ceilings, floors and calculates the operation total dosing/ time to deliver the programmed lethal dose for pathogens. • Reduces colony count of pathogens by >99.9% within 20 minutes. 	<ul style="list-style-type: none"> • Reliable biocidal action against a wide range of pathogens • Room decontamination is rapid for vegetative bacteria (~15 mins) • Does not require to seal off the room • UV is residual free • Low operating cost as no consumable products 	<ul style="list-style-type: none"> • Can only be done for terminal cleaning • All patients and staff must be evacuate from room • Does not remove dust and stains • Sensitive use parameters (e.g. UV dose delivered)
<p>Hydrogen peroxide (HP) System – Vapors/ mist.</p> <ul style="list-style-type: none"> • Using of dry mist technology • Offer uniform diffusion of HP solution even in hard-to reach and hidden areas. 	<ul style="list-style-type: none"> • Reliable biocidal activity against wide range of pathogens • Residual free • Does not give rise to both health and safety concerns 	<ul style="list-style-type: none"> • Only can be carried out for terminal cleaning • All personnel must be evacuated from room • Decontamination process takes approximately 2-5 hours • Substantial capital costs

In summary, the selection of an ideal disinfectant usually depends on its effectiveness in destroying a specific organism. Studies have also shown that the human factor, frequency and duration of cleaning respectively also played a vital role in the entire cleaning process.

3.3 Recommendations

- Routine cleaning is necessary to maintain a standard of cleanliness.[BII]
- The selection of an ideal disinfectant will greatly depend on its effectiveness in getting rid of a specific organism.[AI]
- All chemicals should be properly labeled and stored to eliminate any potential risk of contamination and injuries.[BIII]

4 Cleaning Best Practices for Patient Care Areas

4.1 General Principle

The primary purpose of ensuring best practices is to protect the patient/resident, staff and visitors in the healthcare facility by minimizing the possible spread of infections in the facility.

4.1.1 Resources for Environmental Cleaning

There should be adequate resources to help achieve the prime objective of optimal cleanliness in the facility. These include:

- a) an assigned individual, who has appropriate certification e.g. Certificate of Competency (Healthcare), to be responsible for overall housekeeping of facility
- b) written policies and procedures for cleaning and disinfection of patient/resident areas and equipment that include:
 - i. Defined responsibility for specific items and areas;
 - ii. Clearly defined lines of accountability;
 - iii. Procedures for daily and terminal cleaning and disinfection;
 - iv. Procedures for cleaning in construction/renovation areas;
 - v. Procedures for specific environmentally-hardy microorganisms such as *C. difficile*;
 - vi. Procedures for outbreak management; and
 - vii. Cleaning and disinfection standards and frequency;
- e) Adequate manpower to allow thorough and timely cleaning and disinfection;
- f) Provision for additional environmental cleaning capacity during outbreaks that does not compromise other routine patient care area cleaning;
- g) Education and continuing education of cleaning staff;
- h) Regular monitoring of environmental cleanliness

4.1.2 Contracted Services

When general housekeeping services are contracted out, the contract must clearly outline the infection control-related responsibilities. These should include not only the housekeeping procedures, but also the contracting agency's responsibility for employee health and mandatory training. Contract staff must work collaboratively with Infection Prevention and Control, Nursing and Occupational Health & Safety to ensure the safety of patients/residents, staff and visitors.

The following should be included in the legal agreement with the service provider:

- a) The Occupational Health and Safety policies of the contracting services must be consistent with the facility's Occupational Health and Safety policies as they relate to infection prevention and control, including immunization (including annual influenza vaccination); transparent sharing of information related to work place exposure incidents; access to staff health policies and measures related to Additional Precautions, outbreak investigation and problem-solving.
- b) Recognition that ever-changing activity levels and cleaning protocols will potentially impact on the cost of service; contracts should support (without penalty or financial barrier) a proactive and cooperative environment to consistently implement appropriate cleaning measures; and
- c) There should be clear expectations regarding the levels of cleaning frequency and standards.

4.1.3 Staffing Levels

An adequately staffed Housekeeping Department is one of the most important factors that govern the success of environmental cleaning in a healthcare setting. Staffing levels must be appropriate to each department of the healthcare facility, with the ability to increase staffing in the event of outbreaks.

General staffing levels may be calculated by adding the average time taken for a cleaner to complete individual tasks. Average cleaning time is the normal time required for a qualified cleaner, working at a comfortable pace, to complete an operation when following a prescribed method. Education and training are important factors in determining average cleaning time; a new cleaner will not work at the same pace and as efficiently as an experienced cleaner. Written procedures and checklists for cleaning will assist in standardizing cleaning and disinfection times and will ensure that items are not missed during the cleaning.

Supervisory staffing levels must be appropriate to the number of staff involved in cleaning. Supervisory staff have responsibilities to ensure staff training and compliance when using PPE. Supervisors are also responsible for training and

auditing staff on cleaning procedures. Adequate supervisory staffing levels will help ensure that these requirements are being met.

The following factors should be considered when determining appropriate staffing levels for cleaning and supervisory staff in a healthcare setting:

a) **Building Factors**

- i. Age of the facility – older buildings are harder to clean
- ii. Design of the facility – e.g. amount of walking required to complete a task
- iii. Size of the facility
- iv. Room temperature
- v. Exposure of facility to outside dust and soil, e.g. construction site
- vi. Type of floors and walls
- vii. Presence of carpet and upholstered furniture

b) **Occupancy Factors**

- i. Occupancy rate and volume of cases
- ii. Patient mix/type of care in the area (e.g. acute care, long-term care, clinic) vs. no care in the area (e.g. public area)
- iii. Frequency of cleaning required in an area (e.g. once daily vs. after each case)
- iv. Square metres to be cleaned in patient care areas
- v. Square metres to be cleaned in non-patient care areas
- vi. Admissions/discharges by unit/area – more rapid turnover requires a shorter turnaround time for rooms and equipment
- vii. Facility rates of VRE and *C. difficile* associated diarrhoea – additional staff will be required due to extra cleaning and disinfection required for VRE and *C. difficile* as well as the requirement to put on and remove PPE
- viii. Additional Precautions rooms – extra time will be required to put on and remove PPE

c) **Equipment Factors**

- i. Type of cleaning tools/equipment available (e.g. automated floor cleaner vs. mop and bucket)

- ii. Method of cleaning (i.e. equipment, chemicals, materials and physical ergonomics) and placement of custodial closets
- d) **Training Factors**
 - i. Amount and level of training given to new staff will influence supervisory staffing levels
 - ii. Auditing activities will influence supervisory staffing levels
 - iii. Staff experience (inexperienced staff will work slower than experienced staff)
- e) **Legislative Requirements**
 - i. Amount of regulatory responsibility a supervisor may have

4.2 Frequency of Routine Cleaning

The frequency of cleaning and disinfecting individual items or surfaces in a particular area or department depends on:

- a) Whether surfaces are high-touch or low-touch,
- b) The type of activity taking place in the area and the risk of infection associated with it (e.g. critical care areas vs. meeting room),
- c) The vulnerability of clients/patients housed in the area,
- d) The probability of contamination based on the amount of body fluid contaminating surfaces in the area.

Using these criteria, each area or department in a healthcare setting may be evaluated and assigned a risk score for cleaning purposes, as illustrated in Table 9.4. Each score will relate to a particular level of routine cleaning frequency. If the activity or vulnerability of clients/patients in an area changes, the risk score will change as well, impacting on the cleaning frequency.

4.2.1 Frequency of Contact with Surfaces

All surfaces in a healthcare setting have the potential to harbour pathogenic microorganisms. The potential for exposure to pathogens is based on the frequency of contact with a contaminated surface and the type of activity involved. For example, a conference room table would have less potential for exposure to pathogens than the doorknob in a patient/room. High-touch surfaces will require a more frequent cleaning regimen.

Most, if not all, environmental surfaces will be adequately cleaned with soap and water or a detergent/disinfectant, depending on the nature of the surface and the type and degree of contamination. The process and products used for cleaning and disinfection of surfaces and medical equipment must be compatible with the surfaces/equipment.

The following designations should be used in the Risk Stratification Matrix (Table 9.4) to determine the frequency of cleaning.

a) **High-touch Surfaces**

High-touch surfaces require more frequent cleaning and disinfection than minimal contact surfaces.¹ Cleaning and disinfection is usually done at least daily and more frequently if the risk of environmental contamination is higher (e.g. intensive care units).

b) **Low-touch Surfaces**

Low-touch surfaces are those that have minimal contact with hands. Examples include floors, walls, ceilings, mirrors and window sills. Low-touch surfaces require cleaning on a regular (but not necessarily daily) basis, when soiling or spills occur, and when a patient/resident is discharged from the healthcare setting. Many low-touch surfaces may be cleaned on a periodic basis rather than a daily basis if they are also cleaned when visibly soiled.

4.2.2 Vulnerability of the Patient/Resident Population

Different populations of patients/residents have differing vulnerabilities based on their susceptibility to infection. In some populations, such as bone marrow transplant or burn patients, susceptibility to infection is very high and may be impacted by their environment. The frequency of cleaning may be higher in areas with vulnerable client/patient populations.

The following designations should be used in the Risk Stratification Matrix to determine the frequency of cleaning (Table 9.4):

a) **More Susceptible**

These are patients/residents who are more susceptible to infection due to their medical condition or lack of immunity. These include those who are immunocompromised (e.g. oncology patients; those in transplant and chemotherapy units; neonates; those who have severe burns, i.e. requiring care in a burns unit and those undergoing invasive or operative procedures (e.g. haemodialysis).

b) **Less Susceptible**

For the purpose of risk stratification for cleaning, all other individuals are classified as less susceptible.

4.2.3 Probability of Contamination of Items and Surfaces in the Healthcare Environment

The probability that a surface, piece of equipment or care area will be contaminated is based on the activity in the area, the type of pathogens involved and the microbial load. Areas that are heavily soiled with blood or other body fluids will require more frequent cleaning and disinfection than areas that are minimally soiled or not soiled. (E.g. lounges, offices).

The following designations should be used in the Risk Stratification Matrix to determine the frequency of cleaning (Table 9.5).

a) **Heavy Contamination**

An area is considered to be heavily contaminated if surfaces and/or equipment are exposed to copious amounts of blood or other body fluids (e.g. birthing suite, autopsy suite, cardiac catheterization laboratory, burns unit, haemodialysis unit, Emergency Department, bathroom if the patient/resident has diarrhoea or is incontinent).

b) **Moderate Contamination**

An area is considered to be moderately contaminated if surfaces and/or equipment are contaminated with blood or other body fluids as part of routine activity (e.g. client/patient room, bathroom if client/patient is incontinent) and contaminated substances are contained or removed (e.g. wet sheets). All patient/resident rooms and bathrooms should be considered to be, at a minimum, moderately contaminated.

c) **Light Contamination**

An area is considered to be lightly contaminated or not contaminated if surfaces are not exposed to blood, other body fluids or items that have come into contact with blood or body fluids (e.g. lounges, libraries, offices).

4.2.4 Factors that will impact on environmental cleaning

a) Probability of contamination with pathogens

i. Heavy Contamination (score = 3)

An area is designated as being heavily contaminated if surfaces and/or equipment are routinely exposed to copious amounts of fresh blood or other body fluids (e.g. birthing suite, autopsy suite, cardiac catheterization laboratory, haemodialysis station, Emergency room, patient/resident bathroom if visibly soiled).

ii. Moderate Contamination (score = 2)

An area is designated as being moderately contaminated if surfaces and/or equipment does not routinely (but may) become contaminated with blood or other body fluids and the contaminated substances are contained or removed (e.g. wet sheets). All patient/resident rooms and bathrooms should be considered to be, at a minimum, moderately contaminated.

iii. Light Contamination (score = 1)

An area is designated as being lightly contaminated if surfaces are not exposed to blood, other body fluids or items that have come into contact with blood or body fluids (e.g. lounges, libraries, offices)

b) Vulnerability of population to infection

i. More Susceptible (score = 1)

Susceptible clients/patients are those who are most susceptible to infection due to their medical condition or lack of immunity. These include those who are immunocompromised (oncology, transplant and chemotherapy units), neonates (level 2 and 3 nurseries) and those who have severe burns (i.e. requiring care in a burn unit).

ii. Less Susceptible (score = 0)

For the purpose of risk stratification for cleaning, all other individuals and areas are classified as less susceptible.

c) **Potential for exposure**

i. High-touch surfaces (score = 3)

High-touch surfaces are those that have frequent contact with hands. Examples include doorknobs, telephones, call bells, bedrails, light switches, wall areas around the toilet and edges of privacy curtains.

ii. Low-touch surfaces (score = 1)

Low-touch surfaces are those that have minimal contact with hands. Examples include walls, ceilings, mirrors and window sills.

Table 9.4. Frequency of cleaning based on risk stratification matrix

Total risk score	Risk type	Minimum cleaning frequency
7	High	Clean after each case/event/procedure and at least twice per day Clean additionally as required
4-6	Moderate	Clean at least once daily Clean additionally as required (e.g. gross soiling)
2-3	Low	Clean according to a fixed schedule Clean additionally as required (e.g. gross soiling)

Table 9.5. Example of frequency of cleaning risk stratification matrix in a facility

Location	Probability of contamination	Potential for Exposure	Population	Total Score	Interpretation
	Light (1) Moderate (2) Heavy (3)	High touch (3) Low touch (1)	Less susceptible (0) More susceptible (1)		
Autopsy/mortuary	3	3	0	6	Clean at least once daily. Clean additionally as required (e.g. gross soiling)
Cardiac catheterization and angiography area	2	3	1	6	Clean after each case/event/procedure and at least twice daily. Clean additionally as required (e.g. gross soiling)
Emergency room - trauma room	2	3	1	6	Clean after each case/event/procedure and at least twice daily. Clean additionally as required (e.g. gross soiling)
ICU	2	3	1	6	Clean after each case/event/procedure and at least twice daily. Clean additionally as required (e.g. gross soiling)
Laboratory	3	3	0	6	Clean at least once daily. Clean additionally as required (e.g. gross soiling)
Patient/resident room	2	3	1	6	Clean at least once daily. Clean additionally as required (e.g. gross soiling)
Physiotherapy	1	3	0	4	Clean at least once daily. Clean additionally as required (eg. gross soiling)
Public areas: corridors, elevators, stairwells, lobbies	1	1	0	2	Clean according to a fixed schedule. Clean additionally as required (e.g. gross soiling)

4.3 Equipment

Non-critical medical equipment that is within the patient/resident's environment and shared by patients/residents (e.g. imaging equipment, electronic monitoring

equipment, commode chairs) requires cleaning and disinfection after each use. Selection of new equipment must include consideration for effective cleaning and disinfection needs. The healthcare setting should have written policies and procedures for the appropriate cleaning and disinfection of equipment that clearly define the frequency and level of cleaning and which assigns responsibility for cleaning. A system should be in place to clearly identify equipment which has been cleaned and disinfected.

4.4 Recommendations

- a) Adequate resources must be devoted to Housekeeping Services in all healthcare settings to ensure:
 - i. Single individuals with assigned responsibilities;
 - ii. Written procedures for cleaning and disinfection of care areas and equipment that include:
 - Defined responsibility for specific items and areas;
 - Clearly defined lines of accountability;
 - Procedures for daily and terminal cleaning and disinfection;
 - Procedures for cleaning in construction/renovation areas;
 - Procedures for specific environmentally-hard microorganisms such as *C. difficile*;
 - Procedures for outbreak management; and
 - Cleaning and disinfection standards and frequency;
 - iii. Adequate human resources to allow thorough and timely cleaning and disinfection;
 - iv. Education and continuing education of cleaning staff;
 - v. Monitoring of environmental cleanliness; and
 - vi. Ongoing review of procedures. [BII]
- b) If housekeeping services are contracted out, the Occupational Health and Safety policies of the contracting services must be consistent with the facility's Occupational Health and Safety policies. [BII]
- c) Housekeeping Services staffing levels should reflect the physical nature and the acuity of the facility; levels of supervisory staff should be appropriate to the number of staff involved in cleaning. [BIII]

- d) Cleaning schedules should be developed, with frequency of cleaning reflecting whether surfaces are high-touch or low-touch, the type of activity taking place in the area and the infection risk associated with it; the vulnerability of the client/patients/residents housed in the area; and the probability of contamination. [BIII]
- e) Non-critical medical equipment requires cleaning and disinfection after each use. [AII]
- f) Each healthcare setting should have written policies and procedures for the appropriate cleaning of non-critical medical equipment that clearly defines the frequency and level of cleaning and which assigns responsibility for the cleaning. [BIII]

5 Routine Cleaning and Disinfection Methods

Routine cleaning and disinfection are necessary to maintain a standard of cleanliness, reduce microbial contamination and control or minimize the spread of infectious agents from infected patients to other patients or hospital professional. The criteria to determine the frequency of cleaning and disinfecting individual items or surfaces in a particular area or department via the use the Risk Stratification Matrix had been addressed in Chapter 4. This chapter addresses the cleaning and disinfection practices for high-touch items and surfaces that are more prone to contamination in direct patient care areas.

5.1 General Principles

5.1.1 Personal Safety / PPE

Every cleaning staff must be trained on personal protection/safety and comply with the instruction. Failure to comply with instructions will increase the risk for the cleaning staff and causing an accident which harms themselves or others. The cleaning staff have a responsibility to co-operate with the employer by working safely and efficiently. Hand hygiene is to be observed at all times and the PPE to be worn must comply with the institution's policy.

5.1.2 Cleaning Equipment, Material and Chemical

The cleaning staff shall check the availability of the necessary cleaning equipment, material and chemical before commencing cleaning.

5.1.3 Cleaning Chemical Contact Time

The cleaning staff shall allow adequate contact time, as per the manufacturer's recommendation, after the application of the cleaning chemical onto the surfaces.

5.1.4 Cleaning Sequence

The cleaning is performed from the least contaminated to the most contaminated item and the cleaning of Isolation rooms is performed after completion of cleaning all the non-Isolation rooms.

5.2 Routine Cleaning and Disinfection Methods

Table 9.6. Frequency of routine cleaning

S/N	CLEANING METHOD	HIGH-TOUCH	LOW-TOUCH	MINIMUM CLEANING FREQUENCY
1.	Routine Cleaning	Bed Bed Rails Control Panel Call Bell Cardiac Table Bedside Locker Chair Switches Telephone		At least once daily
2.	Routine Cleaning (On Contact Precautions)	Bed Bed Rails Control Panel Call Bell Cardiac Table Bedside Locker Chair Switches Telephone Main Door Knob Tap Head		At least once daily
3.	Discharged Cleaning	Bed Bed Rails Control Panel Call Bell Cardiac Table	Bed Frame Mattress Wall	Upon discharge

		Bedside Locker		
		Chair		
		Switches		
		Telephone		
4.	Discharged Bed Cleaning (On Contact Precautions)	Bed Rails	Bed Frame	Upon discharge bed
		Control Panel	Mattress	
		Call Bell	Wall	
		Cardiac Table	Ceiling	
		Bedside Locker		
		Chair		
		Switches		
		Telephone		
		Tap Head		
5.	Toilet cleaning	Switches		At least once daily
		Main Door Knob		
		Tap Head		
		Grab Bar		
		Cubicle Door Knob		
		Flushing Button		
		Toilet Seat Cover		

5.3 Recommendations

- a) Every cleaning staff must be trained on personal protection/safety and comply with instructions. [BII]
- b) The cleaning staff shall allow adequate cleaning chemical contact time, as per the manufacturer's recommendation, after the application of the cleaning chemical onto the surfaces. [All]
- c) The cleaning is performed from the least contaminated to the most contaminated item and the cleaning of isolation rooms is performed after completion of cleaning all the non-isolation rooms.[BII]
- d) High-touch and low-touch surfaces and the cleaning frequency for direct patient care areas should be identified. [All]

6 Cleaning Food Preparation Area

Food Preparation areas should be kept clean at all times. Institutions should implement systems on frequency of cleaning and periodically conduct audits to ensure a clean environment during food preparation.

6.1 Cleanliness of appliances, Crockery, Utensils and Receptacles

- a) All crockery, utensils, receptacles and food-contact surfaces used in the preparation, serving, display, or storage of food must be thoroughly clean without any stains or food residue. These should be replaced periodically.
- b) All appliances used must be kept in good working condition. Staff should periodically look for and replace any appliances, crockery, utensil or receptacle which is chipped, broken, cracked or damaged.
- c) Knives, meat mincers and cutting boards should be cleaned regularly after each use and wooden chopping boards must be free of loose fragments, with a more thorough cleaning performed after cutting any raw meat, fish or poultry products to prevent cross-contamination.
- d) All appliances, crockery, utensils and receptacles should be stored in a dry clean area where the food-contact surfaces are protected from dust and other potential sources of contamination.
- e) All appliances, crockery, utensils and receptacles (including ice makers and ice storage receptacles) should be located away from exposed or unprotected sewage lines, leaking water pipes, or open stairwells that may lead to potential contamination.
- f) Keep ice-making machines clean at all times. Ice storage compartments must be emptied and cleaned once a week. Remove all ice and clean all surfaces with soap or detergent solution. During cleaning inspect the gaskets, door tacks and guides.
- g) Pest control services must be engaged to check on all food preparation areas for public health and hygiene purposes.

6.2 Disposal of refuse and food waste

Any area designated for the disposal of refuse and food waste should be properly designed such that they are rat-proof, sheltered from weather elements and easy to clean with proper drainage fittings. All food waste should be discarded in sealed containers.

6.3 Renovation, Construction and Containment

All institutions should ensure adherence with their Infection prevention and Control Policy for any renovation or construction within the premises. Education programs for facilities and construction workers, healthcare professional caring for high-risk patients and staff responsible for controlling indoor air quality heightens awareness that minimizing dust and moisture intrusion from construction sites into patient care areas helps to maintain a safe environment. Housekeepers should perform final cleaning upon completion of construction for newly constructed or renovated areas before allowing patients to enter the areas.

6.4 Recommendations

- a) Institutions should implement systems on frequency of cleaning and periodically conducts audits to ensure a clean environment during food preparation. [All]
- b) All food waste should be discarded in a sealed container. [BIII]
- c) All institutions should follow the individual hospital Infection prevention and Control Policy for precautions relating to any renovation or construction within the premises. [All]

7 Assessment of Cleanliness and Quality Control

Housekeeping is responsible to ensure that the quality of cleaning maintained in the healthcare setting meets appropriate infection prevention and control best practices. The responsibility for ensuring that the standardized cleaning practices are adhered to lies not just with the staff performing the task but also with the direct supervisor and management of the department or agency providing the cleaning service. It is important to incorporate elements of quality improvement into an enhanced cleaning program, including monitoring, audits and feedback to staff and management.

The role of an enhanced cleaning program should be carefully considered for hospitals. There are several benefits of an enhanced compared to a conventional program (outlined in Table 9.7).

Table 9.7. A comparison of the elements of conventional environment hygiene monitoring with enhanced programs

Conventional Program	Enhanced Program
<ul style="list-style-type: none"> • Subjective Visual Assessment • Deficiency approach • Episode evaluation • Problem detection feedback • Open definition of correctable solutions 	<ul style="list-style-type: none"> • Objective quantitative assessment • Performance oriented • Ongoing cycle monitoring • Objective performance feedback • Goal focused structured process improvement model

Monitoring should be an ongoing activity built into the routine cleaning regimen. Periodical monitoring should take place immediately after cleaning to ensure that the cleaning has been carried out to an appropriate and agreed standard. Data from monitoring should be retained and used in trend analysis and compared with benchmark values that have been obtained during the validation of the cleaning program.

Checklists and audit tools will assist supervisory staff in monitoring and documenting cleaning and disinfection. Result feedback to Housekeeping staff has been shown to increase motivation and engagement with resulting improvements in cleaning scores.

Auditing the cleanliness of the healthcare setting periodically and whenever changes to methodologies are made is essential to ensure that achievable standards are maintained and consistent over time.

Audits should:

- a) Be measurable;
- b) Highlight areas of good performance;
- c) Facilitate positive feedback;
- d) Identify areas for improvement; and
- e) Provide a measurement that may be used as a quality indicator.

Measures of cleanliness, as applied to each item in the healthcare setting, ensure a consistent, uniform interpretation of what is considered to be clean. Measures of cleanliness are used for:

- a) Training new Housekeeping staff;
- b) Feedback for Housekeeping staff;
- c) Conducting cleaning audits; and
- d) Ensuring that cleaning expectations are clear and achievable for all staff.

There are several methods of evaluation available to determine if effective cleaning has been implemented, including observation of the environment following cleaning and other newer technologies:

- a) Direct and indirect observation (e.g. visual assessment, observation of performance, patient/resident satisfaction surveys);
- b) Residual bio burden (e.g. environmental culture, adenosine triphosphate – ATP bioluminescence); and
- c) Environmental marking tools (e.g. fluorescent marking).

The advantages and limitations of various monitoring approaches and tools must also be considered. As summarized in Table 9.8 and described below, there are several systems that may be potentially useful for enhanced programmatic monitoring.

Table 9.8. Summary of 5 different methods used in evaluating environmental hygiene

Method	Ease of Use	Identifies Pathogens	Useful for Individual Teaching	Directly Evaluates Cleaning
Covert Observation	Low	No	Yes	Yes
Swab Cultures	High	Yes	Not studied	Potentially
Agar Plate cultures	Good	Limited	Not studied	Potentially
Fluorescent gel	High	No	Yes	Yes
ATP system	High	No	Yes	Potentially

7.1 Direct and Indirect Observation

Observation of the cleaned environment and of the individuals doing the cleaning may be accomplished directly with the use of checklists and other monitoring tools completed by supervisory or other trained staff; or indirectly, as feedback from

clients/patients based on their ‘perceptions’ of cleanliness. Both of these methodologies have been standardized but quantification of results is difficult.

7.1.1 Visual Assessment

Commonly accepted measures of cleanliness rely on visual assessment following cleaning as an indicator of cleanliness. This however has been shown to be an unreliable indicator to assess actual microbial contamination.

A visually clean surface may not be microbiologically or chemically clean. Visibly clean surfaces are free from obvious visual soil; chemically clean surfaces are free from organic or inorganic residues.

Visual assessment must be quantified in order to make it usable for auditing purposes. Malik *et al* provides an example of a scoring system used for visual assessment (see Table 9.9).

Table 9.9. Example of a Scoring System for Visual Assessment

Quantification of Visual Assessment Techniques	Example – 25 items inspected:
Record a site as clean if the dust, debris and soil are absent	Clean = 20 items
Record a site as clean if the dust, debris and soil are present	Dirty = 5 items
Calculate the cleaning rate as a percentage	Cleaning Rate = 80% of items

The pass rate for visually clean surfaces will vary with the type of activity taking place in the area.

7.1.2 Observation of Individual Performance

Visual observation of individuals should be done by trained observers on a routine basis to ensure consistency and reproducibility of observations and evaluations over time. Timely feedback and refresher training should be provided to the observed individual and should become incorporated in the individual’s performance review.

Advantages of visual observation when performed using consistent criteria and feedback to staff include:

- a) ease of implementation and maintenance;
- b) cost-effectiveness;
- c) durability of results;
- d) staff engagement;

Disadvantages of visual observation include:

- a) difficulty in standardizing the methodology;
- b) labour intensive; and
- c) results might be impacted by the Hawthorne effect

Checklists and other audit tools may be used on a regular basis by supervisory staff to assess the level of cleanliness and adherence to the standardized practices.

7.1.3 Patient/Resident Satisfaction Surveys

The results of Patient/Resident Satisfaction Surveys are an indication of the perception of the services and of the environment in which they are serviced. Perceptions are not always indicative of the services that have been provided nor are perceptions always indicative of the state of the environment in which those services are provided.

If surveys are used as an audit tool, the responses to questions must be measurable (e.g. 'yes' for a positive response, 'no' for a negative response); there must be a benchmark/baseline that is used for comparison/assessment (e.g. data from previous surveys); and there should be standardized delivery of the survey (e.g. collect survey data for the same two-week period each year from clients/ patients/ residents on the same unit, then compare percentage of positive responses to those of previous years).

7.2 Measures of Cleanliness: Residual Bioburden

Microbiologically clean surfaces are those with a microbial load that is at an acceptable level (i.e. below the level required for transmission, if known). Assessing the residual bioburden, i.e. the actual bacterial and viral load that remains on an item

or surface following cleaning is not recommended except under specific circumstances.

7.2.1 Environmental Culture

Routine environmental cultures in healthcare settings are neither cost-effective nor generally recommended.

a) **Benchmarking environmental cultures:**

- i. There is no clear evidence on what is the accepted international standards for “microbial clean”¹
- ii. Current evidence proposes that microbial counts should be ≤ 2.5 CFU/cm².¹

b) **Methods of measuring:**

There are two methods for measuring surface contamination:

- i. Aerobic colony count (ACC): monitors total number of bacteria
- ii. Indicator organisms: look at key pathogens e.g. *S. aureus* or MRSA – recommended (but not internationally accepted guidelines) <1cfu/cm²

c) **Methods of culture:** Moistened swab underestimates colony counts compared with press plates/RODAC plates.

The presence of a particular microorganism on an environmental surface does not confirm it as the cause of a patient/resident infection, even if it is the same strain. Decisions to conduct environmental sampling must be made in collaboration with the Microbiology laboratory.

7.2.2 ATP Bioluminescence

Adenosine triphosphate (ATP) is a chemical substance that is present in all living cells, including bacteria and viruses. Detection of this substance would indicate that organic material is still present on an object or surface. ATP detection involves the use of an enzyme and substrate from the firefly which is combined with ATP picked up from the environment on a swab. The resulting bioluminescence or output of light may be measured using a sensitive luminometer. Results are expressed as Relative Light Units (RLU).

ATP bioluminescence is a quantitative method rather than a qualitative method of detection, which reflects the amount of bioburden rather than the type of bioburden present. ATP testing can be used to provide instant feedback on surface cleanliness, demonstrating deficiencies in cleaning protocols and techniques to staff. It may also be used for the evaluation of novel cleaning methods such as steam cleaning and microfibre cloths. Disadvantages include that non-specific elevation of RLU readings occur with residual organic soil, dead bacteria and use of bleach. RLU measurements do not correlate precisely with microbial counts; however, higher microbial counts are associated with higher RLU readings.

Note: Benchmark values of 250 RLU to 500 RLU have been proposed. Additional studies from multiple healthcare settings are needed before an ATP bioluminescence threshold indicating adequate surface cleanliness can be established.

7.3 Measures of Cleaning: Environmental Marking

Environmental marking measures the thoroughness of cleaning using a surrogate marking system. It involves the use of a colourless solution that is applied to objects and surfaces in the client/patient environment prior to cleaning, followed by detection of residual marker (if any) immediately after cleaning, usually involving fluorescence under ultraviolet (UV) light.

Solutions used as markers must be environmentally stable, dry quickly, be easily removed with light cleaning and be invisible in regular room light but be easily visualized using other means. The marker solution is applied to high-touch surfaces in patient/resident rooms prior to cleaning, then evaluated to see if the solution was removed by the cleaning. Environmental marking may be used either on a daily basis to assess routine cleaning, or prior to discharge to assess terminal cleaning.

This methodology may be quantified:

- a) By calculating the percentage of marked objects/surfaces that were cleaned in a particular room or area; or
- b) By deriving a cleaning score (e.g. 3 = heavy fluorescence, 2 = moderate fluorescence, 1 = light fluorescence, 0 = no fluorescence).

7.4 Recommendations

- a) There should be a process in place to measure the quality of cleaning in the healthcare setting. [BII]
- b) Methods of auditing should include both visual assessment and if possible one of the following tools: residual bioburden or environmental marking. [BII]
- c) Results of cleaning audits should be collated and analysed with feedback to staff. [BIII]
- d) An environmental action plan should be developed to identify and correct cleaning deficiencies. [BIII]

8 Laundry and Bedding

8.1 Introduction

Linen may become contaminated by blood, body fluids or excreta and by skin shedding. Hospital linen thus poses an infection risk to staff during handling on the ward, during transport or processing at the laundry.

Linen may also be an infection risk to patients by returning potential pathogens to the immediate patient environment if inadequately laundered or allowed to become recontaminated.

Although pathogenicity from linen is thought generally to be low, nosocomial outbreaks related to linen and laundering have been reported for *Streptococcus pyogenes*, *Salmonella enterica*, methicillin-resistant *Staphylococcus aureus*, vancomycin-resistant Enterococci, *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, *Bacillus cereus*, mucormycosis, gastrointestinal viruses, hepatitis A and scabies.

Safe handling practices are required to prevent unnecessary exposure to infection from soiled or infectious linen. Washing practices must be sufficient to remove potential pathogens from linen including enveloped viruses and vegetative bacteria. Under specific circumstances, it may be required to ensure spore forming

organisms are also removed from linen. Laundry cleaning and hygiene practices must prevent microbial recontamination of washed linen.

8.2 Linen handling

8.2.1 General:

- a) Care must be taken to ensure all sharps or patient equipment is removed from linen. Injury from sharps hidden in linen is a significant risk for environmental services staff and laundry staff.
- b) Staff should wear gloves and apron during linen handling. Any skin lesions on hands must be covered. Masks are not required. Hand hygiene must be practiced after linen handling.
- c) To minimize aerosolisation of any organisms contaminating linen, linen should not be rinsed, shaken or sorted in the clinical area.
- d) Do not place used linen on the floor or any other surfaces.
- e) Do not re-handle used linen once bagged.
- f) Do not overfill linen bags.
- g) Beds and mattresses should be wiped down according to hospital infection prevention and control policies.

8.2.2 Used linen

Used linen should be placed in identifiable linen bags at the point of use. Linen bags may be coloured or have other markings which identifies the bag as containing used laundry.

8.2.3 Contaminated linen

Contaminated linen should be placed into specifically identifiable bags at point of use. These bags should be coloured or have markings indicating that they contain potentially infectious linen. Bags should be impervious to fluids to prevent any leakage of infectious material. The bag should be placed into a secondary container for transport.

8.2.4 Heat labile linen

Heat labile linen should be placed into marked linen bags and handled as above.

8.3 Laundry process

8.3.1 Handling at laundry

- a) Linen should be sorted for washing by laundry staff wearing gloves and aprons. Masks are not required but any lesion on hands must be covered. Laundry staff should receive instruction in proper use of personal protective equipment and hand hygiene.
- b) There must be a workflow which includes physical separation of dirty linen from that which has already been cleaned.

8.3.2 Wash protocol

- a) Heat stable:
 - i. Linen should be washed according to minimum requirements as outlined in international guidelines
 - ii. Temperature and time requirements must include time for mixing and penetration into large loads.
 - iii. Temperature must achieve $>65^{\circ}\text{C}$ for at least 10 minutes, minimum cycle time 14 minutes for low loading or 18 minutes for high loading; or preferably 71°C for at least 3 minutes, minimum cycle time 7 minutes for low loading or 11 minutes for high loading.
- b) Contaminated:
 - i. Requirements outlined above will eliminate most infectious agents with the exception of spore forming organisms. If removal of spore forming organisms is necessary, chemical disinfection with sodium hypochlorite to achieve a free chlorine concentration of >180 ppm in the second rinse is recommended.
 - ii. If linen is heavily soiled, a sluice cycle should be used before the disinfectant cycle.
- c) Heat labile:
 - i. Heat labile fabrics should be processed separately using chemical disinfection (e.g. sodium hypochlorite at >150 ppm free chlorine) at low temperature.

- ii. No recommendation is made regarding disinfecting agent for usual laundry requirements.

8.3.3 Drying

Workflow must ensure separation of washed from unwashed linen. Handling of washed linen should prevent re-contamination.

8.3.4 Laundry cleaning and maintenance

- a) Cleaning and disinfecting of all working areas including technical equipment, storage shelves should be performed on a regular basis and records kept.
- b) Temperature gauges should be regularly checked and calibrated. Volumes, concentrations and expiry dates of disinfectants used should be monitored. Daily records should be maintained.
- c) Written quality control system should be introduced and regularly monitored. Control measures should include risk of cross-transmission, temperature, disinfectants (including concentration).
- d) Servicing of equipment should be performed to manufacturers' recommendations
- e) Water should not be allowed to be stored overnight in a continuous batch tunnel washer. If down time of more than three hours occurs, thermal disinfection is recommended prior to use.

8.4 Linen storage and transport

- a) Clean linen should be packaged, stored and transported in such a way as to protect it from contamination. This includes physical separation on different trolleys/areas from unwashed linen (used/contaminated linen) during transport, loading/unloading and storage.
- b) A designated area for clean linen must be provided. This should be designed in such a way as to protect linen from re-contamination.

8.5 Microbial testing of linen

Testing of linen for viable micro-organisms is not recommended routinely. It is preferred to monitor time and temperature parameters of washing. If sampling is

performed, it should be noted that no internationally accepted guidance for safe bacterial count has been made. A 6 log reduction in total colony count after washing and drying has been suggested. Alternatively, bacterial counts of $\leq 1-2$ colony forming unit (CFU)/10 cm² have been proposed to indicate adequate microorganism removal. It should be noted that surface/contact sampling of linen yields lower bacterial counts than immersion method, but is easier to perform and does not damage sampled items.

8.6 Recommendations

- a) Safe handling of linen is required to prevent exposure of environmental services staff and laundry staff to infection risk.[BII]
- b) Knowledge of personal protective equipment, hand hygiene and safe work practices is required. [BII]
- c) The aims of washing hospital linen must also include neutralization or eradication of infectious agents. [BIII]
- d) Care must be taken to prevent recontamination of clean linen prior to re-use. [BIII]

9 Care and Storage of Cleaning supplies and Cleaners' rooms

9.1 Cleaners' Room

These rooms should be provided throughout the facility to maintain a clean and sanitary environment. Ideally there should be at least one room per patient/resident floor dedicated for the cleaner to perform housekeeping duties and should not be used for other purposes. The room should be well ventilated and the size is determined by the number of rooms to be cleaned and amount of equipment stored.

9.2 Care & Storage of cleaning supplies

- a) The size of the room should be appropriate to the amount of materials, equipment, machinery and chemicals stored within the room and utilized in accordance with Occupational Health & Safety guidelines.
- b) Rooms should be well ventilated with suitable lighting. Locks should be fitted to doors.
- c) Rooms should be easily accessible in relation to the area it serves and free from clutter to enable cleaning of work surfaces.

- d) Rooms should be inspected on a regular basis to ensure is maintained in accordance with good hygiene practices.
- e) PPE such as eye protection, gloves and gowns should be available for use. They should be stored in clean cupboards and not open racks where contamination is possible.
- f) Room should have an appropriate water supply and a slop hopper, deep sink and hand wash basin/floor drain.
- g) Room should not contain personal supplies, food or beverages.
- h) Room should have safe chemical storage and access. All chemicals and materials should be stored above the floor on appropriate shelving at accessible height.
- i) Cleaning and disinfection equipment should be well maintained, in good repair and be cleaned and dried between uses.
 - i. Automated dispensing systems are preferred over manual dilution for accurate calibration.
 - ii. Disinfectants should be dispensed into clean, dry, appropriately-sized bottles clearly labeled and dated. No top up is allowed and it should be discarded after the expiry date.
 - iii. Safety Data Sheet (SDS) should be easily available in case of accidents.
 - iv. Mop heads should be laundered daily and dried thoroughly before storage.
 - v. Cleaning carts should have a clear separation between clean and soiled items, should never contain personal items and should be thoroughly cleaned at the end of the day.

9.3 Soiled utility rooms

Each patient/resident care area should be equipped with a room that may be used to clean soiled patient/resident equipment that is not sent for central reprocessing. The soiled utility rooms should be separate from and have no connection with the clean utility/clean supply rooms.

Guiding principles to minimize the risk of infection transmission in clinical areas that generate soiled equipment, soiled linen and waste:

- a) The soiled utility room should provide adequate space for:
 - i. waste receptacles and soiled linen receptacles
 - ii. storing and transporting soiled linen in covered leak proof containers.
 - iii. equipment and products for cleaning and sanitizing bedpans, urinals, and basins.
 - iv. closed cupboards or covered bins for containing clean supplies such as bedpans, urinals, basins, incontinence supplies, and lab supplies such as urine dipsticks, specimen containers.
 - v. If closed cupboards are not available, ensure open shelves are located away from “splash risks” around sinks, and bedpan sanitizers.
 - vi. PPE are available and accessible to protect staff during cleaning and disinfecting procedures.
- b) Hand washing sink with soap and towel dispensers.
- c) No supplies stored on the floor or under sink, it should be stored 15 cm from the floor.
- d) Protect supplies from dust and moisture; no outer warehouse or shipping boxes are allowed.
- e) A work counter and clinical sink with a hot and cold mixing faucet is required. If a soiled utility room is used only for temporary holding of soiled materials, the work counter and clinical sink is not required; however, facilities for cleaning bedpans must be provided elsewhere. Soiled utility rooms/workrooms should not be used to store unused equipment.

Items that can be stored in Soiled Utility Room include:

- a) Cleaning supplies and products readily available for non-housekeeping staff.
- b) Soiled equipment, soiled laundry.
- c) PPE to wear while cleaning items including eye protection, masks, fluid resistant apron, household gloves.
- d) General and biohazardous waste containers.

Items that should not be kept in a Soiled Utility room include:

- a) Skin antiseptics/cleansers.
- b) Personal hygiene supplies (soaps, mouth care products, lotions).
- c) Sterile items such as wound dressings.
- d) Items cleaned after use, e.g. commodes should to be stored elsewhere.
- e) In long-term care homes, cleaning carts shall be equipped with a locked compartment for storage of hazardous substances. Each cart shall be locked at all times when not attended.

9.4 Recommendations

- a) Clean utility room should be separated from soiled utility room. [BIII]
- b) All chemical cleaning agents and disinfectants should be appropriately labelled and stored in a manner that minimize the risk of contamination, inhalation, skin contact or personal injury. [BIII]
- c) Safety Data Sheet (SDS) must be readily available for each item in case of accidents. [BIII]
- d) Automated dispensing system is preferred to ensure integrity of dilution ratios. If a refillable bottle is filled with a disinfectant solution, it should never be topped up with fresh disinfectant. Always use a clean, dry, appropriately-sized bottle, label the product and date it. The product should be discarded when past the expiry date for stability.[BIII]

10 Education

All housekeepers must undergo a documented orientation session. The training should be completed before new staff members are allowed to work without direct supervision.

The orientation program should include cleaning techniques, highlighting on the high touch areas, cleaning agents and infection prevention and control practices e.g.: blood borne pathogens, isolation precautions and standard precautions, N95 particulate respirator and waste disposal. As a minimum, training must be given in the performance of cleaning tasks, the use of cleaning equipment, control of infection, employee health, manual handling, fire, health and safety and site orientation.

All educational programs for housekeepers should be geared to the education level of the housekeepers and their English proficiency. The program is also recommended to be delivered in different languages with the use of visual aids, demonstrations, repetition, and hands-on training. Trainers for the education programs, whether external professionals or supervisory staff, should be appropriately qualified.

All housekeepers are recommended to undergo performance improvement program and competency testing program. Staff should be assessed on their competency after the training to evaluate their level of understanding. The training should be repeated in its entirety every year for the housekeepers or sooner if a competency issue has been identified. All housekeepers are recommended to have written training records that are signed and dated by the trainer and trainee.

10.1 Recommendations

- a) All housekeepers must undergo a documented orientation session.[BIII]
- b) All housekeepers are recommended to have written training records that are signed and dated by the by the trainer and trainee. [BIII]

11 Occupational Health and Safety Issues Related to Environmental Services

Due to fact that cleaning staff are working in healthcare facilities, the risk of exposure to infectious diseases exists. Hence, occupational health and safety issues include staff immunization, appropriate use of Personal Protective Equipment (PPE), staff exposures to blood and body fluids and other infection hazards, and staff safety issues.

11.1 Immunization (Protection) of cleaning staff

Appropriate immunization will include:

- a) annual influenza vaccine
- b) Hepatitis B vaccine as they may be exposed to contaminated sharps during work.

- c) MMR vaccine for non-immune staff
- d) VZV vaccine for non-immune staff

Contracts with supplying agencies should include the above immunizations for contracted staff.

11.2 Personal Protective Equipment (PPE)

PPE shall be provided for all cleaning staff, and replaced when defective.

Cleaning staff should wear PPE:

- a) For protection from microorganisms;
- b) For protection from chemicals used in cleaning; and
- c) To prevent transmission of microorganisms from one patient environment to another.

Training is to be provided in the correct use, application and removal of PPE. PPE to be used to protect non-intact skin or mucous membranes and to prevent contact with blood, body fluids, secretions, excretions, include:

- a) Gloves when there is a risk of hand contact with blood, body fluids, secretions or excretions, or items contaminated with these;
- b) Gown if contamination of uniform or clothing is anticipated; and
- c) Mask and eye protection or face shield where appropriate to protect the mucous membranes of the eyes, nose and mouth during activities involving close contact (i.e. within two metres) with patients likely to generate splashes or sprays of secretions (e.g. coughing, sneezing).

11.3 Staff Exposures

There must be written policies and procedures for the evaluation of staff (employees or contract workers) who are, or may be, exposed to blood or body fluids and other infectious hazards that include:

- a) A sharps injury prevention program;
- b) Timely post-exposure follow-up and prophylaxis when indicated.

11.4 Recommendations

- a) Housekeeping staff should be given appropriate immunization cover.[AII]
- b) PPE shall be provided for all housekeeping staff and replaced when defective.[BII]

12 Glossary

Adenosine Triphosphate (ATP): A source of energy that can be easily stored and used when needed for cellular functions

Agar dish/plate: Is a petri dish that contains a growth medium (typically agar plus nutrients) used to culture microorganisms

Antiseptic: An agent that can kill microorganisms and is applied to living tissue and skin.

Aerobic Colony Count (ACC): Total number of viable aerobic bacteria sampled from a given surface. Usually expressed as the number of colony forming units per area (e.g. cfu/cm²)

Benchmarking: A standard or point of reference against which things may be compared

Bioburden: Degree of microbial contamination or microbial load; the number of microorganisms contaminating an object

Bioluminescence: The biochemical emission of light by living organisms

Cleaning: The physical removal of foreign material (e.g. dust, soil) and organic material (e.g. blood, secretions, excretions, microorganisms). Cleaning physically removes rather than kills microorganisms. It is accomplished with water, detergents and mechanical action.

Colony-forming unit (cfu): A quantitative measure of the amount of organisms. Usually expressed as the number of viable organisms per unit sampled (e.g. mL for liquids, mg for solids and cm² for surfaces)

Contaminated linen: Refers to linen that represents a substantial hazard to those who may be exposed to it. This includes linen from patients with cholera, dysentery, enteric fever, anthrax, plague, Ebola fever, Lassa fever, Marburg fever, smallpox and SARS. Linen which is grossly soiled with blood or other body fluids or excreta may be considered as contaminated and treated in the same manner

Disinfectant: A product that is used on surfaces or medical equipment/devices which destroys disease-causing pathogens or other harmful microorganisms but might not kill bacterial spores. Disinfectants are

applied only to inanimate objects. Some products combine a cleaner with a disinfectant.

Disinfection: The inactivation of disease-producing microorganisms. Disinfection does not destroy bacterial spores. Medical equipment/devices must be cleaned thoroughly before effective disinfection can take place. See also, *Disinfectant*.

Detergents: remove organic material and suspend grease or oil.

HAI: healthcare associated infection

Hand Hygiene: A general term referring to any action of hand cleaning. Hand hygiene relates to the removal of visible soil and removal or killing of transient microorganisms from the hands. Hand hygiene may be accomplished using soap and running water or an alcohol-based hand rub (ABHR).

Hand Washing: The physical removal of microorganisms from the hands using soap (plain or antimicrobial) and running water.

Healthcare facilities: This refers to hospitals and intermediate and long term care facilities

Heat labile: For linen, this refers to items which are not able to withstand thermal disinfections at temperatures $>60^{\circ}\text{C}$

Hospital Clean: The measure of cleanliness routinely maintained in patient/resident care areas of the healthcare setting. Hospital Clean is 'Hotel Clean' with the addition of disinfection, increased frequency of cleaning, auditing and other infection prevention and control measures in client/patient care areas.

Hotel Clean: A measure of cleanliness based on visual appearance that includes dust and dirt removal, waste disposal and cleaning of windows and surfaces. Hotel clean is the basic level of cleaning that takes place in all areas of a healthcare setting.

Safety Data Sheet (SDS): A document that contains information on the potential hazards (health, fire, reactivity and environmental) and how to work safely with a chemical product. It also contains information on the use, storage, handling and emergency procedures all related to the hazards of the material. SDSs are prepared by the supplier or manufacturer of the material.

Medical Equipment/Device: Any instrument, apparatus, appliance, material, or other article, whether used alone or in combination, intended by the manufacturer to be used for human beings for the purpose of diagnosis, prevention, monitoring, treatment or alleviation of disease, injury or handicap; investigation, replacement, or modification of the anatomy or of a physiological process; or control of conception.

Micro-organisms: Microscopic organisms which include bacteria, viruses, fungi, algae, and protozoa;

Occupational Health and Safety (OHS): Preventive and therapeutic health services in the workplace provided by trained occupational health professionals, e.g. nurses, hygienists, physicians.

Personal Protective Equipment (PPE): Clothing or equipment worn by staff for protection against hazards.

Reprocessing: The steps performed to prepare used medical equipment for use (e.g. cleaning, disinfection, sterilization).

Relative Light Units (RLU): A unit for measuring cleanliness by assessing the levels of Adenosine Triphosphate (ATP). The intensity of the emitted light is proportional to the concentration of ATP.

Used linen: Refers to any linen which has been used in patient care without gross soiling

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Chapter 10. Waste Management

1 Introduction

Proper waste management in healthcare settings can prevent potential healthcare associated infections. These guidelines were developed based on the best available current evidence and existing international guidelines, as well as systematic reviews of the evidence. They provide a basis for healthcare professionals and healthcare facilities to develop detailed protocols and processes for infection prevention and control specific to local settings. The guidelines are for use by all working in healthcare - this includes healthcare professionals, management and support staff.

This guideline describes best management practices to minimize the impact of waste on the environment through appropriate packaging, segregation, treatment, storage and disposable methods.

When implementing these recommendations all healthcare facilities need to consider the risk of transmission of infection and implement according to their specific setting and circumstances.

2 Classification of waste

Under the Environmental Public Health (Toxic Industrial Waste) Regulations, the “pathogenic wastes from hospitals” are listed in the Schedule of the Regulations as waste streams from healthcare setting activities. Healthcare waste includes all the waste generated by healthcare setting, research facilities and laboratories, which includes infectious, chemical, expired pharmaceutical, radioactive items and sharps. They are referred to in this guideline as hazardous healthcare waste and required to be disposed of by licensed hospital waste contractors

2.1 Biohazard waste refers to biological agent waste as defined in the Biological Agents and Toxins Act (BATA). Examples include:

- a) Infectious waste;
- b) Pathological waste; and

- c) Potentially infectious sharps.

2.2 Cytotoxic waste refers to waste that has the capability to alter genetic material.

Examples include:

- a) Expired or unused cytotoxic drugs;
- b) Expired or discontinued intravenous (IV) solutions containing cytotoxic drugs;
- c) Waste material contaminated with cytotoxic drug during the preparation and administration of chemotherapy, e.g. syringes, needles, filters, IV tubing, vials, ampoules, broken glass fragments;
- d) Balance of liquid cytotoxic drug doses generated at patient areas or pharmacy;
- e) Empty boxes that held bottles, blister strips, vials or ampoules containing cytotoxic drugs; and
- f) Body fluid of patients during chemotherapy.

2.3 General waste refers to waste that does not pose a hazard during handling.

Examples include:

- a) Office administrative waste;
- b) Food waste;
- c) Packing material;
- d) Waste water from laundry and floor washing;
- e) Dangerous substances and toxic industrial waste that have been treated and rendered harmless and safe for disposal; and
- f) Consumables used on patients that are not heavily soaked in blood e.g. diapers, dressing set, gauze, cotton swabs.

2.4 Infectious waste refers to a type of biohazard waste that is capable of causing disease. Examples include:

- a) Cultures of infectious agents and blood samples from the laboratory;
- b) Sharps contaminated with blood;
- c) Waste capable of transmitting diseases from patients with level III or IV infectious diseases (e.g. SARS, rabies, viral haemorrhagic fever, smallpox, avian influenza);

- d) Dressings or other wastes dripping with blood, caked with blood or containing free flowing blood; and
- e) Faeces from patients with infectious diseases e.g. Ebola.

2.5 Pharmaceutical waste refers to waste generated from pharmaceutical products and drugs. The vials are discarded into sharps disposal containers. Examples include pharmaceutical products and drugs that:

- a) Have been returned from wards and patients;
- b) Are expired or contaminated; or
- c) Are no longer required by the establishment;

2.6 Radioactive waste in accordance to the Radiation Protection Act refers to waste that is contaminated wholly or partially with radioactive nuclides such as:

- a) Technetium 99m (Tc 99m);
- b) Iodine 131 (I 131);
- c) Fluorine 18 (F 18);
- d) Yttrium 90 (Y 90); and
- e) Carbon 14 (C 14)

2.7 Toxic industrial waste (TIW) refers to any industrial waste, which, owing to its nature, composition or quantity constitutes a danger to human health or the environment or which contain or may produce pathogens or transmissible diseases. Examples include expired, unused and discarded solid and liquid chemicals.

3 Waste Management Plan

Management of healthcare waste requires a multidisciplinary approach and each healthcare setting shall identify and establish proper processes to eliminate or reduce hazards associated with the disposal of health care waste, and manage staff activities to reduce the risk of injuries to individuals and negative impact on the environment. Each healthcare setting shall clearly define the roles and responsibilities of every healthcare professional in implementing these policies and procedures.

3.1 Responsibility for Waste Management Team

All healthcare settings, research facilities and laboratories shall be responsible for the proper management of the waste generated by them until its final disposal in accordance with the provisions of the regulations. Regulation 41 of the Workplace Safety and Health (General Provisions) Regulations states that:

“All hazardous substances in a workplace shall be placed under the control of a competent person who has adequate knowledge of the properties of the hazardous substances and their danger.”

A waste management team from different sections within the health care setting shall be appointed by the management of healthcare setting, research facilities and laboratories. Typical members of the waste management team are:

- a) Head of healthcare setting, research facilities and laboratories
- b) Infection prevention and control expert
- c) Radiation officer
- d) Chief nursing officer or senior representative from Nursing
- e) Chief pharmacist
- f) Engineer
- g) Head of department
- h) Waste management officer

The roles and responsibility of staff that are responsible for waste management in different sections of the healthcare setting shall be clearly defined.

The Waste Management Plan shall be drafted based on Environmental Protection and Management Act (EPMA), the Environmental Public Health Act (EPHA) and to a certain extent, the Workplace Safety and Health Act (WSHA).

The Waste Management Plan shall include:

- a) A plan of the hospital showing the waste disposal holding areas for the healthcare setting, research facilities and laboratories;
- b) Frequency of waste collection from each locations;

- c) Duties and responsibilities for each of the different categories of healthcare setting, research facilities and laboratories staff who will generate healthcare wastes and be involved in the management of wastes;
- d) Procedures for the management of waste requiring special handling before final disposal;
- e) Contingency plan for storage or disposal of hazardous waste in the event of disease outbreak, breakdown of incinerator or of maintenance or collection arrangements;
- f) Training courses and programs; and
- g) Emergency procedures.

The Waste Management Plan shall be regularly monitored, reviewed and updated by the appointed Waste Management Officer.

3.2 Logistics

All healthcare setting, research facilities and laboratories shall develop detailed mapping of waste flows within the facilities, followed by a waste assessment to ensure an effective and secure waste storage facilities.

A storage location for healthcare waste should be designated inside the healthcare setting or research facility. The wastes, in bags or containers, should be stored in a separate area, room or building of a size appropriate to the quantities of waste produced and the frequency of collection.

3.3 Waste Labelling

Under the Environmental Public Health (Toxic Industrial Waste) Regulations, all healthcare setting, research facilities and laboratories are required to segregate pathogenic wastes and put them in colour-coded plastic bags for waste labelling, to ensure that proper precautions are observed when handling the different types of waste. All staff including staff from the external agencies handling waste management must be trained and familiar with the colour coding.

According to the National Environment Agency (NEA), colour-coded disposal bags are also used in hospitals to segregate wastes that need special handling and disposal (outlined in Table 10.1):

- a) Yellow bags: biohazardous wastes
- b) Purple bags: cytotoxic wastes
- c) Red bags: radioactive wastes
- d) Black and transparent/clear bags: general wastes

3.4 Emergency Response/ Contingency Plans

Members of the waste management team shall review waste management arrangements in their areas of responsibility regularly. Effort shall be made in handling spills of hazardous wastes or substances in the healthcare setting, research facilities and laboratories. Appropriate personal protection equipment and spill kit shall be made available for protection of staff and spill clean-ups.

3.5 Recommendations

Each healthcare setting is responsible for the handling and management of their waste, including clinical and related waste, from the point of generation until the final point of safe disposal regardless of whom may be contracted. [AIII]

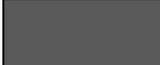
4 Waste Segregation

Waste should be segregated to ensure correct disposal route, maintain staff safety, minimise environmental harm and allow recycling. Waste must be identified and segregated based on potential hazard, suitability of treatment and disposal route. Appropriate handling of waste from the point of generation to final disposal is vital to minimise the transmission of diseases.

Waste segregation is based on the type of waste produced and not the location of where the waste is generated. The responsibility of waste segregation should start from immediate staff member involved in generation of the particular waste. Therefore, appropriate waste bin should be made available in waste generating areas.

Colour coded waste disposal bags and containers outlined in this section are recommended to provide a simple yet effective approach for waste segregation (See Table 10.1).

Table 10.1. Recommended colour segregation scheme by Workplace Safety and Health Council Singapore (Workplace Safety and Health Council. Workplace Safety and Health Guidelines Healthcare; 2008)

Colour Code and Symbol	Waste type	Examples
	<ul style="list-style-type: none"> • Infectious waste • Pathological waste • Chemical waste 	<ul style="list-style-type: none"> • Gauzes soiled with body fluids • Used needles contaminated with body fluids • Glass vials drugs
	<ul style="list-style-type: none"> • Cytotoxic waste • Biohazardous contaminated with cytotoxics 	<ul style="list-style-type: none"> • Expired cytotoxic drugs • Disposable gloves and gowns used during chemotherapeutic drugs preparation • Used needles for administering chemotherapeutic drugs • Glass vials with cytotoxic drug residue
	<ul style="list-style-type: none"> • Radioactive waste • Biohazardous and contaminated with radioactive materials <p>Stored in lead bin for decay</p>	<ul style="list-style-type: none"> • Disposable gloves and gowns used in the preparation of radioactive materials • Used needles for administering radioactive isotopes • Glass vials with radioactive residue
	<ul style="list-style-type: none"> • General Waste 	<ul style="list-style-type: none"> • Office waste • Kitchen waste

4.1 Handling of sharp disposal container

The sharps disposal container must be kept upright and must not be more than two-thirds full. This is to minimise the risk of sharps injuries. Sharps disposal containers must not be emptied or cleaned manually or in any other ways that will cause risk of sharps injuries. Before disposing of the sharps container, they must be closed to prevent spillage of its contents. In the event of potential leakage, the sharps container must be placed into a secondary sharp disposal container that is closable and clearly labelled with biohazard symbol. Sharps generated through use in cytotoxic

and radioactive procedures should be discarded in a separate sharps disposal container. It should be properly labelled and treated appropriately.

4.2 Recommendations

- a) Appropriate waste bin should be made available in waste generating areas [AIII]
- b) Colour coded waste disposal bags and containers should be used to segregate waste. [AIII]
- c) The sharps disposal container must be kept upright and must not be more than two-thirds full. [AIII]

5 Storage

5.1 Storage and frequency of collection

The collection period should be scheduled and regular to ensure that odours from the waste do not cause nuisance. The following general principles of waste segregation, storage and transportation relate to the control of waste flow from generation to disposal:

Healthcare waste generated in a medical area should be segregated at point of use by the person who produces each waste item. Where waste accumulates in small quantities daily, the interval between collections should be as short as reasonably practicable.

Healthcare waste receptacles (holding bins) may need to be stored before being transported to treatment/ disposal sites. They should not be allowed to accumulate at corridors, wards or other places accessible by unauthorized personnel or members of the public.

Arrangements should be made to routinely transport waste from ward level, treatment room or department to a storage area ending collection by the designated waste contractor of the respective institutions. Biohazard waste is collected and transported manually (using trolleys) to the waste holding area at environmental services 2-3 times a day.

Healthcare waste should be stored securely so as to prevent the escape of waste, harm to the environment and harm to human health. Failure to do so is a breach of statutory duty of care. This is also applicable to storage at the production point and bulk storage areas.

Note: Care is required when storing waste and arranging the collection of waste to ensure it is secure and duty of care requirements are fulfilled. Some areas have similar colours for other waste streams like waste recycling, therefore it is essential the waste is secure and transferred to the appropriate party for collection and treatment. If there are waste recycling initiatives by the institution, a separate bin clearly labelling as Recycling should be prepared. The list of items which can be recycled should also be clearly indicated so as not to confuse users to use the wrong bins.

5.2 Containers for disposal of waste

Plastic bags used for the collection and storage of clinical waste must be strong and durable enough to safely contain the waste they are designed to hold, and must be labelled according to the accepted colour coding e.g. Yellow (Biohazard waste), Purple (Cytotoxic waste), Red (radioactive waste) and Black (normal waste). They should not be filled to more than two thirds of their capacity, in order to allow buffer to do the final closure (tying). They should not be secured with closure devices that protrude e.g. metal staples.

5.2.1 Cytotoxic waste

Cytotoxic waste must be contained in labelled, sealed, impervious containers that are strong enough to protect from spillage, leakage or breakage when transporting. The container must be protected by secondary containment for capture of spills during transit.

5.2.2 Pharmaceutical waste

Pharmaceutical waste must be collected in containers that are non-reactive, tamper-proof and designed to resist impact rupture. There should be measures to capture any en-route spills and prevent the removal of waste after it has reached the point of final disposal. Pharmaceutical waste awaiting disposal must be securely

stored, such that access by unauthorized personnel is prevented, just as it is when the pharmaceuticals were "in use". All pharmaceutical and cytotoxic waste must be stored in a way to prevent contamination of food and to preclude access by unauthorized personnel. For chemical wastes containing significant concentration of heavy metals, the Safety Data Sheet provides details of suitable disposal methods.

5.2.3 Sharps

Sharps must be placed in sharps containers that are rigid. The containers should not be emptied, cleaned or reused. It should be locked (close tightly) before being sent to the disposal holding area.

5.2.4 Other waste disposal containers

Other rigid-walled containers: reusable rigid wall containers such as mobile garbage bins (wheelie bins), should be resistant to leakage, impact rupture, corrosion and must be washable. These containers should be appropriately color-coded. Internal surfaces must be smooth and impervious. They must be cleaned regularly and whenever the internal area has been accidentally contaminated by unsealed clinical waste. Where small quantities of clinical waste are being generated, effective storage can be achieved using 120/240 litre bins (wheelie bins) or other waste containers that have been placed on a tray which has sufficient sides to hold any potential spills. Wastes should not be stored in plastic liners that have been placed directly on floors.

5.3 Bin Centre for clinical and related waste

Transport to a disposal site: Clinical and related waste requiring transport to an appropriate disposal site is to be properly packaged and labelled. All waste holders have the responsibility to ensure contracted carriers are licensed carriers and comply with the requirements of NEA.

Waste transport and storage methods should ensure that the health of staff and the public is protected at all times. During transportation, use trolleys for transport of clinical waste contained in plastic bags or non-mobile rigid containers that will contain accidental leakage and be dedicated for that use and cleaned on a regular basis. Storage must be in a dedicated waste storage area that maintains segregation and the storage area must be labelled so it is obvious to be identified on what type of waste

is stored within. If there is a potential for putrefaction to occur, the storage area should ensure that there is no public health risk and no impact on the work environment. Access to the storage area must be restricted and the area locked. The area should also be kept clean, tidy and vermin-proof and there should be access to necessary clean-up equipment, spill kits, PPE and hand washing facilities.

5.4 Storage at point of production

Storage areas at production points (dirty utility room) should be secured and located away from public areas. Storage areas should be sufficient in size to allow packed waste to be segregated and avoid waste of different classifications being stored together in the same area. Hand hygiene facilities should be made available. Ensure that the storage area is regularly cleaned, at least daily. Avoid placing clean items in the storage area.

5.5 Bulk storage (waste holding area before collection by licensed vendors)

Bulk storage areas may be situated within healthcare premise or at a licensed or permitted transfer/ disposal facility. Regardless of location, bulk storage should be:

- a) Reserved for healthcare waste;
- b) Well-lit and ventilated;
- c) Sited away from food preparation and general storage areas and routes used by public;
- d) Totally enclosed and secured;
- e) Provided with separate storage for sharps receptacles, anatomical and waste medicines (which may need a higher degree of security to prevent unauthorized access);
- f) Sited on a well-drained, impervious hard standing;
- g) Readily accessible but only to authorized people;
- h) Kept locked when not in use;
- i) Secure from entry by animals and free from insect or rodent infestations;
- j) Provided with wash-down facilities;
- k) Provided with separate, clearly labelled areas for waste that requires, different treatment/ disposal options;
- l) Provided with access to first-aid facilities and hand washing facilities;
- m) Appropriately drained to a sewer (with discharge consent); and

- n) Cleaned regularly.

5.6 Considerations for radioactive waste

Radioactive wastes are usually divided into three categories – unsealed radioactive sources, sealed radioactive sources and lead protective aprons. They are discarded as two types of wastes; solid lead or solid waste and biohazard wastes (solutions). Their examples and method of discarding are described in Table 10.2.

Table 10.2. Types of radioactive waste

Type	Examples	Comments
Unsealed radioactive source	Tc-99m	Usage: Patient injection for bone scans Waste: minute remainder after injection in syringes, needles, gauze etc. Disposal: (a) delay-and-decay to at least 10 times half-lives (one half life for Tc-99m is 6h) and to be disposed as biohazard waste; (b) notify NEA via fax before disposal
Sealed radioactive sources	Co-57 flood source, Co-57 pen source, Co-57 pen source, etc.	Usage: equipment calibration, patient skin marking Waste: solid waste Disposal: to be returned to manufacturers (e.g. USA) as required under NEA L4 license for possessing radioactive sources
Lead protective aprons	Full length front, thyroid shields, etc.	Usage: PPE for inside x-ray exam rooms Waste: solid lead Disposal: to be disposed by NEA's licensed toxic industrial waste collectors

Use puncture-resistant container before placing into Red colour radioactive disposal bag. It is then stored in waste holding area in DDII Nuclear Medicine room to allow the waste to decay to background radiation level before transferring into biohazard (yellow) bag and dispose as biohazard waste.

6 Waste Treatment and Disposal

Infectious waste with national public health issues (e.g. Ebola) must be treated prior to final disposal. Overall objective of any waste treatment process is to render the waste non-hazardous and inoffensive, so that it can be disposed of safely. The treatment process must be controlled so that it does not lead to other environmental

problems. It is the responsibility of the waste generator to ensure that all waste types are only sent to treatment facilities that are licensed for those specific waste types.

6.1 The treatment process must ensure that:

- a) Waste pipelines from wards with highly infectious waste with a potential public health impact to be linked to the chemical disinfection dosing system at Plant Room;
- b) When the waste discharge flow through the pipeline inside the Plant Room, the dosing system will measure the waste-water flow-rate and dispense Sodium Hypochlorite (NaOCl) to treat the waste water;
- c) The treated waste water will flow into a Septic Tank and hold for at least 10min to complete the whole disinfection process before this waste water is discharged into the public sewer system; and
- d) Sufficient NaOCl should be applied to achieve a 3ppm of free chlorine in the waste water.

NEA has a requirement for allowable Limits for Trade Effluent Discharge to Sewer/ Watercourse/ Controlled Watercourse (<http://www.nea.gov.sg/anti-pollution-radiation-protection/water-pollution-control/allowable-limits>).

6.2 Frequency of Trade Effluent Test

The frequency of Trade Effluent Test conducted should minimally be half-yearly. An accredited laboratory is to be engaged to conduct this test.

Healthcare facilities are encouraged to evaluate new technologies that may contribute to minimizing the environmental and health impacts associated with waste disposal.

7 Transport

Healthcare facilities should conduct review to optimize the waste collection process, reduce handling and transportation and promote safe work practices. The use and installation of chutes for transport of waste are not recommended because they can increase the risk of airborne transmission.

7.1 Transport within Healthcare Facility

Waste should be transported according to its category i.e. General Waste, Hazardous or Infectious waste and Chemical waste. Staff involved in transporting of waste must be informed of potentially infective waste and possible health and safety hazards. They must be trained in appropriate handling and disposal method. There should be a fixed planned route to the central storage area. Transportation routes should avoid food preparation and areas with heavy traffic.

7.2 Handling Waste Bags

Staff transporting waste must wear appropriate PPE to minimize exposure risk (Please see chapter 9). All waste bags must be handled away from the body by the closed top of the bag and placed directly into the waste receptacle. All waste waiting for transportation, must be placed in a secured place with restricted access.

7.3 Waste Receptacle

Transport of waste must be done using a waste receptacle to decrease spills. Minimize collector contact with waste and minimize handling.

Waste receptacle (please see Figure 10.1) used for transport of waste contained in plastic bags must be made of:

- a) Puncture proof, leak proof and rigid material;
- b) Smooth internal surface that do not have crevices and do not allow particles to be trapped;
- c) Made of washable material that is easy to clean and drain;
- d) Do not allow harbourage of insects and vermin; and
- e) Easy to operate (Push & pull and load & unload).

Figure 10.1. Waste Receptacle



Waste receptacle used to transport biohazardous waste and sharps disposal containers should be labelled with 'infectious waste' or 'biohazard' signs for dedicated use and must be cleaned regularly. It must not be overfilled during transportation to prevent spillage. Waste must be transported to the main storage area as regularly as possible to prevent housekeeping hazards.

7.4 Waste receptacle cleaning

Healthcare facility should have scheduled cleaning for waste receptacles. Waste receptacle must be visually inspected for cracks, breaks and leaks every-time it is emptied. Staff washing the waste receptacle must wear appropriate PPE to prevent accidental exposure. Healthcare facility should use neutral detergent and water for cleaning. Cleaned waste receptacle must be separated from soiled waste receptacles.

7.5 Transport from Healthcare Facility to Disposal Site

Off-site transport is the carriage of healthcare waste away from the healthcare constitution. It must comply with the NEA regulations. Collection must be done at scheduled and regular intervals. Medical waste must be transported in a closed, impervious containers to the disposal site.

7.6 Recommendations

- a) Staff involved in transporting of waste must be informed of potentially infective waste and possible health and safety hazards. They must be trained in appropriate handling and disposal method. [BIII]
- b) Transport medical waste in closed, impervious containers to the disposal site. [BII]

8 Spills Management

Healthcare facilities must develop a spill management plan with well-defined standard operating policies and procedures for handling spills safely (See Annex AA – Removal of biohazard spills). Staff who are managing spills must be trained on managing spills safely. They must be aware of the risks and available options when they require assistance. Spill kits must be readily available and accessible. A spill kit should contain necessary items required to clean up spills of clinical or toxic nature. Contents of the kit should minimally include the below. Cytotoxic spill kit must be made available and accessible for areas with cytotoxic drugs. Staff who are exposed to the spill must seek immediate medical attention.

- a) PPE (Face mask, Face shield, Gloves, Apron or Long Gown)
- b) Absorbent Pads / Materials
- c) Receptacle/ tongs
- d) Mops
- e) Disinfectant (E.g. sodium hypochlorite granules/diluted solution, household bleach)
- f) Plastic waste bags with appropriate labels
- g) Warning signage
- h) Waterproof leg protector or disposable boots (Where applicable)

8.1 Recommendations

Healthcare facilities must develop a spill management plan with well-defined standard operating policies and procedures for handling spills safe. [BIII]

8.2 Management of body fluid spills

This procedure outline provides the steps for removing body fluid spills (E.g. urine, faeces and vomitus) from hard floor surfaces like vinyl, ceramic tiles and concrete.

A. Preparation	
1.	Display caution signs to prevent traffic from stepping onto spill.
2.	Collect tools and chemicals: tongs, surfactant and sodium hypochlorite (10,000 ppm), mop, biohazard bag and absorbent material.
3.	Don disposable gloves and disposable apron/gown. Optional: Face shield /goggles and waterproof leg protector if anticipating possible splashes.
B. Remove Spill	
1.	Carefully place absorbent material over fluid to absorb as much of it as possible. Clear soaked material and any solids using tongs and deposit into biohazard bag.
2.	Pour sodium hypochlorite (10,000 ppm) onto affected floor area. At the same time, spray tongs to disinfect.
3.	Leave for 10 minutes for sodium hypochlorite (10,000 ppm) to disinfect effectively. If needed (for heavy spills), use more absorbent material to sponge up the affected area, and spray sodium hypochlorite solution a second time.
4.	Mop affected area with surfactant detergent, starting from outer ring of the affected area towards centre.
5.	Use tongs to remove mop head and place into a bag and deposit into the bucket dedicated for soiled mop head.
C. Clear Tools and Perform Hand Washing	
1.	Remove gloves, apron and mask and discard in biohazard bag. Secure open end of biohazard bag, and dispose in biohazard bin in dirty utility.
2.	In dirty utility room, disinfect and clean tools with detergent and sodium hypochlorite (10,000 ppm).
3.	Wash hands thoroughly.
4.	Remove caution signs when floor is completely dry.

9 Recycling

In line with the National Environment Agency (NEA) 3Rs “Reduce, Reuse & Recycle” initiatives, organisations are encouraged to adopt 3R practices to minimize waste and sustain clean environment. Listed below shows the items which have recycling opportunities in the health-care facilities:

9.1 Waste from non-clinical areas

Office paper, newspaper, magazine, corrugated cardboard, aluminium can, glass, plastic bottles, light bulbs, fluorescent tubes, food, computer, electronic devices, batteries.

9.2 Waste from clinical areas

Polyethylene bottles for irrigation water, saline solutions, sterilisation wrap, empty surgical pack.

Healthcare facilities must carefully evaluate the items suitable for recycling. Waste which pose any cross infection risk or environmental hazards must not be recycled. These include items which contain or come into contact of pathogenic or biological substances such as single use devices, hypodermic needles, syringes, catheters, masks, gowns, gloves etc. Similarly, packaging which is used for containment of toxic or hazardous materials (e.g. xylene, formalin, cytotoxic drugs) must not be considered for recycling and must be discarded appropriately according to the waste guideline.

9.3 Recommendations

Do not recycle hazardous waste that pose cross infection risk and environmental hazards [All].

10 Health and safety practices for waste workers: training and supervision

10.1 Guiding principles

This section addresses the occupational safety of healthcare professional and workers handling waste. Workers’ health and safety should be safeguarded by

undertaking measures to ensure compliance to correct handling, treatment, storage and disposal procedures which include the following:

- a) Develop a standardized set of management rules and operating procedures for healthcare waste;
- b) Inform and train waste workers so that they perform their duties properly and safely; involve waste workers in the identification of hazards and recommendations for prevention and control;
- c) Provide equipment and clothing for personal protection; and
- d) Establish an occupational health programme that includes information, training and medical measures when necessary, such as immunization, post-exposure prophylactic treatment and regular medical surveillance.

Training must ensure that workers know of and understand the potential risks associated with healthcare waste, and the procedures required for its safe management. They should be informed on the importance of consistent use of PPE and should be aware of where to obtain post-exposure follow-up in case of a needle-stick injury or other blood exposure.

Healthcare professional should be trained for emergency response if injured by a waste item. Written procedures for the different types of emergencies should be in place and easily accessed. For dangerous spills of hazardous chemicals or highly infectious materials, the clean-up operation should be carried out by staff specially trained for this purpose.

10.2 Exposure prevention and control

All healthcare workers are at risk of exposure to blood at work and shall be immunized or documented to be immune to the hepatitis B virus before commencing employment. Documentation of immunization status of all waste management workers shall be kept by the employer and the healthcare facility using such services.

10.3 Protective equipment

The most appropriate PPE in reducing risk of injury are gloves to protect from exposure to blood, other potentially infectious materials and chemicals; particulate masks (respirators) to protect from respiratory infections hazards and particulates from

burning waste; and boots for waste handlers to protect from sharps injuries to the foot. All necessary PPE shall be made available to workers where needed. The type of protective clothing used will depend to an extent on the risk associated with the type of healthcare waste.

Access to soap and water, and alcohol hand rub must be available for hand hygiene.

10.4 Training

Healthcare waste handlers should be trained:

- a) Before starting work handling waste;
- b) At regular intervals (e.g. annually) to update their knowledge of prevention and control measures;
- c) When new equipment is introduced; and
- d) When technological change occurs.

Training should address and educate on the following:

- a) The different types of waste and the potential hazards from such waste;
- b) Protection from blood-borne pathogens and the purpose of immunization;
- c) Safe waste-handling procedures;
- d) Knowledge of first aid and medical management in the event of a sharps injury or mucous membrane exposure to blood or body fluid;
- e) The process for mandatory reporting of exposures and injuries;
- f) Preventing infection following an exposure with post-exposure prophylaxis (PEP); and
- g) The use of PPE and competency assessment of donning and doffing PPE.

10.5 Staff who transport waste

Drivers and waste handlers should be aware of the nature and risks associated with the waste they transport. In particular, transport staff should be trained to be able to carry out all waste-related procedures in accordance with instructions and should

include PPE, waste classifications and risks, safe handling of hazardous waste, labelling and documentation and emergency and spillage procedures.

Managers at a healthcare facility should liaise with the waste collector to ensure that the waste-collection crew is well trained and should have direct access to emergency services and their departments in cases of emergency or accidents. Untrained personnel should not be allowed to handle hazardous healthcare waste as they could be a danger to others and to themselves.

10.5 Audits to assess compliance

Supervisors shall carry out competency checks on PPE utilization and audit adherence to protocols on waste collection, segregation and transport on a regular basis.

10.6 Handling of Cytotoxic Waste:

All disposable sharp items (e.g. needles, syringes) that have potentially come in contact with cytotoxic drugs during compounding or administering shall be placed in a puncture-resistant Sharps container, which should be labelled as Cytotoxic Sharps. Balance of excess liquid cytotoxic drugs shall be put into vials and discarded as above.

Cytotoxic Wastes shall be segregated from all other wastes. Cytotoxic Wastes (including the Cytotoxic Sharps container) are disposed in bins lined with purple bag with Cytotoxic Symbol. They must be double bagged and the second bag must be sealed before being deposited at a designated assembly area.

Housekeeper is to wear gloves and secure the purple bag with cable tie. Transfer the filled and secured purple bags to the Biohazard Waste Hold Room located at designated area. The purple bags are placed into the black bins and the bin covers are to be closed before leaving.

Designated housekeeper collects and sends bin to the central holding area. Daily collection is done by a Licensed Waste Disposal Contactor for disposal at the

Government Refuse Incineration Plant. All expired / unused cytotoxic drugs should be returned to Overseas Suppliers for discard.

10.7 Recommendations

- a) All healthcare professionals are at risk of exposure to blood at work and shall be immunized or documented to be immune to the hepatitis B virus before commencing employment. [All]
- b) Training for healthcare professionals shall ensure that staff know of and understand the potential risks associated with healthcare waste, and the procedures required for its safe management. [BII]
- c) Appropriate PPE shall be worn at all times and all necessary PPE shall be made available to staff where needed. [All]

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Chapter 11. Construction and Renovation

1 Introduction

Construction work in healthcare settings may pose risks to patients, particularly those who are immunosuppressed. Previously published data indicates that demolition, construction and maintenance activities can have a serious impact on patients. It is recognized that the dust generated from such activities predispose patients to healthcare associated infections; fungal infections such as *Aspergillus* sp and bacterial infections due to aerosolisation of pathogens have all been reported. In immunosuppressed patients, opportunistic infections may also result.

Other complication that can escape notice is contamination of the building's surrounding excavation sites due to shared/close proximity to HVAC (Heat, ventilation, and air-conditioning) systems. Air handling ducts that were modified or simply closed off, if not re-pressurised appropriately may dislodge fungal spore laden dust and allow these to become airborne

In addition, excavation allows the release of microorganisms from the soil. These microorganisms eventually enter and contaminate the air, cooling towers, and water systems. Water systems may also become contaminated. Where systems may have to be shut down, stagnation and the follow-on problems such as scale, corrosion and bacteria (e.g. legionella) delivered to patient care areas on re-establishment of water supplies should be mitigated against by flushing and decontamination of the affected water systems.

Damaged pipes may also give rise to leaks and result in dampness and/or floods in the surrounding workspaces. If areas affected are not promptly cleaned and dried, mold can grow on materials like gypsum wallboard, ceiling tile or spray-applied fire-proofing.

1.1 Challenges

Despite the challenges, many hospitals, by necessity still constantly undergo expansions, renovations and construction in order to respond to changes in healthcare delivery, emerging technology, and to update aged infrastructure. Therefore, it is important for Infection Prevention and Control staff to identify the infection risks involved and plan for ways to minimize these risks. This work involves the collaboration of multiple stakeholders including engineers, nurse managers, administrators, architects and physicians who must be intimately involved before, during and after the construction projects. This must also be juxtaposed to existing regulatory requirements for risk assessment and reduction to ensure patient safety.

1.2 Healthcare associated infections related to construction and renovation

A review of the literature of healthcare associated infections over a 20-year period (1978-1998) revealed many nosocomial outbreaks to be related to construction and renovation projects caused primarily by fungi/mould (e.g. *Aspergillus*, *Penicillium*, *Candida*, *Zygomycetes*, *Fusarium*), and also, to a lesser extent, by bacteria (e.g. *Legionella*, *Bacillus*, *Nocardia*, *Mycobacteria*).

1.2.1 Fungi/ Mould

The most common aetiological agent is *Aspergillus* species. In particular, *A. fumigatus*, *A. flavus*, *A. niger* and *A. terreus* have been repeatedly documented in outbreaks. Amongst these, *A. fumigatus* is considered the most pathogenic and is responsible for more than 90% of all *Aspergillus* infections. Fungi occur ubiquitously in the environment and are therefore, impossible to avoid in day to day living. Fungal spores (conidia) are capable of remaining viable for months in dry locations. During construction and renovation, when floors, walls, or ceilings are penetrated, spores can be dispersed together with dust or dirt particles. Since *Aspergillus* spores are small (2.5µm-3.5 µm) and settle very slowly (0.03 cm per second), they can remain suspended in the air for prolonged periods. This increases the likelihood of it contaminating environmental surfaces or being inhaled.

In healthy people, they pose no threat as the hosts' immune system is able to wall off and get rid of these pathogens. In people with compromised immune systems,

however, these fungi are not as readily expelled, resulting in growth, multiplication and invasion of body tissues causing infection once exposed.

In immune-compromised patients, these infections are often fatal. The attributable mortality is said to be between 40% and 90% in spite of appropriate treatment. It becomes essential then to minimise risk particularly when demolition/construction occurs in or close to areas with immunosuppressed patients. Effective strategies that help minimise exposure and protect this vulnerable group must be employed.

1.2.2 *Legionella* species

Legionellosis is an environment-related, acute respiratory infection caused by Gram-negative *Legionella* bacteria, of which the most pathogenic is *Legionella pneumophila*. The infection is usually acquired due to the inhalation of contaminated aerosols generated in man-made water systems such as air-conditioning cooling towers, evaporative condensers, heated potable water systems, heating and air conditioning systems, whirlpool spas, and decorative fountains which have not been properly maintained. Other modes of transmission such as the aspiration of contaminated water are also possible.

Outbreaks of *Legionella* are frequently associated with construction and renovation projects where water supplies may have been turned off, such that water stagnates and *Legionella* multiplies. During construction activities, the introduction of contaminated soil into the plumbing system may also increase the amount of *Legionella* bacteria in the pipes. *Legionella* grows best in water temperatures of between 35°C to 46°C, meaning that hot water systems may represent perfect breeding ground for this bacteria.

Numerous cases of *Legionella* outbreaks have been associated with excavation. Some experts believe that excavation causes *Legionella* to be released from the soil and then to enter cooling towers, air intakes, water pipes and by direct inhalation of at risk individuals.

The occurrence of a nosocomial infection caused by *Legionella* depends on several factors, including the host immune response, exposure to a contaminated source, and the level of contamination of the source. Patients receiving high dose steroids are at a particular risk with *Legionella* from the water supply. Legionnaires' disease can be difficult to diagnose if not suspected, requires special diagnostics and can cause significant morbidity and mortality in older individuals. Thus, preventive measures to decrease the transmission of *Legionella* should be implemented whenever construction or renovation activities disrupt healthcare facilities' water supply.

1.3 Risk factors for healthcare associated infections related to construction and renovation

Any patient exposed to construction activities or soil excavation may be at an increased risk of acquiring a construction-related nosocomial infection. However, certain patients are at an increased risk of construction-related nosocomial infections due to their underlying medical conditions. Comorbidity is one of the best predictors of the development of invasive Aspergillosis or Legionnaires' disease.

1.3.1 Risk factors for fungal infections

- a) Exposure to construction activities
- b) Immunosuppressive conditions (e.g. bone marrow or solid organ transplantation; graft versus-host disease requiring treatment; prolonged neutropenia or granulocytopenia because of cytotoxic chemotherapy; prolonged use of antibiotics to treat fevers or previous infections; and steroid therapy or other immunosuppressive therapy)
- c) AIDS, congenital immunodeficiencies
- d) Dialysis, renal failure
- e) Diabetic ketoacidosis
- f) Mechanical ventilation
- g) Smoking
- h) Age of the patient (e.g. neonates and very old patients have a greater risk)

1.3.2 Risk factors for Legionnaires' Disease

- a) Exposure to soil excavation during construction and malfunction of plumbing systems
- b) Immunosuppressive conditions (e.g. bone marrow or organ transplantation; graft-versus-host disease requiring treatment; and steroid therapy)
- c) Advanced age
- d) Chronic pulmonary disease
- e) Smoking
- f) Excessive use of alcohol
- g) Surgery
- h) Diabetes
- i) Neoplastic disease
- j) Renal failure
- k) Cardiac failure

2 Preventive measures

2.1 Pre-designing and consultation phase

2.1.1 Multidisciplinary team

Pre-design planning is the most important phase in construction and renovation. Appropriate infection prevention and control measures must be employed throughout the construction and renovation project. This requires collaboration among a multidisciplinary team of architects, engineers, facility staff, infection prevention and control staff, safety officers, representatives from environmental services, administration and staff from specialized areas concerned with or impacted by the project. It is important for the Infection Prevention and Control staff to play an active role in all phases of the project.

The multidisciplinary team would be involved in developing appropriate risk management planning for the project. This includes detailed project-specific risk control plans based on the risk assessment, and should provide a strategic, proactive design to mitigate environmental sources of microbes and to prevent infectious hazards through architectural design. It should also consist of control measures to

mitigate potential contamination during actual construction or renovation (e.g. dust barriers). This will be documented in the document that Project Architect and Consultant Engineers will use to design protective systems and procedures for the duration of the project. Infection prevention and control policy specifically for construction and maintenance works should be available. The key functions and responsibilities of this team are to:

- a) Coordinate members' input in developing a comprehensive project management plan;
- b) Conduct a risk assessment of the project to determine potential hazards to susceptible patients;
- c) Prevent unnecessary exposures of patients, visitors, and staff to infectious agents;
- d) Oversee all infection prevention and control aspects of construction activities;
- e) Establish site-specific infection prevention and control protocols for specialised areas;
- f) Provide education about the infection prevention and control impact of construction to staff and construction workers;
- g) Ensure compliance with technical standards, contract provisions, and regulations;
- h) Establish a mechanism to address and correct problems quickly;
- i) Develop contingency plans for power failures, water supply disruptions, fires, short or long term delays (due to industrial action or material's delays) and emergency response;
- j) Provide a water damage management plan (including drying protocols) for handling water intrusion from floods, leaks, and condensation; and
- k) Develop a plan for maintenance on the site during construction as well as afterwards.

2.1.2 Risk Assessment

Risk assessment identifies potential hazards and the type of containment measures necessary for a safe environment. It should be carried out during the pre-planning stage as part of a robust risk management programme. Two key factors influencing the risks are:

- a) Types of patients (vulnerability to HAI associated with construction); and
- b) Types of projects (the extensiveness of project in generating dust).

For external projects, the following may be considered:

- a) Determine the location of air intakes in relation to any projects;
- b) Find out whether the ventilation system will function correctly with the pressure drop from excess contaminants collecting in the air intake system;
- c) Find out the need to increase preventative maintenance of the ventilation system to ensure proper functioning during external demolition or excavation;
- d) Locate any infiltration points pre-construction such as windows and doors;
- e) Determine whether the project requires penetration of existing walls and if so, how the occupants will be affected; and
- f) Determine how environmental issues affect the project such as prevailing winds, outdoor temperatures.

For internal projects, factors to consider include:

- a) Investigate whether the project requires utility outages, and if so, the effect on occupants by outages;
- b) Determine the outage's effect on ventilation upstream and downstream;
- c) Decide whether to use recirculated air, and if so, how contaminants from the construction site will be trapped so that they are not dispersed into the general circulation;
- d) Determine where vulnerable patient care areas are located under the project site;
- e) Investigate whether the construction activities produce vibrations, if so specify type; and
- f) Investigate whether the vibrations create problems for facility operations e.g. surgery.

2.1.3 Planning

At the beginning of the planning stage, it is necessary for the Infection prevention and Control precautions to be integrated into all documentation. The dust and infection prevention and control principles developed during the pre-design stage must be integrated at the initial stages of design development. It is also important that the pre-design team brief the design team and submit the findings of the survey and risk profile. It is important to address the following items:

- a) Determine the types, extent and locations of dust barriers. Ensure barriers are properly sealed right up to the slab, not just the ceiling, and to the floor and around all services to prevent air leakage. The barriers should be as air tight as possible;
- b) Establish locations for negative pressure HEPA filter units to create a negative pressure for the site. If an exhaust can be ducted to the outside and no air intakes are in the vicinity, subject to risk assessment, a HEPA filter may not be required and a simple temporary duct and fan used;
- c) If the site is close to a high-risk area, determine locations for HEPA filter clean air units outside the site access points;
- d) Determine the type of barrier required. This would depend on the duration of the job; light duty or temporary barriers for the jobs anticipated to take hours through to a framed and sheeted wall for longer durations. The risk level assigned needs consideration when choosing the barrier type;
- e) Determine the location of the nearest smoke or firewalls. The use of these can reduce the amount of above ceiling barrier required;
- f) Document sealing of windows, upgrading of air filter elements to a higher efficiency, and a higher frequency of air filter replacement if exterior work is required. The extent of this will be determined by how dusty the activity is;
- g) Develop and document a demolition strategy and include the method of removing the debris safely. Consider that external chutes have a stack effect that can potentially draw dust back up from the bin presenting potential dangers;
- h) Develop and document construction workers traffic routes, taking into account high-risk patient locations;

- i) Determine and document locations remote from the construction site that can be used for dirty/dusty work;
- j) Develop and document material handling, transport and storage, taking into account high-risk patient locations;
- k) Check locations above and below the site if penetrations are required. Develop strategies for the protection of high-risk patients during these events; and
- l) Develop comprehensive dust and infection prevention and control specification clauses specific to the project. Ensure appropriate penalties are included for repeated breaches of infection prevention and control clauses. As *Aspergillus* sp. thrive on water-damaged plasterboard, a clause should state that all gypsum plasterboard be protected from water damage. Plasterboard that remains moist (or not totally dry) for 72 hours must be replaced.

2.1.4 Education and Training of Construction Workers

This should be done before work begins. The curriculum should address the following:

- a) Why and how to adhere to infection prevention and control measures;
- b) Potential environmental risks e.g. fungal contamination for plumbers;
- c) Use of particulate respirators or other PPE;
- d) Risk prevention for safety issues e.g. noxious fumes or asbestos;
- e) How to seek help and report exposures; and
- f) Training before site entry.

These educational sessions should be documented.

2.2 Construction Phase

Attention to detail in the planning stages will ensure correct processes are in place for the construction phase. The risk to patients from construction and maintenance activities is greatly reduced when a formalized approach to risk management is conducted in conjunction with sound infection prevention and control practices. Constant vigilance is required to ensure processes are in place and adhered to.

For external projects, the objective is to keep dust out of functioning facilities through the following manner:

- a) Water mist the soil or wall before excavation or demolition;
- b) Water mist the dust surfaces of truck including wheels;
- c) Keep windows and doors closed as much as possible;
- d) Keep the facility air pressure positive to the outside;
- e) Ensure sufficient air supply and exhaust; and
- f) Regular filter maintenance to ensure intake of clean air.

For internal projects done in facilities amidst patient care areas, the objective is to keep dust in within the work area through the following manner:

- a) Hoarding;
- b) Negative pressure within the worksite;
- c) Site cleanliness and waste management;
- d) Traffic control;
- e) Additional measures for patient protection;
- f) Monitoring for compliance; and
- g) Post-procedure clean up.

Refer to Appendix 11.1 for detailed precautionary measures to be taken according to type of project work. In general, negative pressure is to be maintained within the area of work. This may be achieved with the use of HEPA filter placed within the work area. The HEPA filter captures particulates whilst creating negative pressure at the site in relation to adjacent areas. The filters are to be sealed and bagged securely at the point of use before disposal.

Hoarding or physical control barriers minimize dust migration to adjacent areas. The types of hoarding to be used depend on the duration and extensiveness of the project. They must be dust-tight and be intact until all dust generating work is complete, walls and ceiling closed, sanding done, and area cleaned. Hoarding material vary:

- a) Plastic sheet hoarding: these may be used for projects with minimal dust generation. They should be sealed at full ceiling height with a minimum of 60-cm overlapping flaps for access to entry

- b) Plaster board hoarding: these may be used for projects with moderate to high level dust generation. They are rigid, dust-proof fire-rated barrier walls (plywood, drywall) and the caulked seams should be tightly sealed
- c) Calcium silicate hoarding: these are cheaper than metal hoarding, easier to construct / amend, durable withstanding exposure to sun and rain. However, they are less lasting than metal hoarding.
- d) Metal hoarding: these are the best hoarding type as it withstands long term exposure to sun and rain. However, they are costly and may be technically difficult to erect.

All hoarding should be carefully and securely taped with heavy-duty tape material. All junctures are to be taped:

- a) Between ceiling tiles and hoarding;
- b) Between juncture of door frames;
- c) In between the gaps of hoarding materials; and
- d) Between hoarding and floor.

When hoarding extends through interstitial space, ensure all holes, pipes, conduits and punctures are tightly sealed.

2.2.1 Audit / Inspection rounds

It is highly recommended that regular audits be done to ensure that infection prevention and control measures are in place. The key factors to check on are:

- a) Integrity of hoarding and efficacy;
- b) Negative pressure maintenance in renovation work area; and
- c) Environmental cleanliness i.e. dust control.

The frequency of audits to be done is highly dependent on type of work. It is recommended that audits be done at least daily when work activity results in significant dust generation e.g. when demolition work is being conducted.

2.2.2 Air Monitoring

Serial fungal air sampling may be done to monitor risk for healthcare associated *Aspergillus* infections. Where possible, a baseline should be established prior to the

start of a construction or renovation project that can serve as a reference, as there are no standard cut offs that can be used for the interpretation of fungal counts. Cumulative data over time should be used to monitor levels air contamination to correlate with construction / renovation activities and effectiveness of control measures. The following readings should be collected at time of fungal air monitoring to assist in the interpretation of results:

- a) Wind direction;
- b) Air velocity;
- c) Temperature;
- d) Relative humidity; and
- e) Presence or absence of HEPA filter.

The air samplers used for fungal monitoring should be a slit or sieve impactor sampler that is capable of collecting large volumes of air in short periods of time to detect low numbers of fungal spores.

2.2.2.1 Indication for Air Sampling

- a) To monitor levels of contamination prior to occupancy of special controlled environment e.g. to determine efficiency of HEPA filters.
- b) To correlate outbreaks of invasive aspergillosis with hospital construction or demolition work
- c) To identify potential sources of nosocomial aspergillosis when a case has been identified.
- d) To predict environmental spore contamination from outside sources.
- e) To identify defects/breakdown in hospital ventilation systems

Routine air sampling is only recommended for commissioning and re-commissioning of operating rooms and clean rooms. It may be useful during construction where immunocompromised patients may be impacted, or during investigation of a cluster of infections. Air sampling only measures indoor air quality at a single point of time and are dependent on a number of confounding variables including:

- a) Indoor traffic;
- b) Visitors coming into the facility;

- c) Temperature;
- d) Time of day or year;
- e) Relative humidity;
- f) Relative concentration of particles or organisms; and
- g) Performance of the air handling system components.

All results need to be compared with baseline results if available, or with other defined areas with similar conditions, or time periods in order to be meaningful.

2.2.2.2 Active Sampling Procedure for fungi and bacteria in construction

This procedure samples the air for the enumeration of bacteria and fungi. As part of a construction program or as an aid to investigation into infection clusters, air sampling is conducted at an interval determined by the Infection Prevention and Control Committee, to detect fungi (including *Aspergillus fumigatus* spore loads) and bacteria. It generally only provides usable readings when a baseline level of counts is available to compare the latest results with. When commencing a sampling program, baseline sampling must be undertaken to establish both background levels and historical records. Historical records are essential to allow seasonal variations in spore count to be taken into account. Cumulative data is used to establish indoor and outdoor background levels of filamentous fungi for a particular site. This will enable establishment of risk profiles for particular locations in and around the hospital.

2.2.2.3 Location of Sampling

Sampling height is 1.2 metres for room hygiene, with other samples taken for exploratory purposes that are near suspected to the potential sources of contamination. Multiple air sampling over a period of time is preferred to a single sample.

2.2.2.4 Interpretation of air sampling results

Sampling results are highly variable due the factors already outlined. Depends on the season, outdoor total spore count levels can exceed 1,000 colony-forming units per cubic meter (CFU/m³) but can be as high as 10,000 CFU/m³. *A. fumigatus* levels in outdoor air averages 1–15 CFU/m³. Indoor spore levels below 100 CFU/m³ total spore count are considered to be inconsequential in areas not housing an at risk

population. In outbreaks involving at-risk patients, aspergillosis cases have occurred when fungal spore concentrations in protective environment ambient air ranged as low as 0.9–2.2 CFU/m³ of air.

Investigators have also suggested limits of 15 CFU/m³ for total spore counts of fungal organisms and <0.1 CFU/m³ for *Aspergillus fumigatus* and other potentially opportunistic fungi in HEPA filtered areas with at least 12 ACH and positive air pressure. There has been no reported correlation of these values with the incidence of healthcare-associated fungal infection rates. Other investigators suggest specialised areas with HEPA filtered supply air systems with an air change rate of at least 15 air changes per hour should achieve a concentration of 0.03 CFU/m³ of *A. fumigatus* for Bone Marrow Transplants and laminar flow suites should achieve a concentration of 0 CFU/m³ of *A. fumigatus*. Total indoor spore counts in these areas should not exceed 15 CFU/m³.

2.3 Hand-over and Pre-Occupation Stage

After hand-over it is the hospital's responsibility to ensure that the area complies with hospital cleanliness standards for occupation. The hospital should thoroughly clean and decontaminate all surfaces including walls, ceilings, and windows as well as high-risk area ventilation systems, service cavities and ceiling spaces.

If air sampling and particle counts are being conducted, sufficient time must be allocated for culturing. It is advisable to implement a program of air sampling in high risk areas for a period of time after hand-over and occupation. Once all these tasks have been completed, re-certify HEPA filters and laminar / clean flow systems where installed.

There is limited literature or published guidelines on post-construction inspection and commissioning. The recommendations listed below are largely referred from the recommendation by Bartley and Olmsted and applies to newly constructed facility. A checklist should be developed during planning stage and agreed upon by all key stakeholders in the project team, including Infection Prevention and Control committee and contractors, to ensure a systematic assessment of all important

aspects during post-construction inspection and commissioning. In general, the inspection should include, but are not limited to, the following:

- a) Airflow, pressures, filters, location of air intakes and vents are meeting the pre-set requirement; and
- b) Drains to the sanitary sewer system are connected and functioning.

The inspection should be carried out according to the type and the phase of the project.

2.3.1 Two weeks before moving into new facility:

- a) Use processing packs to check steam, gas sterilizers (applicable to newly constructed Supplies Sterilization and Processing Room).
- b) Verify correct water temperatures. Verify the quality of water with microbiological testing and check that the parameters are within acceptable range as specified by NEA
- c) Complete written schedules and procedures for routine maintenance of equipment, cooling towers, and suction machines (central and portable); establish documentation.
- d) Determine transportation systems.
- e) Walk through the facility with local health department representative and facility management staff to ensure compliance with national guidelines.

2.3.2 One week before moving into new facility:

- a) Evaluate heat, ventilation, air-conditioning (HVAC) supplying special areas, such as operating rooms and interventional cardiology rooms. Objective evidence should be requested from contractor that HVAC is providing air exchanges and filtration as designed, before owner acceptance. Assess methods for determining effectiveness of particulate matter removal, whether it should be particle, bacterial or fungal spore counts monitoring.
- b) Evaluate laminar air hoods for effective operation; ensure functioning according to manufacturer specifications. Ensure a maintenance contract has been arranged and testing accomplished.

- c) Ensure that there is adequate number of hand hygiene facilities (hand washing basins, paper towel dispensers, and alcohol-based hand rub holders). Ensure that the hand hygiene facilities are designed according to the requirement (including the type of basin and sink top, location, functionality of the dispensers).
- d) Verify that sinks in critical patient-care areas have properly functioning fixtures.
- e) Open all faucets simultaneously to test drain effectiveness. Assess the water flow to ensure acceptable flow rate and to observe for the presence of water stagnation at the tip of the faucet. This is particularly important if sensor-operated faucets are used.
- f) Check that aerators are not on designated faucets.
- g) Check floor drains, and ensure that traps have water seals to prevent sewer gases from entering rooms.
- h) Check that there is adequate number of puncture-resistant containers and waste bins. The containers and bins should be installed according to requirements. The location of the containers and bins should be aligned with the work process of the users, and the height of the puncture-resistant containers is at eye level.
- i) Check that carpeting is not used in high-traffic zones in patient care areas or where spills are anticipated (e.g. burn therapy units, operating rooms, laboratories, and intensive care units) or in patient rooms in areas housing immunocompromised patients (e.g. protective environment areas).
- j) Ensure that contractors have completed their own cleaning and disinfecting; ensure housekeeping department has completed facility follow-up cleaning.
- k) Ensure registered pest control and management are functioning and checked.
- l) Infection Prevention and Control team should be prepared to intensify surveillance for HAIs and monitoring of infection Prevention and control practices.

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Appendix 11.1. Infection Prevention Risk Assessment Matrix of Precautions for Construction and Renovation

Step One:

Using the following table, *identify* the Type of Construction Project Activity (Type A-D)

TYPE A	<p>Inspection and Non-Invasive Activities Includes, but is not limited to: Removal of ceiling tiles for visual inspection limited to one tile per 50 square feet Painting (but not sanding) Wall covering, electrical trim work, minor plumbing, and activities which do not generate dust or require cutting of walls or access to ceilings other than for visual inspection</p>
TYPE B	<p>Small scale, short duration activities which create minimal dust Includes, but is not limited to: Installation of telephone and computer cabling Access to chase spaces Cutting of walls or ceiling where dust migration can be controlled</p>
TYPE C	<p>Work that generates a moderate to high level of dust or requires demolition of any fixed building components or assemblies Includes, but is not limited to:</p> <ul style="list-style-type: none"> ■ Sanding of walls for painting or wall covering ■ Removal of floorcoverings, ceiling tiles, and casework ■ New wall construction ■ Minor duct work or electrical work above ceilings ■ Major cabling activities ■ Any activity which cannot be completed within a single work shift
TYPE D	<p>Major demolition and construction projects Includes, but is not limited to: Activities which require consecutive work shifts Requires heavy demolition or removal of a complete cabling system New construction</p>

Step Two:

Using the following table, *identify* the Patient Risk Groups that will be affected.

If more than one risk group will be affected, select the higher risk group:

Infection Prevention Risk Groups			
LOW RISK	MEDIUM RISK	HIGH RISK	HIGHEST RISK
<ul style="list-style-type: none"> ■ Office areas 	<ul style="list-style-type: none"> ■ Cardiology ■ Echocardiography ■ Endoscopy ■ Nuclear Medicine ■ Physical Therapy ■ Radiology/MRI ■ Respiratory Therapy ■ Dental Office 	<ul style="list-style-type: none"> ■ CCU ■ Emergency Room ■ Labour & Delivery ■ Laboratories (specimen) ■ New-born Nursery ■ Outpatient Surgery ■ Paediatrics ■ Pharmacy ■ Post Anaesthesia Care Unit ■ Surgical Units 	<ul style="list-style-type: none"> ■ Any area caring for immunocompromised patients ■ Burn Unit ■ Cardiac Catheterization Lab ■ Central Sterile Supply ■ Intensive Care Units ■ Medical Unit ■ Negative pressure isolation rooms ■ Oncology ■ Operating rooms including C-section rooms

Step Three: Match the

- **Patient Risk Group (*Low, Medium, High, Highest*)** with the planned...
- **Construction Project Type (*A, B, C, D*)** on the following matrix, to find the...
- **Class of Precautions (*I, II, III or IV*)** or level of infection prevention activities required.

Class I-IV or Color-Coded Precautions are delineated on the following page.

IC Matrix - Class of Precautions: Construction Project by Patient Risk

PATIENT RISK GROUP	CONSTRUCTION PROJECT TYPE			
	TYPE A	TYPE B	TYPE C	TYPE D
LOW Risk Group	I	II	II	III/IV
MEDIUM Risk Group	I	II	III	IV
HIGH Risk Group	I	II	III/IV	IV
HIGHEST Risk Group	II	III/IV	III/IV	IV

CLASS I	<ol style="list-style-type: none"> 1. Execute work by methods to minimize raising dust from construction operations. 2. Immediately replace a ceiling tile displaced for visual inspection.
CLASS II	<ol style="list-style-type: none"> 1. Provide active means to prevent airborne dust from dispersing into atmosphere. 2. Water mist work surfaces to control dust while cutting. 3. Seal unused doors with duct tape. 4. Block off and seal air vents. 5. Place dust mat at entrance and exit of work area. 6. Remove or isolate HVAC system in areas where work is being performed.
CLASS III	<ol style="list-style-type: none"> 1. Remove or isolate HVAC system in area where work is being done to prevent contamination of duct system. 2. Complete all critical barriers i.e. sheetrock, plywood, plastic, to seal area from non-work area or implement control cube method (cart with plastic covering and sealed connection to work site with HEPA vacuum for vacuuming prior to exit) before construction begins. 3. Maintain negative air pressure within work site utilizing HEPA equipped air filtration units. 4. Contain construction waste before transport in tightly covered containers. 5. Cover transport receptacles or carts. Tape covering unless solid lid.
CLASS IV	<ol style="list-style-type: none"> 1. Isolate HVAC system in area where work is being done to prevent contamination of duct system. 2. Complete all critical barriers i.e. sheetrock, plywood, plastic, to seal area from non-work area or implement control cube method (cart with plastic covering and sealed connection to work site with HEPA vacuum for vacuuming prior to exit) before construction begins. 3. Maintain negative air pressure within work site utilizing HEPA equipped air filtration units. 4. Seal holes, pipes, conduits, and punctures appropriately. 5. Construct anteroom and require all personnel to pass through this room so they can be vacuumed using a HEPA vacuum cleaner before leaving work site or they can wear cloth or paper coveralls that are removed each time they leave the work site. 6. All personnel entering work site are required to wear shoe covers. Shoe covers must be changed each time the worker exits the work area. 7. Do not remove barriers from work area until completed project is inspected by the owner's Safety Department and infection prevention Department and thoroughly cleaned by the owner's Environmental Services Department.

Step 4: Identify the areas surrounding the project area, assessing potential impact

Step 5: Identify specific site of activity, e.g. patient rooms, medication room.

Step 6: Identify issues related to: ventilation, plumbing, electrical in terms of the occurrence of probable outages.

Step 7: Identify containment measures, using prior assessment. What types of barriers? (E.g. solids wall barriers); will HEPA filtration be required?

(Note: Renovation/construction area shall be isolated from the occupied areas during construction and shall be negative with respect to surrounding areas)

Step 8: Consider potential risk of water damage. Is there a risk due to compromising structural integrity? (E.g. wall, ceiling, roof)

Step 9: Work hours: Can or will the work be done during non-patient care hours?

Step 10: Do plans allow for adequate number of isolation/negative airflow rooms?

Step 11: Do the plans allow for the required number and type of hand washing sinks?

Step 12: Does the infection prevention staff agree with the minimum number of sinks for this project? (Verify against AIA Guidelines for types and area.)

Step 13: Does the infection prevention staff agree with the plans relative to clean and soiled utility rooms?

Step 14: Plan to discuss the following containment issues with the project team, e.g. traffic flow, housekeeping, debris removal (how and when).

Note: Identify and communicate the responsibility for project monitoring that includes infection prevention concerns and risks. The ICRA may be modified throughout the project. Revisions must be communicated to the Project Manager.

Steps 1-3 Adapted with permission V. Kennedy, B. Barnard, St Luke Episcopal Hospital. Houston TX; C Fine, CA Steps 4-14 Adapted with permission Fairview University Medical Centre, Minneapolis MN. Forms modified and provided courtesy of J. Bartley, ECS, Inc., Beverly Hills MI 2002

Infection Control Rounds (Samples adapted from SGH Checklists)

Construction & Renovation Infection Control On-site Checklist
for Class Precaution III

Location of project:																
Nature of project:																
Project start date:																
Contractor in-charge:																
Project officer in-charge:																
Date of assessment:																
A. Barriers	Y	N	NA	Y	N	NA	Y	N	NA	Y	N	NA	Y	N	NA	
1	All construction barriers are completed before construction begins.															
2	Correct type of barrier is used and the barriers erected effectively seal the work area from non-work area.															
3	Clear signboard is put up to direct pedestrian traffic away from construction area.															
B. Negative pressure	Y	N	NA	Y	N	NA	Y	N	NA	Y	N	NA	Y	N	NA	
1	Air vents are blocked off and sealed (if applicable).															
2	HVAC system is removed or isolated (if applicable).															
3	HEPA equipped air filtration units are utilized to maintain negative air pressure within the work site (if applicable).															
C. Dust control	Y	N	NA	Y	N	NA	Y	N	NA	Y	N	NA	Y	N	NA	
1	Windows at the site are closed when hacking is in process.															
2	Clean dust mat is placed at entrance and exit of work area.															
3	Work area is swept, wet mopped or vacuumed daily.															
4	Construction waste is contained and covered properly before transportation.															
D. Upon completion of project	Y	N	NA	Y	N	NA	Y	N	NA	Y	N	NA	Y	N	NA	
1	Construction waste is contained and covered properly before transportation.															
2	Barrier materials are wiped before removal and are removed carefully to minimize spreading of dust.															
3	All surfaces are wiped with disinfectant.															
4	Work area is vacuumed with HEPA filtered vacuum and wet mopped with disinfectant.															
5	Isolation of HVAC system is removed (if applicable).															
Endorsement by Project Officer																

Please place 'X' in the appropriate column ('Y', 'N' or 'NA')
 Y = Compliance is observed
 N = Non-compliance is observed*
 NA = Non-applicable
 *To inform Project Officer immediately when Non-compliance is observed

*Part II. Standard Infection Prevention and Control Practices:
Chapter 11. Construction and Renovation*

**Construction & Renovation Infection Control On-site Checklist
for Class Precaution IV**

Location of project:																
Nature of project:																
Project start date:																
Contractor in-charge:																
Project officer in-charge:																
Date of assessment:																
A. Barriers																
1	All construction barriers including an anteroom are completed before construction begins.	Y	N	NA												
2	Clear signboard is put up to direct pedestrian traffic away from construction area.															
B. Negative pressure																
1	Air vents are blocked off and sealed (if applicable).															
2	HVAC system is removed or isolated (if applicable).															
3	HEPA equipped air filtration units are utilized to maintain negative air pressure within the work site (if applicable).															
C. Dust control																
1	Windows at the site are closed when hacking is in process.															
2	All gaps, holes or opening are covered adequately.															
3	Clean dust mat is placed at entrance and exit of work area (anteroom).															
4	Anteroom is wet mopped or vacuumed daily.															
5	All personnels entering the work site pass through the anteroom.															
6	All personnels entering the work site wear work shoes and overalls where applicable.															
7	Personnel remove work shoes and overalls in the anteroom before leaving the work area.															
8	Work area is kept clean and debris is removed daily.															
9	Construction waste is contained and covered properly before transportation.															
D. Upon completion of project																
1	Construction waste is contained and covered properly before transportation.															
2	Barrier materials are wiped before removal and are removed carefully to minimize spreading of dust.															
3	All surfaces are wiped with disinfectant.															
4	Work area is vacuumed with HEPA filtered vacuum and wet mopped with disinfectant.															
5	Isolation of HVAC system is removed (if applicable).															
Endorsement by Project Officer																

Please place 'X' in the appropriate column ('Y', 'N' or 'NA')
 Y = Compliance is observed
 N = Non-compliance is observed*
 NA = Non-applicable
 *To inform Project Officer immediately when Non-compliance is observed

PART III.

PREVENTION OF DEVICE-ASSOCIATED AND SURGICAL SITE INFECTIONS

Chapter 12. Prevention of Healthcare-associated Pneumonia

Chapter 13. Prevention of Intravascular Catheter-related Infections

Chapter 14. Prevention of Catheter-associated Urinary Tract Infection

Chapter 15. Prevention of Surgical Site Infections

Chapter 12. Prevention of Healthcare-associated Pneumonia

1 **Introduction**

1.1 **Definition**

Pneumonia is an inflammatory process of the lung parenchyma caused by a microbial agent. Pneumonia can be classified according to its origin to guide antimicrobial therapy decisions as the causative organisms are likely to be different. Hospital-acquired pneumonia (HAP) is defined as pneumonia that occurs more than 2 calendar days after hospital admission that was not present at the time of admission. Healthcare-associated pneumonia (HCAP) includes patients who have recently been hospitalized within 90 days of the infection, resided in a nursing home or long-term care facility, or received parenteral antimicrobial therapy, chemotherapy, or wound care within 30 days of pneumonia. Ventilator-associated pneumonia (VAP) refers to hospital-acquired pneumonia that develops in patients who have been intubated and have received mechanical ventilation for at least 48 hours. The National Healthcare Safety Network defines VAP as any pneumonia that develops after the patient has been intubated, regardless of the time elapsed. The term HAP is often used to represent both VAP and HCAP.

1.2 **Pathogenesis**

In general, it is believed that the colonization of the upper respiratory tract precedes the development of healthcare-associated pneumonia. For pneumonia to develop, pathogenic microorganisms must reach the distal lung and then multiply, overcoming host defences at each step. These host defences include filtration and humidification of air in the upper airways, epiglottic and cough reflexes, ciliary transport by respiratory epithelium, phagocytes and opsonins in the distal lung, and systemic cell-mediated and humoral immunity.

The probable sources of colonization are postulated to be:

- a) Endogenous sources including upper respiratory tract and less commonly, the stomach and intestines; and,
- b) Exogenous sources from either another patient or healthcare professional (HCP). This most probably occurs via hands of HCP,

involving direct inoculation of micro-organisms into the tracheobronchial tree during the manipulation of ventilator circuits or tubes.

The environment (air, water, sink, faucets, respiratory care equipment, and fomites) and tube-feeding formulas are other sources reported to be associated with outbreaks of HAP.

Of all the plausible routes, micro-aspiration of oropharyngeal organisms to the lower respiratory tract is believed to be the most important route for HAP and community-acquired pneumonia. Persons with abnormal swallowing, such as those who have depressed consciousness, respiratory tract instrumentation and/or mechanically assisted ventilation, gastrointestinal tract instrumentation or diseases, or who have just undergone surgery, especially thoracic and/or abdominal surgery, are particularly likely to aspirate. In patients receiving mechanical ventilation, aspiration of oropharyngeal pathogens, or leakage of bacteria-containing secretions around the endotracheal tube cuff, is believed to be the primary routes of bacterial entry into the lower respiratory tract. Similarly, in nursing homes, silent aspiration is said to be the most important cause of pneumonia in the elderly population.

1.3 Risk factors

Risk factors for the development of HAP can be differentiated into modifiable and non-modifiable conditions. Modifiable risk factors are obvious targets for improved management. These include:

- a) intubation and mechanical ventilation;
- b) supine patient positioning;
- c) enteral nutrition;
- d) oropharyngeal colonization;
- e) stress bleeding prophylaxis;
- f) exposure to transfusion of blood products;
- g) poor glucose control; and
- h) exposure to antibiotics.

Non-modifiable factors reported are mostly patient-related: 1) male sex, 2) pre-existing pulmonary disease, 3) multiple organ system failure, 4) presence of underlying

morbidity and impairment of the local and systemic host defences, 5) other host factors such as extremes of age; malnutrition; prior episode of a large-volume aspiration; depressed level of consciousness; and severe trauma. In addition to the abovementioned factors, independent predictors of nursing home-associated pneumonia (NHAP) have included poor functional status; presence of a nasogastric tube; swallowing difficulties; occurrence of an unusual event associated with altered mental alertness.

The risk factors for HAP, VAP and HCAP with multidrug-resistant organisms (MDRO) are: 1) history of antimicrobial therapy in preceding 90 days, 2) current hospitalization of 5 days or longer, 3) high prevalence of antibiotic resistance in the community or in the specific healthcare institution, and, 4) presence of the abovementioned risk factors for HCAP.

1.4 Epidemiology

HAP carries a crude mortality rate of 30 to 70% with an estimated attributable mortality rate to pneumonia between 27% and 50%. In USA, the exact incidence of HAP is usually between 5 and 15 cases per 1,000 hospital admissions depending on the case definition and study population. Incidence of HAP increases by 6 to 21 fold in mechanically ventilated patients, rendering VAP as the most common nosocomial infection in critically ill patients. Development of a VAP was associated with an increase of more than USD\$ 40,000 in mean hospital charges per patient. Patients with late onset of HAP and VAP are more likely to be infected with MDRO and have higher crude mortality rates than patients with early onset disease. In long term care facilities (LTCF), pneumonia is the first or second most common nosocomial infection and accounts for 13 – 48% of all nursing home-associated infections. The case-fatality rate of NHAP is reported to be from 6% to 23%.

Bacteria cause most cases of HAP, VAP and HCAP and many infections are polymicrobial. Aerobic gram-negative bacilli and gram-positive cocci are the most common pathogens associated with HAP, VAP and HCAP. These include *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Acinetobacter baumannii* and *Staphylococcus aureus*. However, it is important to note that the causative agents can vary depending on the length of time the patient has spent in the ICU (Intensive Care

Unit) and/or received mechanical ventilation. In addition, the lack of reports of the association of HAP due to anaerobic bacteria or viruses is partly because anaerobic bacterial and viral cultures were not performed routinely in some reporting facilities. The rates of *Legionella pneumophilla* also vary considerably between hospitals and disease occurs more commonly with serogroup 1 when the water supply was colonized or when there was on-going construction. *Legionella* spp. and *Chlamydia pneumonia* have caused outbreaks in LTCF. Outbreaks of influenza and respiratory syncytial virus were reported sporadically especially in nursing homes and the risk of infection can be substantially reduced with widespread effective infection control, vaccination and use of anti-influenza agents. The prevalence of MDRO varies by patient population, hospital, and type of ICU and this underscores the importance of HAP surveillance in individual institutions.

The bacterial etiology of non-HAP (NHAP) is inconclusive primarily because definitive etiologic diagnosis usually is not rigorously pursued. *Streptococcus pneumonia*, *Haemophilus influenzae*, *Staphylococcus aureus* and *Moraxella catarrhalis* are said to be the most common causative agents. There is a lack of reports on the NHAP in Singapore. However, a retrospective descriptive study on patients with severe community-acquired pneumonia reported similar findings. Gram-negative organisms were responsible for 47% of the patients recruited in the study and the most common bacteria identified were *Klebsiella pneumoniae*, *Haemophilus influenzae* and *Streptococcus pneumoniae*.

2 General Recommendations for all Healthcare Settings

Increasing complexity of patient/client care and the increasing severity of illness of patients and clients in all healthcare settings necessitate increasing awareness of the appropriate infection prevention and control measures and how to apply them. Continuing education should be provided to all HCPs consistent with their work environment (e.g. patient care, administration, engineering services, housekeeping) and responsibility level within the facility and/or organization regarding the following:

- a) routine practices and additional precautions for preventing the transmission of infections in healthcare facilities;
- b) epidemiology of HAP, specific to the work setting;

- c) modes of transmission of specific microbial agents responsible for HAP;
- d) specific measures and procedures to prevent and control healthcare-associated pneumonia; and
- e) the importance of compliance with infection prevention and control practices and procedures to prevent and control healthcare-associated pneumonia.

2.1 Recommendations

- a) Healthcare facilities and organizations providing patient/client care should have policies and procedures for the prevention of healthcare-associated pneumonia. [All]
- b) Continuing education should be provided to all HCPs on infection prevention and control principles in the prevention of transmission of healthcare associated infections as well as the prevention of HAP. [All]

3 Recommendations for Acute Care Facilities and Community Hospitals

Mechanical ventilation is the primary risk factor for the development of pneumonia in acute care settings. The key prevention strategies therefore focus on three main issues, namely aspiration, colonization of the aerodigestive tract and contamination of respiratory care equipment. With these strategies there should be ongoing quality improvement programs including infection surveillance for outcome measures, direct observation and audit for compliance and educate healthcare professional who care for patients undergoing ventilation.

3.1 Prevent aspiration

- a) Intubation and mechanical ventilation should be avoided whenever possible. The risk of aspiration around an artificial airway can be reduced by noninvasive positive pressure ventilation, using either a full face mask or a nasal mask.
- b) Nurse the ventilated patient in semi-recumbent position between 30 – 40 degrees, especially during feeding and transportation, unless there is a contraindication.

- c) Decrease the duration of intubation by assessing the patient's readiness for weaning and the appropriateness of spontaneous breathing trials on a daily basis.
- d) Avoid continuous use of paralytics.
- e) Avoid over-sedation.
- f) Interrupt or lighten sedations daily at an appropriate time.
- g) Ensure gastric tube is in the proper position every time before feeding.
- h) For long term ventilated patients, the use of gastrostomy tube feeding can lower the risk of aspiration.

3.2 Prevent colonization of the aerodigestive tract

- a) Consistent and thorough hand hygiene is the most effective means of preventing colonization and infection caused by exogenous microorganisms. All healthcare workers should diligently observe the five moments of hand hygiene. Gloves should be worn if contact with respiratory secretions or contaminated objects are anticipated, and appropriate hand hygiene should be performed before and after glove use.
- b) Provide oral care to ventilated patients such as 0.12% Chlorhexidine antiseptic oral rinse at regular interval.
- c) The use of stress ulcer prophylaxis to prevent peptic ulcers for ventilated patients can reduce gastric acidity which can result in greater gastric colonization with pathogenic bacteria and should be used judiciously.

3.3 Prevent contamination of respiratory care equipment

- a) Practice Standard Precautions during respiratory care.
- b) Maintain aseptic technique when performing intubation procedures. Mask and gloves should be worn.
- c) Use the oral route for insertion of the endotracheal tube if there is no contraindication.
- d) Perform endotracheal suctioning only when indicated. Measure the depth of suction catheter insertion beforehand and carry out suctioning procedures using aseptic technique.

- e) Saline instillation to loosen sputum for suction should be avoided. If there is a need to do so, single dose sterile solution should be used.
- f) Whenever possible, use steam sterilization or high level disinfection for reprocessing respiratory equipment.
- g) Sterile water should be used to rinse reusable respiratory equipment.
- h) All respiratory care items should be stored in a clean area away from exposure to dust, excess heat or moisture.
- i) The humidifier on the ventilator should be positioned below the bed level to prevent condensation from draining towards the patients.
- j) Condensate from ventilator circuits should be removed before repositioning the patient. During condensate removal the ventilator circuit should be kept closed.
- k) Change the ventilator circuit only when visibly soiled or malfunctioning.

3.4 Prevention of VAP

3.4.1 Elevation of head of bed

A semi-recumbent position with head elevated to 30-45° reduces the potential for aspiration and increases capacity of the lungs for breathing. Drakulovic *et al* in 1998 conducted a randomized controlled trial of 86 mechanically ventilated patients. Patients were randomly assigned to semi recumbent or supine position. Results showed suspected cases of VAP in 34% of patients in the supine position and 8% in the semi-recumbent position ($p=0.003$). Confirmed cases of pneumonia were 23% and 5% respectively ($p=0.018$).

Recommendation

Whenever possible, the head of bed is routinely elevated and measured to be at least 30-45 degrees [B]

3.4.2 Daily 'sedation vacations' and assessment for readiness to extubate

Daily review of sedation with the aim to lighten it helps to prepare patient for readiness to extubate. It becomes easier to wean off the ventilator as the patient is more alert and able to cough and control secretions. Early extubation also decreases the time spent on mechanical ventilation and directly reduces the risk of VAP. In a randomized controlled trial by Kress *et al*, 128 mechanically ventilated adult patients

irrespective of clinical condition and clinician discretion, were randomized to receive daily interruption of sedation. This resulted in a significant reduction in mechanical ventilation time from 7.3 to 4.9 days (P=0.004).

Sedation vacations are not without risk. Careful assessment and graduated lightening of sedation should be practiced to prevent self-extubation, keep the patient comfortable with minimal pain and anxiety while allowing return of self-breathing and synchrony with the ventilator and avoid episodes of desaturation.

Recommendation

In patients mechanically ventilated for >48 hours, a daily sedation vacation and assessment for readiness-to-extubate is undertaken (AI)

3.4.3 Daily oral care with chlorhexidine

The recommended chlorhexidine solution strength used is 0.12%. In mechanically ventilated patients, dental plaque occurs because of the lack of mechanical chewing and absence of saliva production. These plaques serve as reservoirs for potential respiratory pathogens that cause VAP. Good oral care prevents this.

Chlorhexidine antiseptic has proven to inhibit the development of dental plaque formation and gingivitis. A study in 1996 by DeRiso et al. demonstrated that the use of 0.2% chlorhexidine oral rinse reduces nosocomial respiratory tract infections in cardiac surgery patients.

Chan et al (2007) reported in a meta-analysis, the evaluation of eleven studies for the effect of oral decontamination on the incidence of ventilator-associated pneumonia and mortality in mechanically ventilated adults. Results concluded that oral decontamination using chlorhexidine is associated with a lower risk of ventilator-associated pneumonia in mechanically ventilated patients.

Recommendation

Oral decontamination with chlorhexidine twice a day is recommended for the prevention of VAP (AI).

3.4.4 Route of Endotracheal Intubation

While the causality between sinusitis and VAP has not been firmly established, aspiration of infected secretions from nasal sinuses would, intuitively, predispose to the development of VAP.

In a prospective randomized study (n=300), Holzapfel *et al* demonstrated that orotracheal intubation is associated with lower VAP rates as compared to nasotracheal intubation (RR 0.52; 95% confidence interval 0.24- 1.13). This study, together with 4 other trials showed a decreased incidence of sinusitis with orotracheal intubation. Of note, patients who do not develop sinusitis have a lower incidence of VAP.

Recommendation

Where possible, orotracheal intubation should be used in preference to nasotracheal intubation (AI).

3.4.5 Systematic search for maxillary sinusitis

Maxillary nosocomial sinusitis as a complication of endotracheal intubation has been reported. The incidence of infectious sinusitis is estimated at 20% after 8 days of mechanical ventilation in patients orotracheally or nasotracheally intubated. Clinical signs are not specific. Sinusitis is usually searched for in patients with unexplained fever and is diagnosed by sinus radiograph or sinus CT scan.

Reported risk factors for sinusitis include head trauma, prior high dose steroids, sedation, nasotracheal intubation, nasogastric tubes and duration of endotracheal and gastric intubation.

No recommendation can be made for the systematic search for maxillary sinusitis because of insufficient evidence. There is only one randomised controlled trial that demonstrated that a systematic search for maxillary sinusitis in patients who are intubated by the nasotracheal route may decrease the incidence of VAP.

3.4.6 Frequency of ventilator circuit changes

The relation between the frequency of ventilator tubing change and the incidence of ventilator associated pneumonia has been investigated by several groups¹⁻⁵. No benefit in terms of reducing infection has been demonstrated by routinely changing ventilator circuits. Randomized trials have found that when circuits were changed when visibly soiled or mechanically defective, they were associated with rates of VAP similar to or modestly lower than rates occurring with regularly scheduled changes.

Handling and disposing of the condensate that forms on the inspiratory phase tubing of ventilator circuits poses a risk of pneumonia in patients undergoing mechanical ventilation with humidification. This condensate rapidly becomes colonized with flora if not appropriately drained. Contaminated fluid may be accidentally washed directly into the patient's trachea when the tubing is manipulated.

Decontaminate hands with soap and water (if hands are visibly soiled) or with an alcohol-based hand rub after performing the procedure or handling the fluid (IA).

Recommendations

- a) The ventilator circuit should only be changed when defective or physically soiled (AI).
- b) Breathing-circuit-tubing condensate in the tubing of a mechanical ventilator is to be drained periodically. Precautions are to be taken not to allow condensate to drain toward the patient (BI) .
- c) Gloves are to worn when performing the previous procedures and/or when handling the fluid (BI).

3.4.7 Type of airway humidification

When the upper airway is bypassed, humidification during mechanical ventilation is necessary to prevent hypothermia, inspissation (thickening by dehydration) of airway secretions, destruction of airway epithelial cells and atelectasis. This may be accomplished using a heat and moisture exchanger (HME) or heated humidifier. HMEs operate passively by storing heat and moisture from the patient's exhaled gas and releasing it to the inhaled gas. Heated humidifiers operate actively to increase the heat and water vapour content of inspired gas.

No recommendations can be made for the preferential use of either HMEs or heated humidifiers to prevent pneumonia in patients receiving mechanically assisted ventilation. Use of heat and moisture exchangers may be associated with a slight decrease in incidence of VAP compared with heated humidifiers.

Heat and moisture exchangers are contraindicated in patients with haemoptysis or who require high minute ventilation. Cost considerations favour the use of heat and moisture exchangers.

Recommendation

No recommendation can be made on the use of HMEs over heated humidifiers in the prevention of VAP (BI).

3.4.8 Frequency of change of airway humidification

Manufacturers state that HME should be changed every 24 hours but there is no clinical data to support this recommendation.

Studies have suggested that the same HME can be safely left in place for longer than 24 hours without adverse patient outcomes. Infrequent changes to heat and moisture exchangers may be associated with a slightly decreased incidence of VAP. Reduction in the frequency of humidifier changes might be considered as a cost-reduction measure.

Recommendations

- a) Change a HME that is in use on a patient when it malfunctions or becomes visibly soiled (BII). Do not change more frequently than every 48 hours a HME that is in use on a patient (BII).
- b) Do not change routinely the breathing circuit attached to a HME while it is in use on a patient in the absence of gross contamination or malfunction (BII).

3.4.9 Type of endotracheal suctioning system (Open vs Closed)

Endotracheal suctioning is an essential part of care for patients requiring mechanical ventilation, to keep the airways free from bronchial secretions, thereby guaranteeing good ventilation and oxygenation. There are 2 types of suction systems. In the conventional open system, endotracheal suctioning requires opening of the respiratory circuit, which is usually performed by disconnecting the patient from the ventilator and introducing a single-use sterile suctioning catheter into the endotracheal tube. The closed suction system, which was developed in the 1980s, removes the necessity of disconnecting the patient from the respiratory circuit and employs multiuse suction catheters. Suctioning is performed without barrier precautions, because a plastic envelope protects the catheter.

The potential benefits of the closed system, compared with the open system, are:

- a) No loss of positive end expiratory pressure and lung volume;
- b) Reduced exogenous contamination of the inside of the endotracheal tube; and
- c) Decreased contamination of the environment or of the hands of healthcare professionals from respiratory microorganisms.

The main concern about closed systems is increased colonization inside the suction catheter during the multiple uses in 24 hours. There is auto-contamination of a larger number of microorganisms into the trachea each time suctioning is performed.

Although the literature reports several advantages for the closed suction system, reviews showed that the two systems were comparable in the outcomes of ventilator-associated pneumonia and mortality.

The Centres for Disease Control and Prevention do not establish recommendations about the type of endotracheal suction systems that should be used and the frequency of changing catheters in closed suction systems.

3.4.10 Does the type of endotracheal suctioning system (open or closed) affect the incidence of VAP?

There were 2 trials which concluded that the type of suctioning system has no effect on the incidence of VAP. Another 2 studies compared an open endotracheal suctioning system to a closed system. One study reported significantly less environmental contamination with closed suctioning than with open suctioning. Accordingly, the patient usually contaminates the catheter, rather than vice versa. Use of closed suctioning has been recommended as part of a VAP prevention program. The other study, however, reported a 3.5 times greater risk of VAP in patients randomized to receive open suctioning than those receiving closed suctioning. As ventilator circuits do not need to be changed at regular intervals for infection prevention and control purposes, this might suggest that in-line suction catheters also do not need to be changed at regular intervals for infection prevention and control purposes. Another observational study reported no change in VAP rate when in-line suction catheters were changed on a weekly rather than daily basis.

Available evidence is inconclusive on whether closed suctioning increases or decreases the risk of VAP. The type of endotracheal suctioning system (open or closed) has no effect on duration of ventilation. Safety considerations (patient and healthcare professional such as exposure to aerosols) support the use of a closed system.

Recommendation

There is no recommendation for the routine use of closed endotracheal suctioning for the reduction of VAP (A1).

3.4.11 Frequency of change of endotracheal suctioning system

When closed suction catheters are used, scheduled daily changes or unscheduled changes of the suctioning system have no effect on the incidence of VAP.

Recommendation

In-line catheters for closed endotracheal suction systems should only be changed when defective or soiled (B1).

3.4.12 Subglottic Secretion Drainage (SSD)

Aspiration of oropharyngeal secretions containing bacterial pathogens into the lower respiratory tract is an important consideration in the pathogenesis of VAP.

SSD is designed to minimize the pooling and subsequent leakage of secretions around the cuff of the endotracheal tube (ETT).

A randomized, controlled, multicentre study involving 333 patients demonstrated a significant reduction of VAP in the treatment arm (intermittent SSD) as compared to control group (RR 0.42; 95% confidence interval 0.10- 0.63). The beneficial effects of SSD was seen both in early and late onset VAP patients.

Similarly, a recent meta-analysis with a total of 2442 randomized patients showed a reduction of VAP rates in the SSD arm (RR 0.55; 95% confidence interval 0.46-0.66). The use of SSD was also associated with decreased length of mechanical ventilator days (-1.08 days; 95% confidence interval -2.04 to -0.12), shortened ICU length of stay (-1.52 days; 95% confidence interval -2.94 to -0.11) and increased time to the first episode of VAP (2.66 days; 95% confidence interval 1.06- 4.26).

Subglottic- suction ETTs are, however, more expensive than standard ETTs and are more likely to benefit patients who need prolonged mechanical ventilation. Various studies analysing the cost effectiveness of such tubes on VAP modelling showed an overall cost savings per episode of VAP prevented with SSD despite a higher acquisition cost.

Recommendation

Use of SSD is recommended in patients who are expected to require mechanical ventilation for more than 72 hours (AI).

3.4.12 Timing of Tracheostomy

Tracheostomy has several advantages in patients who require prolonged intubation and mechanical ventilation. It affords better patient comfort, and facilitates oral hygiene and secretion management while reducing anatomical dead space and airway resistance. Early tracheostomy (usually within 7 days of laryngeal intubation)

has been postulated to prevent VAP, this is however controversial with some studies showing benefit and some none.

A prospective randomized trial (n=120) reported early tracheostomy (within 2 days of intubation) was associated with reduced incidence of pneumonia, length of ICU stay and ventilator days when compared to the late group (14-16 days).¹ In contrast, Blot *et al* found no difference in VAP rates, duration of mechanical ventilation and ICU stay between early tracheostomy (within 4 days) versus prolonged endotracheal intubation.

In a randomized controlled multi-centre trial, early when compared to late tracheostomy did not result in any significant improvement in the incidence of VAP.

Similarly, the authors of a recent meta-analysis (seven trials, 1044 patients) comparing important outcomes in ventilated patients who received early versus late tracheostomy concluded that early tracheostomy did not reduce incidence of VAP (RR 0.94; 95% confidence interval 0.77-1.15). The timing of tracheostomy was also not associated with reduced duration of mechanical ventilation nor shortened ICU stay.

Importantly, though, it is noted that the trials till date have significant methodological limitations and heterogeneity. Caution should be taken while interpreting these pooled results. The yet to be published results of the TracMan trial may, in the future, provide a clearer indication on the role of early tracheostomy in critically ill patients.

Recommendation

Early tracheostomy is not recommended routinely for the prevention of VAP (AI).

3.4.13 The VAP Bundle

The Institute of Health Improvement (IHI) Ventilator Bundle¹ is a series of evidence based interventions that when implemented together will achieve significant outcomes of reducing VAP in patients on mechanical ventilation.

The components of the VAP Bundle are:

- a) Elevation of head of bed;
- b) Daily 'sedation vacations' and assessment for readiness to extubate;
- c) Peptic Ulcer Disease prophylaxis;
- d) Deep Venous Thrombosis prophylaxis; and
- e) Daily oral care with chlorhexidine.

It is controversial whether all the components of the VAP bundle contribute equally to the prevention of VAP. As discussed, there is reasonably good evidence for elevation of the head of bed, sedation vacations and daily oral care. Prophylaxis against peptic ulcers and deep vein thrombosis represents good practice in all mechanically-ventilated patients as these complications are relatively common. However, these interventions have not been individually shown to reduce VAP, nor is there a good biologic rationale to believe so. Nevertheless, when the VAP bundle is implemented as a whole, before-and-after studies seem to suggest that VAP rates are reduced. For example, in a recent publication by Al-Tawfiq *et al*, implementation of the IHI VAP bundle resulted in a reduction of VAP from 9.3 per 1000 ventilator days to 2.3 per 1000 ventilator days.

Chapter 13. Prevention of Intravascular Catheter-related Infections

1 Introduction

1.1 Definition

The term catheter-related bloodstream infection (CRBSI) has been used interchangeably with central line-associated bloodstream infection (CLABSI). While CRBSI is mostly used for diagnosing and treatment purpose, CLABSI is a term used by CDC's National Healthcare Safety Network (NHSN) for surveillance. In general, a CLABSI is a primary BSI in a patient that had a central line in place on the date of, or the day before, onset of symptoms or collection of positive blood culture, and where the central line was in place for more than 2 days, and is not a BSI related to a secondary source. It is important to note that the CLABSI surveillance definition may overestimate or underestimate the true incidence of CRBSI as some secondary sources may not be easily recognized and some concurrent colonisations at secondary sites may be misclassified as sources. Refer to Surveillance Technical Manual for definition of CLABSI used in national surveillance.

Because of the challenge of identifying the source of a patient's signs of sepsis, patients with abrupt onset of signs and symptoms of sepsis without any other identifiable source should prompt suspicion of an IV catheter-associated infection. If purulence at the catheter insertion site is seen in combination with signs and symptoms of sepsis, it is highly likely the patient has an IV catheter-associated BSI, implying the necessity of removal of IV catheter. In addition, recovery of certain microorganisms in multiple blood cultures, such as staphylococci, *Corynebacterium* or *Bacillus species*, or *Candida* or *Malassezia species* in patients with sepsis and no other source strongly suggests infection of the IV catheter. Prompt resolution of symptoms in such cases with catheter removal also supports the diagnosis of catheter related bloodstream infection.

1.2 Pathogenesis

The pathogenesis of IV catheter-associated infections involves complex interactions between the invading microorganism(s), the catheter and its components and the infusate, and the host. For microorganisms to cause an IV catheter-

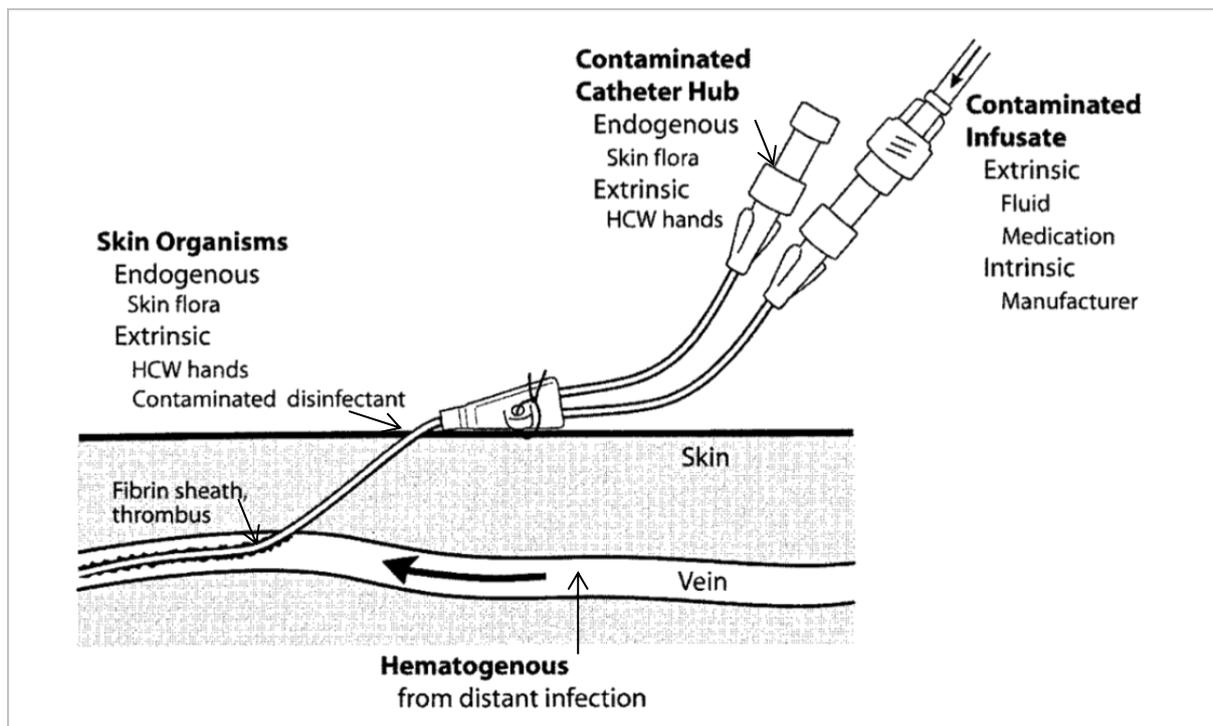
associated infection, they must first gain access to the extra luminal or intraluminal surface of the catheter, where they can adhere, produce, and subsequently form a layer of biofilm. This biofilm acts as a protected enclave, in which microbial organisms can embed themselves, allowing various microorganisms to withstand host defence mechanisms (i.e. engulfment and killing by polymorphonuclear leukocytes).

Four identified routes for catheter contamination are:

- a) Transcutaneous migration of endogenous or extrinsic organism(s) at the insertion site into the extra luminal surface of the catheter with colonization of the catheter tip;
- b) Direct contamination of the catheter or catheter hub by contact with healthcare professional's hands or contaminated disinfectant, fluids or devices;
- c) Haematogenous seeding from distant, unrelated sites of infection; and
- d) Contaminated infusate, the most frequent cause of epidemic CRBSI.

Figure 13.1 illustrates the potential sources of contamination of IV catheters. The longer the duration a catheter remains in place, the higher likelihood of a break in asepsis taking place, leading to contamination of the hub of a catheter. Therefore, while short-term catheters are most frequently colonized via the transcutaneous route, longer-term catheters become colonized via hub contamination.

Figure 13.1. Potential sources of infection of a percutaneous IV catheter



(From Crnich CJ, Maki DG. The promise of novel technology for the prevention of intravascular device-related bloodstream infection. I. Pathogenesis and short-term devices. *Clin Infect Dis* 2002;34(9):1232–1242.)

1.3 Risk factors

Factors associated with increased risk of IV catheter-associated BSI include:

- a) Patient-related factors: prolonged hospitalization, severity of illness, underlying severe immunosuppression (e.g. neutropenia), prematurity, renal dialysis, huge loss of skin integrity (Burns Intensive Care Unit patients), and bone marrow transplantation;
- b) Catheter-related factors: non-cuffed central venous catheter (CVC), multi-lumen catheters, hyperalimentation (total parenteral nutrition), the conditions under which the catheter was inserted (breach in asepsis), site of insertion (femoral site) and maintenance (breach in asepsis, excessive manipulation); and
- c) Institutional factors including academic affiliation of the institution and bed size, the experience and training of healthcare professionals.

1.4 Epidemiology

CVCs account for almost 90% of CRBSI. The incidence of CLABSI in short-term use, non-cuffed CVCs is higher than in surgically implanted cuffed Hickman lines and other cuffed catheters. CLABSIs have been associated with extended hospitalization and increased healthcare costs. However, most studies have not found CLABSI per se to be an independent risk factor for mortality. Reports on CLABSI attributed by peripherally inserted central venous catheters (PICC) are rare but PICC used for parenteral nutrition has a higher infection rate than PICC used for other indications. Of note, while peripheral venous catheters are rarely associated with BSI, the sheer prevalence of such catheters means that they cannot be ignored.

An analysis of 159 prospective studies reported that skin microorganisms form the largest proportion of IV catheter-associated BSIs: Coagulase-negative staphylococci 31%; *Staphylococcus aureus* 18%; and, *Corynebacterium* spp. 5%. Additionally, enteric Gram-negative bacilli account for third largest proportion (14%) and *Candida* spp. 6% of the BSI. It is important to note that fungal pathogens are becoming important organisms associated with BSI in patients receiving parenteral nutrition fluids. The data from 2008 NHSN Annual Update indicate that multidrug-resistant organisms are commonly implicated in CLABSIs.

2 Education and Surveillance

Appropriate education, training, and competency assessment resources are needed for all staff responsible for the insertion and maintenance of CVCs. The following factors can affect the success of any improvement initiative that is designed to reduce or eliminate healthcare-associated infections (HAIs), including CLABSIs:

- a) Leadership
- b) Culture of safety
- c) Multidisciplinary teams and teamwork
- d) Accountability of healthcare professionals
- e) Empowerment
- f) Resource availability
- g) Data collection and feedback of CLABSI rates
- h) Policies and procedures

i) Involvement of patients and families

The safety culture in any healthcare setting should hold that everyone is accountable for following evidence-based CLABSI prevention practices, and organization leaders must clearly communicate that department or unit leaders are accountable for the CLABSIs that occur in their patients.

Surveillance for healthcare-associated infections (HAIs), including CLABSIs, is an essential component in any infection prevention and control program, a necessary first step in defining the nature and magnitude of the problem. Surveillance involves systematically collecting, analysing, interpreting, and disseminating data to members of the healthcare team as a means to facilitate improvement in patient outcomes.

3 Care of Specific Catheters

3.1 Central venous catheters (CVCs) including peripherally inserted central venous catheters (PICCs), haemodialysis and pulmonary artery catheters

3.1.1 CLABSI Insertion Bundle

a) Hand hygiene

Hand hygiene, combined with aseptic techniques before catheter insertion and during subsequent catheter care, reduces the risk of catheter-associated BSI significantly. Hence, hand hygiene should be performed prior to the handling of the catheter or its administration set, either with alcohol-based hand rub preparation or hand wash with antiseptic soap (e.g. 4% chlorhexidine gluconate).

b) Maximum barrier precautions

Maximal sterile barrier (MSB) precautions require the CVC inserter to wear a mask and cap, a sterile gown, and sterile gloves and to use a large (head-to-toe) sterile drape over the patient during the placement of a CVC or exchange of a catheter over a guide wire.

c) Alcoholic chlorhexidine skin preparation

Use of 2% chlorhexidine with 70% isopropyl alcohol preparation has been reported to be effective in preventing CRBSIs. If there is a

contraindication to chlorhexidine, tincture of iodine, an alcoholic iodophor, or 70% alcohol can be used as alternatives. No recommendation can be made for the safety or efficacy of chlorhexidine in infants aged <2 months. The antiseptic used should be allowed to have sufficient contact time with the skin and allowed to dry according to the manufacturer's recommendation, prior to placing the dressing. After the antiseptic has been applied to the site, further palpation of the insertion site should be avoided, unless aseptic technique is maintained.

d) **Optimal site selection**

Data derived from several observational studies of CVC insertions suggest that the greatest risk of infection in adults is associated with use of the femoral vein as the insertion site, and the lowest risk is associated with subclavian site insertions, with an intermediate level of risk associated with internal jugular vein insertions for non-tunnelled CVCs.

To ensure compliance, it is recommended that an institutional checklist of appropriate indications for CVC insertion be made incorporating the above components and audits done regularly for adherence. Ultrasound guided insertion of IJV central lines should be considered where available to reduce risks of complications, including CRBSI.

3.1.2 CLABSI Maintenance Bundle

a) Hand hygiene

Hand hygiene reduces the risk of IV catheter-associated BSI significantly. Hand hygiene is to be performed before and after accessing, replacing, repairing, or dressing the catheter.

b) Cleaning and changing the needleless access device aseptically

Strict adherence to disinfection and maintenance recommendations is important, so as to minimize the incidence of catheter-related bloodstream infections (see section 6).

c) Dressing for catheter entry site

Dressing of catheters that are associated with higher risk of CRBSIs (including arterial catheters, all types of CVCs and PICCs) should be changed under aseptic technique using sterile gloves. In contrast, clean

gloves (donned using a “no-touch” technique), could be used when changing the dressing of peripheral IV catheters, and care must be taken to avoid re-contamination of the access site.

There are two major types of dressing materials recommended for dressing of IV catheter site: sterile gauze and tape, or sterile transparent, semipermeable, polyurethane film dressing. It is recommended that either type of dressing could be used for peripheral IVs and short-term CVCs. Conversely, polyurethane dressings are not generally used on arterial catheters. In addition, gauze dressing is recommended in diaphoretic patients or when the catheter site is bleeding or oozing. There is some evidence on the clinical effectiveness of the use of chlorhexidine-impregnated sponge or other dressings in reducing CRBSI in adult patients and paediatrics with short-term CVCs. However, the use of chlorhexidine dressing in neonates with low birth weight (<1000 g) and extremely premature infants is not advised due to the risk of ototoxicity. Additional studies are required before chlorhexidine dressing can be recommended for routine use with long-term CVCs. Therefore, if the institutional CLABSI rate is above benchmark despite comprehensive preventive strategies, a chlorhexidine-impregnated sponge or other dressing is recommended for temporary short-term catheters in patients older than 2 months of age.

The dressing regimes vary according to the type of dressing material used and patient’s condition. The HICPAC/CDC guidelines recommend replacing the dressing on short-term CVCs every two days for gauze dressing and at least every 7 days for transparent dressings. Exception should be made for paediatric patients where the risk of the catheter dislodgement may outweigh the benefit of dressing changing. For tunnelled or implanted CVCs, the dressing should be replaced no more frequently than weekly, until the site is healed. There is a paucity of evidence supporting routine dressing changes but dressings should be inspected daily.

Apart from the regime, replace the dressing if it becomes dampened, loosened or visibly soiled. The catheter site should be monitored for signs of local infection. This is done by visually monitor the dressing or by palpation through the intact dressing on regular basis. The dressing should be removed for thorough examination if the patient manifests signs and symptoms suggesting CRBSI. Patients should be advised to

monitor and report to their healthcare professionals if they observe any changes in their catheter site or new discomfort. They should be informed not to submerge the catheter site in water. Showering is permitted if care could be taken to prevent the catheter site from contamination (e.g. cover the dressing and the connecting device with an impermeable cover during the shower).

Topical antibiotic ointment or creams are not recommended for the routine care of insertion site with the exception of haemodialysis catheters, because of their potential in promoting fungal infections and antimicrobial resistance. CDC recommends using povidone iodine ointment or triple antibiotic ointment (bacitracin / gramicidin / polymyxin B) at the hemodialysis catheter exit site after catheter insertion and at each hemodialysis session and emphasizes the importance of ensuring the compatibility of the ointment with the catheter material. Catheter rupture had been reported in a patient after application of mupirocin ointment to the insertion site of peritoneal catheter.

a) Standardize tubing change

Replace tubing used to administer blood, blood products, or fat emulsions within 24 hours of initiating the infusion. Replace tubing used to administer propofol infusions every 6 or 12 hours, when the vial is changed, per the manufacturer's recommendation. For other tubing, there is limited evidence for shorter changes.

b) Daily review of catheter necessity

A meta-analysis by Cook and colleagues found no significant benefit of routine replacement of short-term CVCs. In addition, studies have showed that routine replacement of CVC without clinical indication does not reduce the risk of CRBSI. The Cochrane review in 2013 also found no conclusive evidence of benefit in routine changing of peripheral IV catheters every 72 to 96 hours. These reports suggest that daily assessment of the catheter necessity and replacement based on clinical assessment a more cost-effective approach in preventing CRBSI. Institute for Healthcare Improvement (IHI) provides a detailed approach on conducting daily review of catheter necessity and recommends daily review for the intensive care population as it may not be appropriate for

long-term CVCs. All IV catheters should be removed as soon as it is no longer required.

4 Care of Administration Sets

Several studies in both local and overseas settings report that IV administration sets do not need to be replaced more frequently than every 96 hours. Adding on, the HICPAC/CDC guidelines recommend the replacement to be done at least every 7 days, unless CRBSI is suspected or when infusing blood, blood products, or lipid emulsions. Effort must be made to keep all components of the administration sets sterile and asepsis must be maintained in accessing to the IV system. When there is a suspected infusion-associated BSI, it is prudent to change administration sets within 24 hours of initiating the infusion. Similarly, administration sets used to administer blood, blood products, or lipid emulsions should be changed within 24 hours of initiating the infusion. A report of an outbreak of BSI involving sixty two patients indicate that the source, propofol, a lipid-based medication, could be a good medium for bacterial growth when it is left at room temperature. It is recommended in the HICPAC/CDC guidelines that the administration sets used to administer propofol infusions should be replaced every 6 to 12 hours.

When a pressure monitoring is used, the transducer should be replaced at every 96 hours. This includes other components of the system (the tubing, continuous-flush device, and flush solution). With the reported lower incidence of bacterial contamination of the arterial system, a closed system with continuous flush is preferred to an open system for the maintenance of the patency of the system. Beck-Sague and Jarvis reported eight outbreaks of nosocomial BSIs which were traced to contamination of transducer used for arterial pressure monitoring. If the use of disposable transducer is not feasible, reusable transducer is to be sterilized according to the manufacturer's recommendation.

4.1 Recommendations

4.1.1 Insertion of central lines

- a) Perform hand hygiene before and after palpating catheter insertion sites as well as before and after inserting, replacing, accessing, repairing or

dressing an IV catheter. Palpation of the insertion site should not be performed after the application of antiseptic, unless aseptic technique is maintained. [BI]

- b) Maintain aseptic technique for the insertion and care of intravascular devices. [BI]
- c) Wear clean gloves for insertion and care of peripheral IV catheters if access site is not touched after the application of skin antiseptics. [CI]
- d) Wear sterile gloves for the insertion of arterial, central and midline catheters. [AI]
- e) Wear either clean or sterile gloves when changing the dressing on intravascular catheters. [CI]
- f) Prepare clean skin with an antiseptic (70% alcohol, tincture of iodine, an iodophor or alcohol/chlorhexidine gluconate) before peripheral venous catheter insertion. [BI]
- g) Prepare clean skin with a >0.5% chlorhexidine preparation with alcohol before CVC and peripheral arterial catheter insertion and during dressing changes. If there is a contradiction to chlorhexidine, tincture of iodine, an iodophor, or 70% alcohol can be used as alternatives. [AI]
- h) Antiseptics should be allowed to dry according to the manufacturer's recommendation prior to placing the catheter. [BI]
- i) Use either sterile gauze or sterile transparent, semipermeable dressing to cover the catheter site. [AI]

4.1.2 Maintenance of central lines

- a) Replace catheter site dressing if the dressing becomes damp, loosened or visibly soiled. [BI]
- b) Do not use topical antibiotic ointment or creams on insertion sites, except for haemodialysis catheters, because of their potential to promote fungal infections and antimicrobial resistance. [BI]
- c) Do not submerge the catheter or catheter site in water. Showering should be permitted if precautions can be taken to reduce the likelihood of introducing organisms into the catheter (e.g. use of an impermeable cover). [BI]

- d) Replace dressings used on short-term CVC sites at least every 7 days for transparent dressings, except in those paediatric patients in which the risk for dislodging the catheter may outweigh the benefit of changing the dressing. [BII]
- e) Ensure that catheter site care is compatible with the catheter material. [BI]
- f) Use a sterile sleeve for all pulmonary artery catheters. [BI]
- g) Use a chlorhexidine-impregnated sponge or other dressing for temporary short-term catheters in patients older than 2 months if the CLABSI rate is not decreasing despite adherence to basic prevention measures. [BI]
- h) Monitor the catheter sites visually when changing the dressing or by palpation through an intact dressing on a regular basis, depending on the clinical situation of the patient. If patients have tenderness at the insertion site, fever without obvious source, or other manifestations suggesting local or bloodstream infection, the dressing should be removed to allow thorough examination of the site. [BI]
- i) Consider using povidone iodine antiseptic ointment or bacitracin/gramicidin/polymyxin B ointment at the haemodialysis catheter exit site after catheter insertion and at the end of each dialysis session only if the ointment does not interact with the material of the haemodialysis catheter per manufacturer's recommendation. [BI]
- j) In patients not receiving blood, blood products or fat emulsions, replace administration sets that are continuously used, including secondary sets and add-on devices, no more frequently than at 96-hour intervals, but at least every 7 days. [CI]
- k) Replace tubing used to administer blood, blood products, or fat emulsions within 24 hours of initiating the infusion. [BI]
- l) Replace tubing used to administer propofol infusions every 6 or 12 hours, when the vial is changed, per the manufacturer's recommendation. [AI]
- m) Use disposable, rather than reusable, transducer assemblies when possible. [BI]
- n) Replace disposable or reusable transducers at 96-hour intervals. Replace other components of the system (including the tubing,

continuous-flush device, and flush solution) at the time the transducer is replaced. [BI]

- o) Keep all components of the pressure monitoring system (including calibration devices and flush solution) sterile. [AI]
- p) Do not administer dextrose-containing solutions or parenteral nutrition fluids through the pressure monitoring circuit. [AI]

5 Care of Infusate, IV medication and Admixture

Lipid-containing solutions are to complete infusion within 24 hours of hanging the solution; whilst lipid emulsions alone will need to be completed within 12 hours, and maximum within 24 hours. Single-dose vial of parenteral additive and medications are recommended as far as possible. Diaphragms of the multi-dose vials are to be disinfected with 70% alcohol before insertion. Any unopened parenteral fluid or admixture that has visible turbidity, containing particulate matter or container with leaks or cracks are to be saved, and reported to the Infection Prevention and Control team for investigation. Routine culture of parenteral fluids, as a check on sterility for infection preventive measure is not recommended. It is recommended that a distinctive supplementary label be attached to each admixed parenteral fluid given; this should have information on the additive and dosage, the date and time of compounding, the expiration time and signature of the worker who did the compounding.

6 Needleless Intravascular Catheter Systems

Needleless connectors are originally designed with the aim to reduce the risk of needle stick injuries among healthcare professionals during the care of IV catheter. The most common types of needleless connectors include split septum connector and mechanical valve device. In most hospitals and healthcare settings in the majority of developed world, these devices are used routinely to protect staff. This is especially so in Singapore with a high prevalence of blood borne pathogens in our patient population. However, there are a variety of needleless connector types, and some have been associated with an increase in central venous catheter-related bloodstream infections, especially with use of the mechanical valve devices. It is thus vital that care be taken in the selection and use of needleless connectors. Strict adherence to disinfection and maintenance recommendations is important, so as to minimize the

incidence of catheter-related bloodstream infections. The choice of disinfectant used to disinfect the connector prior to the access of the IV system and the duration of disinfection are also important factors in the development of CRBSI.

To reduce the risk of CRBSI associated with the use of needleless connector, the following are recommended:

- a) disinfect or scrub the access port immediately prior to each use with an appropriate antiseptic (2% chlorhexidine with 70% IPA, povidone iodine, or 70% alcohol);
- b) access the port only with sterile devices;
- c) ensure that all components of the needleless system are compatible to minimize leaks and breaks in the system;
- d) change needleless connector according to the manufacturer's recommendations or no more frequently than every 72 hours;
- e) change the needleless components at least as frequently as the administration set; and,
- f) use of needleless system with a split septum valve is preferred over some mechanical valves.

6.1 Recommendations

- a) Needleless connectors with mechanical valves **should** not be routinely used before a thorough assessment of risks, benefits and education regarding proper use. Split septum connectors should be preferentially used over needleless connectors with mechanical valves until more clinical data becomes available. [BII]
- b) Positive-pressure needleless connectors with mechanical valves **should** not be routinely used before a thorough assessment of risks, benefits and education regarding proper use. [BII]
- c) There is insufficient clinical evidence to make recommendations for the use of antiseptic barrier caps and silver-coated needleless connectors, and further clinical evaluation is required. [CIII]
- d) Infection Prevention and control committee **should** be involved in the selection of needleless connectors. [CIII]

- e) When any product changes are made, education should be provided to all users, and rates of infection and occlusion **should** be monitored to detect any increase in incidence of catheter-related bloodstream infection. [CIII]
- f) Needleless connectors **must** be disinfected before accessing the catheter. [BIII]
- g) Chlorhexidine/alcohol or povidone-iodine **should** be preferentially used over isopropyl alcohol for disinfection of needleless connectors. [BI]
- h) Catheter access ports **should** be disinfected with 5 to 15 seconds of vigorous scrubbing with alcohol or chlorhexidine. [BII]
- i) There is insufficient evidence to support the regular change of end caps of needleless connectors to minimize catheter associated bloodstream infection. [BIII]
- j) Needleless connectors **should** be changed at least as frequently as the administration set. There no benefit to changing these more frequently than every 72 hours. [BIII]
- k) Needleless connectors with mechanical valves **may** not be recommended for use on central venous catheters in patients on home infusion therapy or in long-term care facilities in view of possible increased risks of catheter related blood stream infection. [BII]

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Chapter 14. Prevention of Catheter-associated Urinary Tract Infections

1 Introduction

1.1 Epidemiology

Urinary tract infections (UTIs) remain the commonest nosocomial infection worldwide. UTIs have been estimated to cause about 32% of healthcare-associated infections (HAIs) in the acute care setting in the United States (US). Of these, approximately 75% are associated with a urinary catheter. The sheer number of urinary catheters in use leads to the significance of catheter-associated UTI (CAUTI) in the healthcare system even though their impact on morbidity and mortality is relatively limited.

The problem of CAUTI extends globally, and also outside of the acute care setting. UTIs have been found to be the commonest cause of HAIs among residents of long-term care facilities, accounting for 40% of HAIs in an Irish prevalence study. A systematic literature review and meta-analysis of HAIs in Southeast Asia found a pooled incidence density of 8.9 CAUTI per 1000 catheter-days (95% CI, 6.2-11.7). This was in contrast to a rate of 3.3 per 1,000 catheter-days in comparable US intensive care units (ICUs). There are no published local epidemiology data from Singapore but small case series suggest that the majority of extremely drug resistant gram-negative organisms have a urinary tract origin.

1.1.1 Definition for surveillance

Refer to Surveillance Technical Manual for definitions to be used in surveillance of CAUTI.

1.2 Pathogenesis

The presence of a urethral catheter will bypass or inhibit natural host defences, predisposing patients to CAUTIs. This is further exacerbated by the development of biofilm on the urinary catheters, which provides a favourable environment for bacterial proliferation & invasion.

Bacteria may be introduced into the urinary tract via several routes, such as:

- a) Inoculation at the time of catheter insertion, especially in patients who have had inadequate disinfection of the urethra opening prior to catheterization.
- b) Via intraluminal ascent in the urinary catheter after contamination of the urinary catheter and/or bag (such as via breaks in aseptic practice during the opening of urinary drainage bag taps, or disconnection of catheters from urinary bags).
- c) Via the extraluminal route of ascent, along the external surface of the urinary catheter and the urethra.

The risk of developing bacteruria hence correlates with duration of catheterization.

1.3 Risk factors

Risk factors for CAUTI are broadly divided into host factors, bacterial factors and catheter factors. Prospective observational studies which did multivariable analyses identified the major risk factors for CAUTI, which include:

- a) Duration of catheterization;
- b) Female gender;
- c) Anatomical or functional abnormalities of the urinary tract;
- d) Insertion of the catheter outside the operating theatre;
- e) Diabetes mellitus; and
- f) Poor catheterization technique or breaks in aseptic technique.

2 Conducting a CAUTI Risk Assessment

CAUTI risk assessment should be performed to guide the development of a surveillance, prevention, and control plan that is based on facility-specific data and conditions.

The risk assessment includes obtaining the demographics of those patients or residents who have the highest utilization of indwelling urinary catheters.

Surveillance data collected by Infection Prevention and Control team will help to provide information needed to identify areas for improvement or to monitor if preventive measures are working.

The following steps may be used for conducting a CAUTI Risk Assessment:

Step 1: Assess whether an effective organization program exists

Step 2: Assess population at risk

Step 3: Assess baseline outcome data

Step 4: Determine financial impact

Examples of Baseline CAUTI Risk Assessment Tool are found in Appendix 14.1 and 14.2. A Data Collection sheet (Refer to Appendix 14.3) can be used at baseline, during and after program implementation.

A point prevalence study may be used to provide baseline data to complete the risk assessment, monitor trend in care practices and identify outliers per unit, shift, or service. The point prevalence survey questions may those in example shown in Table 14.1.

Table 14.1. Example of survey questions on compliance to good practices in care of urinary catheters

NO.	CRITERIA	YES	NO
1	Is there a Foley catheter in use?		
2	Is this the type of catheter normally used in this facility?		
3	Is a closed system being maintained?		
4	Is the Foley inserted using a pre-connected tray		
5	Is the Foley secured to the patient's body to prevent urethra tension?		
6	Is the bag below the level of the patient's bladder?		
7	Is the tubing from the catheter to the bag free of dependent loops?		
8	Is the tubing secured to the bed or chair to prevent pulling on the entire system?		
9	Is the bag hanging free without touching the floor?		

10	Does the patient have an individual measuring urine device marked with his / her name and room number?		
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The denominator for this survey is the number of patients who have urinary catheters during the surveillance period on the unit / population being survey.

Once the facility-specific CAUTI risk assessment baseline is established, CAUTI rates can be compared over time to determine if there are trends within patient populations and/or departments. Evaluation of the CAUTI risk assessment will influence plans for control of CAUTI in the facility e.g. it may be decided that the CAUTI surveillance, prevention and control plan will target symptomatic CAUTI (i.e. exclude asymptomatic bacteriuria).

Recommendations

Perform a CAUTI risk assessment and implement an organization-wide program to identify and remove catheters that are no longer necessary using one or more methods documented to be effective. [BII]

3 CAUTI Insertion Bundle

3.1 Verification of need prior to insertion

The most important measure to prevent CAUTI is to limit the use of urinary catheters to carefully selected patients and leave them in place only as long as indications for catheterization persist.

Prior to catheterization, consideration should be given to alternative management methods (e.g. condoms or intermittent catheterization). Urinary catheters should only be used when necessary and should be removed as soon as possible to avoid potential complications such as infection, bacteraemia, urethritis, urethral stricture, and haematuria and bladder perforation. Establishing institutional guidelines may help to prevent inappropriate urinary catheterization, leading to reduction in catheter use and CAUTI rates.

Studies have shown that indwelling catheters are frequently used when not indicated or, if indicated, remain in situ longer than necessary. Various studies have

demonstrated that the presence of the urinary catheter is inappropriate in 21 – 54% of catheterized patients.

3.2 Common indications for catheterization

- a) To relieve clinically significant urinary retention or bladder outlet obstruction (temporary relief or longer term drainage if medical therapy not effective and surgical correction not indicated).
- b) To assist the healing of an open sacral sore or perianal wound.
- c) To monitor accurately the urine output in critically ill patients.
- d) During prolonged surgical procedures with general or spinal anaesthesia, selected urological and gynaecological procedures.
- e) For patients requiring prolonged immobilization e.g. potentially unstable thoracic or lumbar spine, multiple traumatic injuries such as pelvic fractures.
- f) Improvement in comfort in end of life care if needed.
- g) Management of gross haematuria with blood clots in urine.

3.3 Insert urinary catheter using aseptic technique

There are few data on the optimal level of sterility required to insert an indwelling urinary catheter, and this remains contentious. The use of aseptic technique at insertion of urethral catheter was preferred, although further study is warranted.

Tambyah et. al. found that patients catheterized in the operating room had a lower incidence of early community acquired bacteriuria (CA-bacteriuria) than those catheterized in the ward to in the emergency department (RR 0.5; 95%CI 0.2-1.0; P=.03). This suggests that augmented barrier precautions at the time of catheter insertion may reduce the risk off early CA-bacteriuria. Shapiro et. al. also showed that catheter insertion outside of the operating room is associated with a higher risk of CA-bacteriuria.

However in a prospective trial conducted in the operating room, 156 patients who were undergoing pre-operative urethral catheterization were randomly allocated to sterile or clean/non-sterile technique (hands washed with soap and tap water, non-

sterile gloves, cleaning external genitalia with tap water only and holding the catheter within its plastic sheath). There was no statistically significant difference between the 2 groups with respect to the incidence of CA-bacteriuria but the sterile method was twice as expensive.

HCPs performing urethral catheterization should be trained, assessed and credentialed as competent on the technical aspects, including application of the principles of aseptic technique to minimize the risk of infection. Standard precautions must be applied by all HCPs when inserting and caring for urinary catheters with particular reference to hand hygiene, personal protective equipment (PPE) and management of waste. Aseptic technique refers to the practices that help to reduce the risk of post-procedure infection in patients by decreasing the likelihood of microorganisms entering the body during the clinical procedure. Sterile equipment and aseptic technique must be used during insertion and intermittent urinary catheters in acute healthcare settings. Antiseptic hand hygiene must be performed immediately before donning sterile gloves prior to insertion of a urinary catheter and after removal of PPE. For catheter insertion, a disposable plastic apron and sterile gloves will usually be sufficient.

3.3.1 Meatal cleaning and environmental disinfection

As infection can occur extraluminally (via the external surface of the catheter) when the catheter is inserted, the urethral meatus should be carefully cleaned prior to catheterization. The use of antiseptic solution versus sterile saline for meatal preparation prior to catheter insertion remains unresolved. Before the procedure, the environmental surfaces involved should be effectively cleaned and disinfected. HCPs should use sterile gloves and a drape to create a sterile field. All inclusive sterile catheter packs should be used where available.

3.3.2 Insertion procedure for indwelling urethral catheterization

Urethral catheterization can cause bruising and trauma to the urethral mucosa which then acts as an entry point for microorganisms into the blood and lymphatic system. It is recommended that the smallest gauge urinary catheter possible is used, and an appropriate lubricant or anaesthetic gel from a single-used container should be applied to the urethral meatus and catheter surface prior to the insertion of the

catheter to minimize urethral trauma or infection. Once the catheter is inserted, urine is allowed to drain before the balloon is inflated. The indwelling catheter should be connected to a closed sterile drainage bag which is placed below the level of the bladder to facilitate drainage.

When a catheter is inserted, the following information should be documented in the patient's record:

- a) Indication for catheter insertion;
- b) Date and time of catheter insertion;
- c) Type and size of catheter used;
- d) Any complications encountered; and
- e) Name of HCP who inserted the catheter.

Antimicrobial-impregnated catheters may reduce the risks of CAUTI slightly in short-term catheterization, but cannot be recommended for routine use due to costs and the risks of promoting antimicrobial resistance. Silver alloy catheters are not recommended for routine use, and no recommendations can be made on the use of hydrophilic-coated catheters.

Recommendations

- a) Indwelling catheters should be placed only when they are indicated, and removed as soon as possible to reduce the risk of CAUTI and other complications (AIII).
- b) Institutions should develop a list of appropriate indications for inserting indwelling urinary catheters, educate staff about such indications and periodically assess adherence to the institution-specific guidelines (AIII).
- c) Alternative bladder drainage management methods should be considered, although evidence of efficacy in preventing symptomatic UTI remains limited (CII).
- d) Institutions should require a physician's order in the chart before an indwelling catheter is placed, and information on the catheter insertion should be documented. (AIII).
- e) Indwelling urethral catheters should be inserted using aseptic technique and sterile equipment (BIII).

- f) Only properly trained HCPs who have correct technique of aseptic catheter insertion and maintenance are given this responsibility (BI).
- g) Further research is needed on the use of antiseptic solution versus sterile saline for meatal cleaning prior to catheter insertion (No recommendation – unresolved issue).

4 CAUTI Maintenance Bundle

As with most device-associated infections, the removal of the device is the primary approach to prevention of the infection. There is a growing body of evidence, as well as general consensus among infection Prevention and control practitioners, to support the reduction of urinary catheter use as well as limiting its duration. Where catheterization is indicated, strict adherence to catheter care maintenance practices is recommended, although the evidence for most of the measures is not very conclusive due to the difficulty in conducting randomized controlled clinical trials.

Key features in the maintenance bundle include:

- a) Daily review of urinary catheter for necessity of use.
- b) Check the catheter has been continuously connected to the drainage system.
- c) Ensure patients are aware of their role in preventing urinary tract infection – perform routine daily meatal hygiene.
- d) Regularly empty urinary drainage bags as separate procedures, each into a separate clean container.
- e) Maintain unobstructed urinary drainage by keeping the collecting bag below the level of the bladder, and preventing kinking of the catheter and collecting tubes.
- f) Perform hand hygiene and don gloves and apron prior to each catheter care procedure; on procedure completion, remove gloves and apron and perform hand hygiene again.

Avoiding and minimizing duration of urinary catheterization remains the key strategy in the prevention of CAUTIs, as continued urethral catheterization is associated with a 3 - 10% daily incidence of bacteriuria. Unfortunately, unnecessary

urinary catheter use remains prevalent, and physicians are often unaware of the presence of urinary catheters in their patients.

Various reminder systems to review the continuation of catheterization have been shown to be efficacious and cost-effective, and **must** be implemented where possible according to what works best in the institution or facility.

These may include:

- a) Nurse generated daily verbal reminders or reminder stickers to physicians to review appropriateness of continuing catheterization.
- b) Computer generated reminders to review indications for continuing catheterization.
- c) Prewritten or computer-generated 'stop orders', whereby a catheter was removed by default after a set time period or when certain clinical criteria are met. Nurse-led, protocol driven review systems have also been found to be effective.

No recommendations can be made for the routine use of antibiotic prophylaxis for the prevention of CAUTI. It has been shown to be associated with a reduction in asymptomatic bacteriuria, but there is no evidence showing reduction in symptomatic UTIs.

Recommendations

- a) Establish a daily reminder system to review the continuation of urinary catheterization. Consider stop-order and nurse-directed urinary catheter removal policies (AI).
- b) Maintain a sterile, continuously closed drainage system (BIII).
- c) Maintain unobstructed urine flow. Keep the collecting bag below the level of the bladder at all times; do not place the bag on the floor. Keep catheter and collecting tube free from kinking (BIII).
- d) Empty the collecting bag regularly using a separate collecting container for each patient. Avoid touching the draining spigot to the collecting container (BIII).

- e) Employ routine hygiene; cleaning the meatal area with antiseptic solutions is unnecessary (BIII).

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Ref type: Online source.

Appendix 14.1. Baseline CAUTI Risk Assessment Tool to Identify Population at Risk

CRITERIA \ UNIT	MEDICAL	SURGICAL	MICU	SICU	ORTHO
Structure					
Number of beds					
Nurse Staffing Ratio					
Number of different physicians					
Does the hospital or unit have any policies or standard operating procedures relating to indwelling urinary catheter use					
Do they use any templates or reminders related to use of indwelling urinary catheters					
Processes					
Where are indwelling urinary catheters placed for patients on this unit					
Staff responsible for performing insertion of indwelling urinary catheters on this unit					
Outcome					
5 day count on number of indwelling urinary catheters / number of patients					
CAUTI / UTI rates for this unit					
Catheter utilization ratio					

Appendix 14.2. Baseline CAUTI Risk Assessment Tool to Assess whether an Effective Organization Program Exists

NO.	CRITERIA	YES (FACILITY WIDE)	YES (UNIT BASED)	NO
1	Guidelines on appropriate indications for urinary catheter use			
2	Guidelines on proper techniques for urinary catheter insertion			
3	Guidelines on proper techniques for urinary catheter maintenance			
4	System of documenting urinary catheter insertions			
5	System of documenting urinary removals			
6	Regular in-service training for appropriate healthcare professional on techniques and procedures for urinary catheter insertion, maintenance and removal			
7	Readily available supplies necessary for aseptic urinary insertion			
8	Policies or guidelines for use of a bladder scanner prior to insertion of a catheter for urinary retention			

Chapter 15. Prevention of Surgical Site Infections

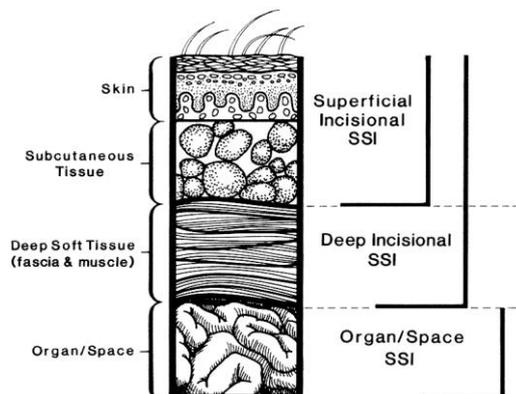
1 Introduction

Surgical site infections (SSIs) are an important source of healthcare-associated infections (HAIs) in which wound infection occurs after an invasive (surgical) procedure. It is the most common HAI and accounts for 20% of all HAIs in inpatients. It is a high burden on both patients and hospitals in terms of morbidity, mortality, prolonged length of hospital stay and additional cost. The incidence of SSIs is dependent on the surgical procedure, the surveillance criteria used, and the quality of the data collection in particular post-discharge surveillance in this era of same-day surgery. The most commonly isolated organisms are *Staphylococcus aureus*, coagulase-negative *Staphylococcus* spp, *Enterococcus* spp. *Klebsiella pneumoniae* and *Escherichia coli*.

1.1 Definition

SSIs are defined as infections occurring up to 30 days after surgery (or up to 90 days after surgery in patients receiving implants where day 1 is the date of procedure) and affecting either the incision or deep tissue at the operation site. Definitions are in accordance with the Centres for Disease Control and Prevention National Nosocomial Infections Surveillance (NNIS) System and the National Healthcare Safety Network (NHSN) definitions for SSI (see Figure 15.1).

Figure 15.1. Centres for Disease Control and Prevention’s National Healthcare Safety Network classification for surgical site infection (SSI)



1.2 Pathogenesis

Most SSIs are believed to be acquired at the time of surgery. However, there is currently no data on the actual proportion acquired in the operating theatre versus post-operative care. The commonest source of pathogens for most SSIs is the endogenous flora of the patient's skin, mucous membranes or hollow viscera as the exposed tissues are at risk of contamination when mucous membranes or skin is incised. Exogenous sources of SSI pathogens include members of the surgical team, the operating room environment including air, and all surgical instruments and materials brought to the sterile field during an operation.

2 Risk Factors

Risk of SSI if no antibiotic surgical prophylaxis is given is estimated to be as follows:

- a) Clean surgical wound classification e.g. inguinal hernia repair: <5%
- b) Clean contaminated wound classification e.g. cholecystectomy with no bile spillage: 5-10%
- c) Contaminated wound classification e.g. appendectomy: 15-25%
- d) Dirty wound classification e.g. sigmoid colectomy (Hartman's procedure) for faecal peritonitis: 25-40%

Patient-related risk factors for SSI include existing infection, existing *Staphylococcus aureus* carriers, low serum albumin concentration, older age, obesity, smoking, diabetes mellitus, immunosuppressive medications and ischemia secondary to vascular disease or irradiation. Surgical risk factors for SSI include prolonged procedures, inadequacy in surgical scrub and inadequacy in antiseptic preparation of the skin. Physiological risk factors for SSI include trauma, shock, hypothermia, hypoxia and hyperglycaemia. Therefore, prevention of SSI requires multimodal interventions i.e. targeting several risk factors at the same time.

3 Infection Prevention and Control Measures

3.1 Pre-operative measures

3.1.1 Preparation of patient

- a) Whenever possible, identify and treat all infections remote to the surgical site before elective operation. Postpone elective operations until the infection has resolved.
- b) Adequately control serum blood glucose levels in all diabetic patients particularly avoid hyperglycaemia peri-operatively. Reduce glycosylated haemoglobin A1c levels to <7% before surgery, if possible. For patients undergoing cardiac surgery, maintain the postoperative blood glucose level at less than 11.1 mmol/L.
- c) Encourage tobacco cessation. At minimum, advise patients to abstain for at least 30 days before elective operation from smoking cigarettes, or any other form of tobacco.
- d) Unless contraindicated, patients should be instructed or assisted to perform two preoperative shampoo and baths or showers the night before and on the morning of the surgery with chlorhexidine gluconate (CHG), or equivalent, before surgery to reduce the number of microorganisms on the skin and reduce the risk of subsequent contamination of the surgical wound. Conditioners and other hair care products should not be used after performing preoperative shampoos with CHG.
- e) Caution should be exercised to avoid CHG contact with the eyes, the inside of the ears, the meninges, or other mucous membranes. If CHG solution gets into the eye, immediately rinse the area with copious amounts of running water for at least 15 minutes and seek medical attention. CHG should not be used on the head if the patient's tympanic membrane is not intact. CHG should not be used on patients for whom it is contraindicated, including patients with a known hypersensitivity to CHG or any other ingredient in the product.
- f) Do not remove hair preoperatively unless the hair at or around the incision site will interfere with the operation. If hair is to be removed, remove immediately just before the operation preferably with electric clippers with a

single-use head. Alternatively, a depilatory agent could be used if testing has been performed without tissue irritation.

- g) Do not routinely use nasal decontamination alone with topical antimicrobial agents aimed at eliminating *Staphylococcus aureus* to reduce the risk of surgical site infection.
- h) Skin preparation prior to operation:
 - i. Thoroughly wash and clean at and around the incision site to remove gross contamination before performing antiseptic skin preparation.
 - ii. Use an alcohol containing antiseptic agent for skin preparation.
 - iii. Apply preoperative skin preparation in concentric circles moving towards the periphery. The prepared area must be large enough to extend the incision or create new incisions or drain sites, if necessary.

3.1.2 Theatre wear

It is good practice to discard all used theatre wear prior to leaving the operating area to prevent healthcare professionals, patients and visitors being exposed to the risk of contamination. However, there is no direct evidence that this practice has any effect on the incidence of SSI. Staff should not leave the operating theatre suite wearing non-sterile theatre wear as this is important in the maintenance of theatre discipline which is important in minimising the risk of SSI.

- a) Patients: Patients may be given theatre wear that is appropriate for the procedure and that provides easy access to the operative site and areas for placing devices, e.g. intravenous cannulae.
- b) Healthcare professionals (HCPs) in all areas:
 - i. Wear dedicated non-sterile attire.
 - ii. Staff should keep their movements in and out of the operating area to a minimum.
- c) HCPs at semi-restricted and restricted areas of the surgical or invasive procedure setting:
 - i. Wear clean surgical attire, including shoes, head covering, surgical masks, and identification badges.
 - ii. Head cover or cap should cover the hair on the head and face fully when entering the operating room.

- iii. Surgical mask should cover the mouth and nose fully when entering operating room if an operation is about to begin or already under way, or if sterile instruments or equipment are exposed. Wear the mask throughout the operation.
- iv. Scrubbed team members are required to put on sterile gloves after donning a sterile gown. Use surgical gowns that are effective barriers to liquid penetration.

3.1.3 Hand decontamination

In certain circumstances artificial nails and jewellery may conceal underlying soiling and impair hand decontamination. Hence, it is advisable that the operating team should remove hand jewellery, artificial nails before operations. Hand decontamination prior to surgery is required to minimise the risk that either the resident flora of microorganisms that normally colonise the skin or transient organisms acquired by touch contaminate the surgical wound. While transient microorganisms are readily removed by soap and water, scrubbing with antiseptics such as alcohol or detergent solutions containing chlorhexidine and povidone-iodine may be required to eliminate microorganisms that reside in deep crevices and hair follicles. Although alcohol rapidly kills microorganisms, it does not physically remove organic material and it should, therefore, not be used when the hands are visibly soiled.

The operating team must decontaminate their hands many times a day. However, the regimen chosen should not damage the skin. Hence, hand rubbing may be preferred compared to traditional hand scrubbing.

- a) HCPs should not wear artificial fingernails, arm or hand jewellery in the perioperative environment.
- b) HCPs should keep natural finger nails short. HCPs should follow a standardized procedure for hand hygiene. A surgical hand cleansing should be performed by staff before donning sterile gloves for surgical or other invasive procedures. HCPs should use either an antimicrobial surgical scrub agent intended for surgical hand antisepsis or an alcohol-based antiseptic surgical hand rub with documented persistent and cumulative activity that has met US Food and Drug Administration (FDA) regulatory

requirements (or appropriate local health authority, e.g. Health Science Authority, Singapore) for surgical hand antisepsis.

- c) The operating team should wash their hands prior to the first operation on the list using an aqueous antiseptic surgical solution (according to the manufacturer's instruction), with a single-use brush or pick for the nails, and ensure that hands and nails are visibly clean. This is followed by preoperative surgical scrub, or a rinse-free alcohol-based surgical hand antisepsis (refer to manufacturer's recommendations on duration).
- d) After performing a preoperative surgical scrub or alcohol-based surgical hand antisepsis, keep hands up and away from the body (elbows in flexed position) so that water runs from the tips of the fingers toward the elbows. Dry hands with a sterile towel and don a sterile gown and gloves.
- e) Before subsequent operations, hands should be washed using either an alcoholic hand rub or an antiseptic surgical solution. If hands are soiled then they should be washed again with an antiseptic surgical solution.

3.1.4 Management of infected or colonized surgical HCP

- a) Educate and encourage surgical HCP who have signs and symptoms of a transmissible infectious illness to report conditions promptly to their supervisory and occupational health service personnel.
- b) Surgical HCP who have draining skin lesions should be excluded from duty until infection has been ruled out or resolved.
- c) Do not routinely exclude surgical HCP who are colonized with organisms such as *S. aureus* (nose, hands, or other body site) or group A *Streptococcus*, unless the HCP has been linked epidemiologically to dissemination of the organism in the healthcare setting.

3.1.5 Antibiotic prophylaxis and mechanical bowel preparation

- a) Administer an antibiotic prophylaxis only when indicated, and select it based on its efficacy against the most common pathogens causing SSI for a specific operation and published recommendations. Do not use antibiotic prophylaxis routinely for uncomplicated clean surgeries without prosthetic implants.

- b) Inform patients before the operation, whenever possible, if they will need antibiotic prophylaxis, and afterwards if they have been given antibiotics during their operation.
- c) Before giving antibiotic prophylaxis, consider the timing and pharmacokinetics (for e.g. the serum half-life) and necessary infusion time of the antibiotic. Give a repeat dose of antibiotic prophylaxis when the operation is longer than the half-life of the antibiotic given.
- d) Administer by the intravenous route the initial dose of prophylactic antimicrobial agent, within one hour before incision to maximize tissue concentration. Vancomycin and fluoroquinolones can be given 2 hours before incision. However, do not routinely use vancomycin to reduce the risk of surgical site infection.
- e) Stop prophylaxis within 24 hours after non-cardiac surgeries; and within 48 hours for cardiac surgeries.
- f) Before elective colorectal operations in addition to the above, mechanically prepare the colon by use of enemas and cathartic agents. Administer non-absorbable oral antimicrobial agents in divided doses on the day before the operation. Do not use mechanical bowel preparation routinely to prevention of surgical site infection.
- g) Give antibiotic treatment (in addition to prophylaxis) to a patient having surgery on dirty or infected wounds.
- h) Consider screening for MRSA carriage and decolonization with nasal mupirocin ointment or octenidine nasal gel and chlorhexidine / octenidine body washes before elective surgery such as cardiac and implant surgery.

3.2 Intra-operative measures

3.2.1 Ventilation and movement of staff

- a) Follow the recommendations of the Facility Guidelines Institute (FGI Guidelines for Healthcare Facilities) or local authorities on the ventilation requirements of an operating room.
- b) Do not routinely use ultraviolet radiation in the operating room to prevent surgical site infection.

- c) Keep operating room doors closed except as needed for passage of equipment, staff and patients. Limit the number of people entering the operating room to necessary personnel only.
- d) The traffic in the operating room should be minimized. Scrubbed HCPs should remain close to the sterile field.

3.2.2 Sterile gown, gloves and drapes

Surgical attire is intended to function as a barrier between the surgical field and the potential sources of microorganisms in the environment, skin of the patient or the staff involved in the operation. It also performs an additional function of protecting the operator from exposure to blood or body fluids. The extent to which the materials used for gowns and drapes act as a barrier depends on the closeness of the weave and water-resistant properties.

Use of gloves is part of the aseptic surgical ritual to reduce the risk of introducing infection. They protect the operating team's hands and also protect the team from viral transmission from patients' body fluids (hepatitis and HIV) during surgery. The use of two pairs of gloves has also been suggested as a means of reducing glove puncture and hence potential contamination of the surgical wound by microorganisms from the operator's skin.

There is no difference between reusable and disposable drapes and gowns in terms of SSI incidence. Although the use of reusable or disposable drapes and gowns is not an issue with regard to reducing risk of SSI, disposable drapes and gowns can be considered when the patient is at risk of or is infected with blood borne pathogens such as HIV.

- a) The operating team should wear sterile gowns or sterile procedure attire in the operating theatre during the operation or procedure.
- b) Change scrub suits that are visibly soiled, contaminated, and/or penetrated by blood or other potentially infectious materials.
- c) Consider wearing two pairs of sterile gloves when there is a high risk of glove perforation as the consequences of contamination may be serious (e.g. operating on a patient who is a hepatitis C carrier or known to have a high viral load of any blood borne virus).

- d) Sterile drapes should be used to establish a sterile field and should be placed on the patient, furniture, and equipment to effectively prevent cross contamination. Once the sterile field is established, shifting or moving of the sterile drape should be avoided.
- e) Use sterile drapes that are effective barriers to liquid penetration.
- f) Do not use non-iodophor-impregnated incise drapes routinely for surgery as they may increase the risk of surgical site infection. If an incise drape is required, consider using an iodophor-impregnated drape unless the patient has an iodine allergy.

3.2.3 Asepsis and surgical technique

- a) Adhere to standard principles of asepsis for all procedures including placement of intravascular devices, spinal or epidural anaesthesia catheters, and when dispensing and administering intravenous drugs.
- b) Assemble sterile equipment and solutions immediately prior to use.
- c) Handle tissue gently, maintain effective haemostasis (see item 4d), minimize devitalized tissue and foreign bodies, and eradicate dead space at the surgical site.
- d) Maintaining effective haemostasis:
 - i. Maintain patient normothermia and prevent 'inadvertent perioperative hypothermia'.
 - ii. Maintain optimal oxygenation during surgery and ensure that an appropriate haemoglobin saturation is maintained during surgery and recovery.
 - iii. Maintain adequate perfusion during surgery.
- e) Do not use intra-operative skin re-disinfection or topical antimicrobials in abdominal surgery to reduce the risk of surgical site infection.
- f) At the end of the operation, cover surgical incisions with an appropriate interactive dressing such as semi-permeable film membrane with or without an absorbent.
- g) Use delayed primary skin closure or leave an incision open to heal by second intention if the surgeon considers the surgical site to be heavily contaminated.

- h) If drainage is necessary, use a closed suction drain. Place a drain through a separate incision distant from the operative incision. Remove the drain as soon as possible.
- i) There is no formal recommendation on the duration of operation although it is known that longer surgeries are associated with higher risks for SSI. Sterilize all surgical equipment according to published guidelines. Minimize the use of immediate-use steam sterilization.

3.2.4 Wound protectors

Use impervious plastic wound protectors for gastrointestinal and biliary tract surgery.

3.3 Post-operative measures

The main purposes of surgical dressings are to allow appropriate assessment of the wound postoperatively, to absorb exudates, to ease pain and to provide protection for newly forming tissue. They maintain an optimal moist wound environment without causing maceration of the surrounding skin as the dressing material is permeable to moisture and gas. Some dressings allow early bathing or showering of the rest of the patient in the first few postoperative days, which is part of early mobilisation. It is generally accepted good clinical practice to cover the wound with an appropriate interactive dressing for a period of 48 hours unless otherwise clinically indicated, for example, if there is excess wound leakage or haemorrhage.

3.3.1 Changing dressings

To prevent microorganisms on hands, surfaces and equipment from being introduced into the wound, aseptic non-touch dressing technique should be employed for the management of post-operative wound.

3.3.2 Postoperative cleansing

The most appropriate and preferred cleansing solution is sterile normal saline because it is non-toxic and the isotonic solution does not damage healing tissues. The objective is to remove excess wound exudate or any mobile slough and wound debris.

3.3.3 Topical antimicrobial agents for wound healing by primary intention

Primary intention healing is healing of a wound where the wound edges heal directly touching each other. This results in a small line of scar tissue, which is the goal whenever a wound is sutured closed. To reduce the risk of surgical site infection, do not use topical antimicrobial agents for surgical wounds that are healing by primary intention.

3.3.4 Dressings for wound healing by secondary intention

Do not use Eusol and gauze, or moist cotton gauze or mercuric antiseptic solutions to manage surgical wounds that are healing by secondary intention. Use an appropriate interactive dressing to manage surgical wounds that are healing by secondary intention.

3.3.5 Antibiotic treatment of surgical site infection and treatment failure

Antibiotic treatment is not routinely recommended for all SSIs. For minor infections pus can be drained by removal of sutures and application of antiseptics. When surgical site infection is suspected, patient should be given an antibiotic that covers the likely organisms. In choosing an antibiotic, one should consider the results of microbiological sensitivity tests and local sensitivity patterns.

3.3.6 Debridement

Debridement is the process of removing necrotic material or slough within the wound margin. The slough acts as a medium for bacterial proliferation therefore delaying the healing process. Currently there are a number of accepted methods available for wound debridement, including sharp debridement, hydrocolloid dressings and hydrogels. The promotion of wound healing is enhanced by appropriately timed dressing changes which allow granulation of tissue.

3.3.7 Specialist wound care services

To improve overall management of surgical wounds, a structured approach to wound care including preoperative assessments to identify individuals with potential wound healing problems should be developed. This can be achieved by providing specialist wound care services, enhanced education to healthcare professionals, patients and carers, and sharing of clinical expertise.

4 Recommendations

- a) Do not remove hair unless hair will interfere with the operation. If hair removal is necessary, remove outside the OT by clipping. Do not use razors. (All)
- b) Encourage smoking cessation within 30 days of procedure. B(I)
- c) Control serum blood glucose levels for all surgical patients, including patients without diabetes. For patients with diabetes mellitus, reduce glycosylated haemoglobin A1c levels to less than 7% before surgery, if possible. (AI)
- d) Use a dual agent for patient skin preparation containing alcohol, unless contraindications exist. (AI)
- e) Administer surgical prophylaxis only when indicated, within 1 hour of incision to maximize tissue concentration. (AI)
- f) Stop surgical prophylactic agents within 24 hours after the procedure for all procedures except cardiothoracic surgery where 48 hours is acceptable. (BII)
- g) Sterilize all surgical equipment according to published guidelines. Minimize the use of immediate-use steam sterilization. (All)
- h) Optimize tissue oxygenation by administering supplemental oxygen during and immediately following surgical procedures involving mechanical ventilation. (BI)
- i) Use impervious plastic wound protectors for gastrointestinal and biliary tract surgery. (BI)

5 SSI Bundle

Application of the SSI Bundle is recommended to prevent SSI i.e. all the following components applied as a package:

- a) If at all possible avoid hair removal; if hair removal is necessary, avoid the use of razors.
- b) Ensure prophylactic antibiotics are prescribed as per local antibiotic policy for the specific operation category and administered within 60 minutes prior to the operation.

- c) Ensure the patient's body temperature was normal throughout the operation (excludes cardiac patients).
- d) Ensure the patient's blood glucose level was normal throughout the operation (diabetic patients only).
- e) Use an alcohol-containing antiseptic agent for preoperative skin preparation.

5.1 Hair removal

The removal of hair may be necessary to give adequate view or access to the operative site. It is known that micro-abrasions of the skin may be caused by shaving with razors. This then may support bacterial multiplication especially if shaving had been done several hours prior to surgery. The increased number of skin colonisers at the operative site may then facilitate contamination of the wound leading to consequent SSI. Hence, where hair removal is required, it is recommended to do so using clippers or depilatory cream on the table at the operating theatre, just prior to surgery.

5.2 Surgical prophylaxis

The objective of administration of surgical prophylaxis is to achieve high tissue levels of antimicrobials at the time of skin incision. Hence, the optimal time for administration of preoperative doses is within 60 minutes before surgical incision. The exception lies with vancomycin prophylaxis, where vancomycin administration is initiated as slow infusion over 1 hour when patient is called to operating theatre. Traditionally, for caesarean section, surgical prophylaxis is given after cord clamping. However, recent evidences now support the practice of surgical prophylaxis be administered before surgical incision. This has been endorsed by ACOG and AAP.

Adequate dosing is important and adjustments by body weight needs to be made for obese patients. For all patients, intraoperative re-dosing is needed to ensure adequate serum and tissue concentrations of the antimicrobial if the duration of the procedure exceeds two half-lives of the drug or there is excessive blood loss during the procedure e.g. re-dosing of cefazolin after every 4 hours of the procedure.

In view of the relationship of antimicrobial utilization and development of

antimicrobial resistance, surgical prophylaxis is therefore, not recommended as a routine for clean non-prosthetic uncomplicated surgery. Where warranted, a single dose or continuation for less than 24 hours is recommended for surgical prophylaxis when administered.

5.3 Intraoperative body temperature

The medical literature indicates that patients undergoing colorectal surgery may have a decreased risk of SSI if they are not allowed to become hypothermic during the perioperative period. Anesthesia, anxiety, wet skin preparations, and skin exposure in cold operating rooms can cause patients to become clinically hypothermic during surgery. Hence, it is recommended that perioperative normothermia (temperature of 35.5°C or more) is maintained in surgical patients who have anesthesia duration of at least 60 minutes. The rationale is that even mild degrees of hypothermia may increase SSI rates. Hypothermia may directly impair neutrophil function or impair it indirectly by triggering subcutaneous vasoconstriction and subsequent tissue hypoxia. In addition, hypothermia may increase blood loss, leading to wound hematomas or need for transfusion, both of which can increase rates of SSI. Some randomized controlled trials have shown the benefits of both preoperative and intraoperative warming to reduce SSI rates and to reduce intraoperative blood loss although others have not shown a similar benefit.

5.4 Perioperative blood glucose control for cardiac surgery

Elevated blood glucose levels may increase patient's susceptibility to SSI. There have been several large cohort studies in cardiac surgery, which indicate that tight postoperative blood glucose control can reduce the risk of surgical site infections, and the serious complication of sternal incision infection in particular. It is recommended that blood glucose control of 10 mmol/L or lower is achieved in cardiac surgery patients in the time frame of 18–24 hours after anesthesia end time. It should be noted that intensive postoperative glucose levels of less than 6.2 mmol/L have not been shown to reduce the risk of SSI and may actually lead to higher rates of adverse outcomes, including stroke and death.

5.5 Pre-operative skin preparation for patient

Skin cleansing with antiseptics is done with the objective to reduce the number

of microorganisms on the skin around the incision. Alcohol-based solutions have the advantage of being both microbicidal and dry rapidly. Hence, it is recommended that skin cleansing at the surgical site be done with an aqueous or alcohol-based antiseptic preparation - povidone-iodine or 2% CHG with 70% IPA are most suitable. If diathermy is to be used, the antiseptic skin preparations should be dried by evaporation and pooling of alcohol-based preparations be avoided to prevent development of fire on the table.

Since the development of the SSI Bundle by the Institute of Health Improvement in December 2006, it has been implemented nationally in the US through the Surgical Care Improvement Project (SCIP). Data from SCIP (September 2010) indicated significant reduction in SSI following implementation using the model for improvement approach. This model has two parts:

- a) Three fundamental questions that guide improvement teams:
 - i. What are we trying to accomplish?
 - ii. How will we know if a change is an improvement?
 - iii. What changes can we make that will result in an improvement?
- b) The Plan-Do-Study-Act (PDSA) cycle to conduct small-scale tests of change in real work settings i.e. by planning a test, trying it, observing the results, and acting on what is learned.

After testing a change on a small scale, learning from each test, and refining the change through several PDSA cycles, the multidisciplinary quality improvement team can then implement the change on a broader scale e.g. hospital-wide. To track progress of implementation of changes, it is recommended that both process and outcome measures be tracked over time e.g.

- a) Prophylactic Antibiotic Received Within One Hour Prior to Surgical Incision
- b) Prophylactic Antibiotic Selection for Surgical Patients
- c) Prophylactic Antibiotics Discontinued Within 24 Hours after Surgery End Time
- d) Cardiac Surgery Patients with Controlled 6 AM Postoperative Serum Glucose
- e) Surgery Patients with Appropriate Hair Removal
- f) Colorectal Surgery Patients with Immediate Postoperative Normothermia

- g) Percent of Clean Surgery Patients with Surgical Infection

6 Enhanced SSI Bundle

An enhanced SSI Bundle is recommended for hip and knee arthroplasty and to be implemented in addition to the SSI Bundle described earlier. The additional interventions are:

- a) Use an alcohol-containing antiseptic agent for preoperative skin preparation.
- b) Instruct patients to bathe or shower with chlorhexidine gluconate (CHG) or octenidine soap for at least 3 days before surgery.
- c) Screen patients for *Staphylococcus aureus* (SA) and decolonize SA carriers with five days of intranasal mupirocin or octenidine nasal gel AND bathing or showering with chlorhexidine gluconate or octenidine soap for at least 3 days before surgery.

6.1 Preoperative skin preparation

Adequate preoperative skin preparation to prevent entry of skin flora into the surgical incision is an important basic infection prevention practice. Preoperative skin preparation of the operative site involves use of an antiseptic agent with long-acting antimicrobial activity, such as chlorhexidine gluconate (CHG) and iodophors. The combination of a long-acting agent (either an iodophor or CHG) is better than povidone-iodine alone for preventing SSI. There is insufficient evidence to support recommending the use of one combination agent over another. Two types of preoperative skin preparations that combine alcohol (which has an immediate and dramatic killing effect on skin bacteria) with long-acting antimicrobial agents appear to be more effective at preventing SSI than povidone-iodine (an iodophor) alone:

- a) CHG plus alcohol; and
- b) Iodophor plus alcohol.

6.2 Pre-operative antiseptic showers

The microbial flora on the skin comprises transient microorganisms that are easily removed by washing with soap, and resident flora that normally live in the skin appendages such as hair follicles. The resident flora is generally not pathogenic but is

not so readily removed by soap although antiseptics can reduce its numbers.

A Cochrane review on its effect on SSI prevention showed no clear benefit and its role in SSI prevention is still uncertain. Given that there is limited scientific evidence to guide recommendations, individual physicians may wish to consider intervening with CHG or octenidine soap bath or showers for at least 3 days before surgery after discussing the risks and benefit with the patient. Where MRSA is of high prevalence, this may be an additional adjunct measure towards reducing SSI associated with MRSA.

Implementation of the Enhanced SSI Bundle is best done using the model of improvement described earlier for implementation of the SSI Bundle. For best results, it is recommended that one carefully consider the current practices in the hospital for each intervention and then move on to develop a coordinated strategy to sequence implementation of the 3 interventions, since each intervention requires changes in different systems. The success of implementation of the interventions is best tracked using process and outcome measures over time for both the SSI Bundle and Enhanced SSI Bundle. Examples of additional measures to be tracked are:

- a) Percentage of patients undergoing hip or knee replacement surgery with skin antisepsis at the surgical site using an alcohol-containing preoperative skin antisepsis agent.
- b) Percentage of patients undergoing elective hip or knee replacement surgery who have bathed or showered with CHG or octenidine soap or wipes for at least 3 days prior to surgery.
- c) Percentage of patients undergoing hip and knee replacement surgery who have had preoperative nasal swabs to screen for *Staphylococcus aureus* / MRSA / both.

PART IV.

MANAGEMENT OF MULTI-DRUG RESISTANT ORGANISMS AND ORGANISMS OF SPECIFIC CONCERN

Chapter 16. National Infection Prevention and Control of MDROs

Chapter 17. Infection Prevention and Control Measures for MDROS in Healthcare
Setting

Chapter 18. Infection Prevention and Control Measures for MDROS in Healthcare
Setting

Chapter 19. Vancomycin-Resistant Enterococcus

Chapter 20. Carbapenemase-producing Carbapenam-resistant Enterobacteriaceae

Chapter 21. Mobilised Colistin Resistance

Chapter 16. National Infection Prevention and Control of MDROs

1 Executive Summary

Active surveillance cultures help to identify colonised MRSA patients in a facility or in a specific unit. This is recommended for all acute care institutions or facilities in Singapore. Patient population groups with known low risk factors for MRSA colonisation e.g. psychiatric, paediatric and obstetric patients may be exempted from active surveillance.

Healthcare institutions worldwide are increasingly faced with the emergence and transmission of multidrug-resistant organisms (MDROs). Patients can be harmed by MDRO infections. Left unchecked, the spread of MDROs will also increase the burden on healthcare infrastructure e.g. isolation rooms, as well as increase healthcare costs.

The prevention and control of MDROs is a national priority. Leadership and coordinated response by the Ministry of Health (MOH) and all relevant national agencies are critical. All healthcare institutions must participate in national MDRO control efforts. The national objective in controlling emerging or new MDROs of low incidence should be to contain the spread of these organisms in all Singapore healthcare facilities and prevent them from becoming endemic. For MDROs already endemic, the national objective should be to control and reduce their incidence in all Singapore healthcare facilities.

Nationally, there must be good communication and coordination on MDRO issues. Positive clinical or screening cultures for MDROs (MDRO clinical records information) should be communicated **appropriately** between healthcare facilities (taking into consideration principles of patient confidentiality) to allow appropriate infection prevention and control (IPC) measures to be taken in the receiving facility. The aim of tagging and untagging MDRO patients **within** a healthcare facility is so that the healthcare facility can act on this risk information and take the necessary IPC precautions. Tagging and untagging information is NOT for the purposes of informing another healthcare facility as different healthcare facilities have different IPC risk.

Instead the appropriate MDRO clinical records information should be communicated between healthcare facilities, taking into consideration principles of patient confidentiality.

Responses to MDRO clusters and outbreaks must be aggressive to contain and prevent spread to other patients and healthcare facilities. Escalation of new MDRO cases, clusters or outbreaks to MOH in a timely manner is critical should national level assistance or coordination be required to support and/or direct institutional infection prevention and control efforts or outbreak investigation.

Patient safety and the practice of appropriate infection prevention and control is the responsibility of all healthcare institutions. All healthcare institutions must have a comprehensive IPC programme that is developed based on an understanding of the risks, capabilities and capacity, and challenges within each healthcare facility. An MDRO Risk Assessment, best done annually, will give guidance to the institution's MDRO programme.

All healthcare institutions should build up IPC capabilities and capacity to ensure appropriate Infection Prevention and Control precautions when patients present with MDROs. All healthcare institutions should have the ability to mobilize appropriate resources to support their MDRO Surveillance, Risk Assessment and IPC programme. No patient should be declined admission to any healthcare facility because of carriage of MDROs.

Measuring the compliance with IPC precautionary measures on a routine basis, as well as enabling the benchmarking of IPC data will provide the healthcare institution with information on its success in these interventions. Implementation of an MDRO bundle will help the institution or facility monitor and ensure compliance.

Methicillin-resistant *Staphylococcus aureus* (MRSA) is endemic in many healthcare facilities and efforts to minimize transmission should continue. The incidence of vancomycin-resistant *enterococcus* (VRE) is increasing and similar efforts should be made to minimize transmission.

Carbapenemase-producing Carbapenem resistant *Enterobacteriaceae* (CP-CRE) has emerged as a worldwide threat since first being recognized in mid-2000s. They leave almost no antimicrobial options for those infected. Enhanced IPC measures, including active surveillance, are needed. Healthcare institutions need to be vigilant and intervene decisively and appropriately to maintain a low prevalence in Singapore.

2 Introduction

Healthcare institutions worldwide are increasingly faced with the emergence and transmission of multidrug-resistant organisms (MDROs). Multidrug-resistant organisms (MDROs), including methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant *Enterococcus* (VRE) and Carbapenemase-producing Carbapenem resistant *Enterobacteriaceae* (CP-CRE) have important patient safety and healthcare system implications.

Patients can become unnecessarily harmed as a result of MDRO infections. Left unchecked, the spread of MDROs will also increase the burden on healthcare infrastructure e.g. isolation rooms, as well as increase healthcare costs. Vigilant infection prevention and control, amongst other strategies to control antimicrobial resistance through management of antimicrobial utilization is needed.

As such, the prevention and control of MDROs is both a national priority, as well as a priority of healthcare institutions or facilities. The subsequent sections of this chapter provide recommendations and considerations for national infection prevention and control (IPC) of MDROs. The chapter covers topics such as emerging and endemic MDROs, role of national agencies such as the Ministry of Health (MOH) and the National Public Health Laboratory (NPHL), coordination of national MDRO control efforts, as well as guidance on expedited flow of information between healthcare institutions and MOH, including escalation and containment of new MDROs, MDRO clusters and outbreaks. The role of appropriate antimicrobial management is also briefly discussed in section 5.

Chapter 17 provides detailed guidance on the infection prevention and control measures for MDROs in healthcare settings. The Chapter includes guidance for acute care institutions or facilities.

Finally, specific measures for the different MDROs, as well as detailed data collection and reporting requirements for MDROs are also detailed in the respective MDRO chapters (see 18 Methicillin-resistant *Staphylococcus aureus* (MRSA), Chapter 19 Vancomycin Resistant *Enterococcus* (VRE), Chapter 20 Carbapenamase-producing Carbapenam resistant *Enterobacteriaceae* (CP-CRE) and Chapter 21 Mobilised Colistin Resistance-1 (MCR-1).

In addition, guidance on IPC strategies and practices within healthcare settings are also detailed. Although *Clostridium difficile* is not a MDRO, it is included as an Appendix 16.1 in this MDRO guideline to give some guidance to institutions on the management of patients or residents with this organism.

The prevention and control of MDROs is a national priority – one that requires all healthcare facilities to assume and exercise responsibility in MDRO prevention and control. Achieving control within healthcare institutions alone is insufficient since MDROs do not respect institutional boundaries. Healthcare institutions must participate in national MDRO control efforts.

Leadership and facilitation by MOH and all relevant national agencies are critical. Financial and human resources must also be made available to enable IPC efforts. These include expert consultation, laboratory support, adherence monitoring, and data analysis.

There must be good communication and coordination on MDRO issues between healthcare institutions, and between healthcare institutions and national agencies such as MOH and NPHL. Responses to MDRO clusters and outbreaks must be aggressive to contain and prevent spread to other healthcare facilities. The aim should be to reduce, and where possible, eliminate all patient harm that is caused by MDROs. Doing so will also bring about improvements to the operational efficiency of our healthcare system, as well as reduce costs.

3 Emerging versus Endemic MDROs

Emerging or new MDROs of low incidence are occasionally identified because of better technology or as a result of widespread use of broad spectrum antimicrobials over time. Refer to Appendix 16.2: Definitions and Abbreviations Used in the Document for a list of pathogens currently classified as emerging in Singapore healthcare institutions, for example CP-CRE, vancomycin-resistant *Staphylococcus aureus* (VRSA). In the management of these MDROs, the national objective should be to contain the spread of these organisms in all Singapore healthcare facilities and prevent them from becoming endemic.

Endemic MDROs refers to MDROs with relatively high but stable incidence. Refer to Appendix 16.2: Definitions and Abbreviations Used in the Document for a list of pathogens currently classified as endemic in Singapore healthcare institutions. This list is not exhaustive, and each institution should develop its own MDRO reduction program to include target pathogens of interest, for example multi-resistant *Pseudomonas*, multi-resistant *Acinetobacter* species. For MDROs that are already endemic, the national objective should be to control and gradually reduce their incidence in all Singapore healthcare facilities.

4 Role of National Agencies

4.1 Ministry of Health

Preventing and controlling MDRO infections at the national level requires collaboration among all types of healthcare facilities with MOH. The key functions of the MOH include:

- a) Leadership and coordination of the national MDRO control strategies and efforts. This includes:
 - i. Implement a National MDRO Control Program
 - ii. Setting of relevant MDRO related guidelines and quality improvement standards
 - iii. Data collection to monitor progress of the National MDRO Control Program.

- iv. This includes benchmarking, and ensuring timely feedback of such data to healthcare institutions
 - v. Utilizing the appropriate accountability platforms to improve performance in MDRO control, antimicrobial management and IPC issues
 - vi. Facilitation of MDRO control, antimicrobial management and IPC related quality improvement initiatives
 - vii. Facilitating the sharing of best practices and initiatives amongst healthcare institutions to accelerate pace and scale of quality improvement
- b) Conducting national risk assessments and prevalence surveys:
- i. A national MDRO risk assessment should be conducted at the minimum annually. More frequent risk assessment should be considered depending on the threat posed by particular MDROs in consultation with experts drawn from healthcare institutions in Singapore. The development of national level MDRO control strategies should in turn be drawn up based on national MDRO risk assessments
 - ii. Periodic national prevalence surveillance should be done to assess efficacy of IPC measures in the national MDRO Control Program
- c) Developing national antibiograms and conducting epidemiologic investigations if and when necessary
- d) Conducting targeted regulatory audits to ensure good institutional control:
- i. Periodic audits for facility compliance to recommended practices should be done by MOH. Depending on compliance rates, additional educational outreach, such as in-service trainings and webinars, may need to be provided to individual facilities
 - ii. Receive escalations and coordinate national responses for novel MDROs, relevant MDRO clusters and MDRO outbreaks (See Escalation and Containment of New MDROs or MDRO Clusters and Outbreaks)
- e) Where appropriate, MOH should also work with other national level regulatory agencies to improve national control of MDROs

- f) Research activities should be encouraged and supported to determine the best control measures possible.

4.2 National Public Health Laboratory

In addition, there must be capabilities at the national level for the following functions to support national MDRO control:

- a) Molecular epidemiology of MDROs
- b) Identification or confirmation of emerging or new MDROs e.g. VRSA
- c) To collect isolates with new or unusual antimicrobial resistance patterns.

These capabilities will provide a better understanding of the epidemiology of the specific MDROs and guide national strategies towards better control.

5 Role of Antimicrobial Management in Healthcare Facilities

Appropriate use of antimicrobials has a major role to play in lowering rates of MDROs and preventing selection of further antimicrobial resistance in the healthcare facility. Healthcare facilities should employ a collaborative group of infectious disease physician, pharmacists, microbiologists and IPC staff to work with heads of departments and clinicians throughout the facility to ensure that there is appropriate and effective management of antimicrobial use for all patient care activities in the healthcare facility. The following interventions for management of antimicrobial usage should be applicable to both acute and long-term care settings, where applicable:

- a) Restricted formulary as recommended by the facility's Pharmacy and Therapeutics Committee or equivalent committee
- b) Clinical guidelines on use of antimicrobials for treatment and prophylaxis. Guidelines should be discipline or disease specific. There should be a system in place within the facility to monitor and ensure compliance to such guidelines
- c) Restricted and appropriate laboratory reporting of antimicrobial susceptibility
- d) Educational program for MDROs and use of antimicrobials
- e) Antimicrobial audit and feedback program e.g. antimicrobial stewardship program (ASP)

6 Communication Within and Between Healthcare Facilities

6.1 Within Healthcare Facilities

Depending on factors such as patient demography and the types of healthcare services provided, the IPC risk posed by patients with MDROs to the healthcare facility is different from facility to facility.

All healthcare facilities should have the ability to “tag” a patient based on the patient’s known MDRO clinical records in accordance to the level of IPC risk posed by patients with the particular MDRO to the healthcare facility. Likewise, all healthcare facilities should have the ability to “untag” a patient when the level of IPC risk posed by a patient when the particular patient’s MDRO clinical records suggest that his/her IPC risk has fallen to an acceptable level. Tagging and untagging of MDRO patient in accordance to the level of IPC risk they pose should be done in consultation with the IPC team of the healthcare facility, taking into consideration MDRO clinical record information drawn from clinical/microbiology/laboratory information systems.

The aim of tagging and untagging MDRO patients in accordance to the level of IPC risk is to enable expedient and clear communication of relevant IPC risk information so that other front-line staff *within* a healthcare facility can act on this risk information to take the necessary IPC precautions to care for MDRO cases and protect other patients. Tagging and untagging information is NOT for the purposes of informing another healthcare facility.

For example, depending on the healthcare facility, the IPC risk information should be made available to front-line staff such as patient transportation staff, patient registration staff, emergency department staff, bed management staff and clinical staff etc. The IPC risk information should be in a form and manner sufficient for staff to take the appropriate IPC actions promptly. In most instances, only the necessary IPC risk information needs to be communicated to preserve patient confidentiality. The exact MDRO clinical record of the patient should be treated like all other clinical records and should be communicated on a need to know basis e.g. to clinical staff directly involved in the care for the patient.

6.2 Between Healthcare Facilities

In order to optimize the care for patients, patient transfer between healthcare facilities may be necessary. Transfers may occur between hospitals, between hospitals and any ILTC facility, or the patient may return home for continued care. Alternatively, patients with MDROs may be discharged from one facility and get re-admitted into another facility in a subsequent healthcare encounter, increasing the risk of an inter-facility transmission. To reduce inter-facility transmission of all MDROs, all healthcare facilities should routinely:

- a) Communicate up-to-date MDRO clinical records information for patients to be transferred to another facility. Information on the level of IPC risk posed by the MDRO in relation to the sending facility may be different from that of the receiving facility and should NOT be communicated to the receiving facility.
- b) Receive and act on MDRO clinical records information for patients being admitted to its care. Institutions should ensure that all the necessary staff e.g. front line or admitting staff are able to access MDRO clinical records information, and are trained to respond to the information in the system. This includes tagging the patient appropriately in accordance to the level of IPC risk posed by the MDRO case to the receiving healthcare facility.

To ensure that MDRO clinical records information communicated between healthcare facilities is clear and effective (contains all necessary information for the receiving institution to decide IPC risk):

- a) In accordance to recommendations in Chapter 18 Methicillin-resistant *Staphylococcus aureus* (MRSA, Chapter 19 Vancomycin Resistant *enterococcus* (VRE) and Chapter 20 Carbapenemase-producing Carbapenam resistant *Enterobacteriaceae* (CP-CRE, all the necessary MDRO clinical records in relation to each MDRO should be communicated to enable other healthcare facilities to assess appropriately the level of IPC risk posed by patients with a particular MDRO to their own healthcare settings and proceed to tag or untag patients in relation to the IPC risk posed to their facility accordingly All healthcare facilities should communicate the patient's up-to-date MDRO

clinical records information to other healthcare facilities through a national electronic system.

- b) Changes to a patient's MDRO clinical records should be updated into the national electronic system, as soon as it is known, even after the patient has left the healthcare facility. For example, if a relevant culture result comes back after the patient has left the facility, this information should be updated into the national electronic system.
- c) All healthcare facilities should update a patient's IPC risk profile and proceed to tag or untag a patient within their own facilities based on the latest MDRO clinical records information updated into the national electronic system.
- d) Information on the level of IPC risk posed by the MDRO in relation to the healthcare facility may be different from facility to facility and this should not be confused with MDRO clinical records information, and should NOT be uploaded into the national electronic system

7 Escalation and Containment of New MDROs or MDRO Clusters and Outbreaks

7.1 Escalation to MOH

Escalation of new MDRO cases, clusters* or outbreaks** to MOH in a timely manner is critical should national level assistance or coordination be required to support and/or direct institutional infection prevention and control efforts or outbreak investigation. This is especially critical if the healthcare facilities involved have little infection prevention and control capabilities. Escalation will also enable a level of national coordination critical to enable other healthcare institutions to undertake the necessary IPC measures, in order to achieve national control.

**Definition of MDRO Cluster: An incident which involves more than the usual number of MDRO cases e.g. more than 2 standard deviations from the monthly mean number of cases for that MDRO, but these cases are either not epidemiologically linked or awaiting epidemiological investigations for confirmation of links*

*****Definition of MDRO Outbreak: An incident which involves MDRO cases that are epidemiologically related or that requires ward closure or cancelling of surgery on a significant scale***

Upon the discovery of any of the following scenarios, the IPC team or the microbiology laboratory in the healthcare facility must immediately notify MOH of the situation:

- a) Any new or emergent MDRO that is *first* identified in the healthcare facility, i.e. never before seen in the healthcare facility concerned. This will ensure that the first case in the country will always be notified to MOH promptly;
- b) All MDRO cluster (s) or outbreak(s);
- c) Any collection of MDRO cases occurring within the healthcare facility that are deemed not manageable by the facility;
- d) Any MDRO cases for which the source is suspected or traced to an iatrogenic or environmental source, which may have implications for other institutions

Notification to MOH should include the following:

- a) Detailed demographic and clinical information about the MDRO case(s)
- b) Epidemiologic information about each cluster(s) or the outbreak

7.2 Containment and Prevention of Future Clusters or Outbreaks

The ability to contain and prevent future MDRO clusters and outbreaks are the responsibility of healthcare institutions. In the event of a MDRO cluster or outbreak, the healthcare facility must put in place all necessary infection prevention and control interventions to arrest the cluster or outbreak, and must conduct all necessary epidemiological investigations to determine the source of the cluster or outbreak. Such activities must be completed in a timely manner to prevent the situation from worsening and harming more patients. The healthcare facility must work with NPHL, when necessary, to determine if there is clonal spread. Where the cluster or outbreak situation exceeds the infection prevention and control or epidemiological capabilities within the facility, it is the responsibility of the institution to inform MOH so that necessary assistance can be mobilized.

The healthcare facility must keep MOH updated through the progress of the cluster or outbreak situation through regular epidemiological reports and updates. After the cluster or outbreak has ceased, lessons or gaps in infection prevention and control processes, if any, should be identified and steps taken to close gaps to prevent similar future occurrences.

7.3 Recurrent Similar Clusters or Outbreaks

The healthcare facility should document and trend recurrent similar clusters or outbreaks and if there are recurrent similar MDRO (>2 independent) clusters or outbreaks in the facility, the healthcare facility should conduct an aggregate Root Cause Analysis (RCA) to identify the root cause of such reoccurrence, and take all necessary steps to stop such reoccurrence in future.

8 References

- APIC Implementation Guide to Preventing *Clostridium difficile* Infections, February 2013.
- Cohen SH, Gerding DN, Johnson S *et al.* Clinical Practice Guidelines for *Clostridium difficile*
- Health Protection Network Scottish Guidance. Guidance on Prevention and Control of *Clostridium difficile* Infection (CDI) in Healthcare Settings in Scotland. September 2009.
- Public Health Division: Public Health Protection and Prevention Branch Ministry of Health and Long-Term Care, Ontario, Canada. Control of *Clostridium difficile* Infection (CDI) Outbreaks in Hospitals. December 2009
- Society for Healthcare Epidemiology of America (SHEA) and the Infectious Diseases Society of America (IDSA). Infection in Adults: 2010, Infect Control Hosp Epidemiol 2010; 31(5): 431-455.

Appendix 16.1. Clostridium difficile

Clostridium difficile infection (CDI) is the most common cause of diarrhoea-associated with antimicrobial therapy. Clinical disease ranges from toxin-mediated symptoms associated with mild diarrhoea, which can resolve without treatment, to severe cases such as pseudomembranous colitis, toxic megacolon and peritonitis that can lead to death. In mild disease, diarrhoea is usually the only symptom; where diarrhoea is defined as the passage of 3 or more loose or liquid stools per day, or as more frequently than is normal for the individual (WHO). A single case of severe CDI or a single death due to CDI should always prompt further investigations.

Symptomatic CDI patients shed hardy spores of *C. difficile* via their stools into the environment. The spread of hardy spores of *C. difficile* via contact plays an important role in the transmission of CDI in healthcare facilities. Isolation of symptomatic CDI patients is a key step in preventing the transmission of *C. difficile* within healthcare facilities.

Infection Control Measures in Management of Symptomatic CDI Patients

Patient placement

Symptomatic patients with CDI should preferably be nursed in a single-bedded room with hand washing facilities, en-suite toilet, dedicated care equipment and the door kept closed. Personal protective equipment should be put on before entering the isolation room (or area) with symptomatic CDI patient(s). If isolation in single rooms is not possible, isolation in cohorts should be undertaken. Cohorted patients should be managed by designated staff, where possible, to minimize the risk of infection to other patients (or staff). Isolation precautions may be discontinued when the patient has been symptom-free for 48 hours and bowel movements have returned to normal. If the patient has recurrent CDI, consideration may be given to leaving the patient in a single room accommodation even after resolution of symptoms to minimize the risk of transmission.

Hand hygiene

The spread of *C. difficile* spores via direct and indirect contact is the major route of transmission of CDI in healthcare facilities. Meticulous hand hygiene with soap and water or antiseptics is recommended for all staff if hands are visibly soiled where the physical removal of spores is achieved with rinsing.

Equipment and environment

Care equipment (such as commodes, blood pressure cuffs and stethoscopes) should be dedicated to a single patient. All care equipment should be carefully cleaned and disinfected using a sporocidal agent (e.g. 1000 ppm hypochlorite) immediately after use on a CDI patient. Rectal thermometers should not be shared, and use of electronic thermometers with disposable sheaths should be avoided. Single-use items (including thermometers and other care equipment) should be used when possible.

For environmental cleaning, healthcare facilities should refer to the Environmental Cleaning Chapter herein.

Appendix 16.2. Definitions and Abbreviations

Definitions

Multi-drug resistant organism (MDRO): The term multi-drug resistance as used in these guidelines describes a bacterial isolate which is resistant to one or more agents in three or more different classes of antimicrobials that the isolate is expected to be susceptible to; e.g. penicillins, cephalosporins, aminoglycosides, fluoroquinolones and carbapenems.

Active Surveillance: This is a process to identify MDRO carriers using microbiological tests (culture or PCR) at time of admission with the objective to institute prompt infection prevention and control measures. This could be done either as universal or as targeted active surveillance. Universal active surveillance refers to the screening of all patients or residents on admission for carriage of specific MDRO. In contrast, targeted active surveillance refers to screening of patients or residents according to risk factors.

Infection: The presence of MDRO in tissues or body fluids along with signs and symptoms of infection (either locally or systemically) or the presence of MDRO in normally sterile body sites or fluids (usually but not necessarily with symptoms of infection).

Colonisation: The presence of MDRO in body fluids or tissues (e.g. gastrointestinal tract, urine, or sputum) without clinical signs of infection.

Acute Care Institutions or Facilities: These refer to public and private hospitals, including community hospitals.

ILTC Facilities: These refer to all intermediate and long term healthcare facilities, whether these are residential or non-residential. For example, ILTC healthcare facilities include Nursing Homes, Dialysis Centres and Day Rehabilitation Care settings. ILTC healthcare facilities do not include non-healthcare facilities such as

homes under the Ministry of Social and Family Development (MSF). ILTC healthcare facilities do not include Ambulatory Healthcare Facilities.

Emerging MDROs

- Carbapenemase producing Carbapenem resistant *Enterobacteriaceae* (CP-CRE)
- MCR
- Vancomycin-resistant *Staphylococcus aureus* (VRSA)

Endemic MDROs

- Methicillin-resistant *Staphylococcus aureus* (MRSA)
- Multi-resistant *Pseudomonas species*
- Multi-resistant *Acinetobacter species*
- Vancomycin-resistant *Enterococcus* (VRE)

MDRO Clinical Records Information: This refers to a national electronic record system consisting of patients' multi-drug resistant organism (MDRO) laboratory results to help clinical management decisions.

Abbreviations

BSI: Bloodstream infection

CDC: Centre for Disease Control

HDU: High Dependency Unit

HICPAC: Hospital Infection Control and Prevention Advisory Committee

ICU: Intensive Care Unit

IPC: Infection prevention and control

MDRO: Multidrug-resistant organism

NHSN: National Healthcare Safety Network

NICU: Neonatal Intensive Care Unit

PPE: Personal protective equipment

WHO: World Health Organisation

Chapter 17. Infection Prevention and Control Measures for MDROs in Healthcare Settings

Although transmission of MDROs is most frequently documented in acute care facilities e.g. hospitals, all healthcare settings are affected by the emergence and transmission of antimicrobial-resistant microbes. Successful prevention and control of MDROs requires strong leadership and clinical governance. Healthcare institutions should adopt a continuous quality improvement approach and ensure that the appropriate infection prevention and control strategies are fully implemented. Healthcare institutions should systematically collect IPC data to ensure appropriate feedback to regularly evaluate the effectiveness of IPC strategies. Such data should also be available nationally to provide additional insight into performance of local IPC strategies (See Chapter 16 on National Infection Prevention and Control of MDROs). Strategies should be adjusted such that there is a consistent decrease in the incidence of targeted MDROs. This aim should be to reduce, and where possible, eliminate all patient harm that is caused by MDROs.

The severity and extent of disease caused by these pathogens varies by the population(s) affected and by the healthcare institution(s) in which they are found. Healthcare institutions, in turn, vary widely in physical and functional characteristics, ranging from ILTC facilities to specialty units (e.g. intensive care units [ICU], burn units, neonatal ICUs [NICUs]) in acute care facilities. Accordingly, while the approaches to prevention and control of these pathogens starts from generally applicable interventions such as having infection prevention and control programmes and risk management, these interventions need to be tailored to the specific needs of each population and type of healthcare institution.

1 Infection Prevention and Control Programme and Risk Assessment

An effective IPC programme is essential to control MDROs. IPC programmes must be comprehensive and based upon a clear understanding of the risks, capabilities and capacity, and challenges within each healthcare facility.

All healthcare institutions, whether hospitals or non-acute facilities should have an IPC programme in place, ideally incorporating the following:

- a) Processes for monitoring infection prevention and control problems, including outbreaks of MDROs
- b) Education of employees in IPC practices
- c) Processes for development and updating of IPC policies and procedures
- d) Access to microbiology or laboratory services
- e) Policies for management of antimicrobial use in the healthcare institution
- f) Findings of pharmacy and therapeutics reviews and relevant clinical guidelines
- g) Role of the healthcare facility in national MDRO prevention and control (see Chapter 16 National Infection Prevention and Control of MDROs).

Activities to reduce infections from MDROs begin with an assessment of the specific risks in the healthcare facility. When MDROs are introduced into a healthcare facility, a number of factors aid the transmission and persistence of MDROs in the environment. These include:

- a) Presence of vulnerable patients, such as those with compromised immunity from underlying medical or surgical conditions, those who have indwelling devices including endotracheal tubes, vascular catheters or urinary catheters
- b) The reservoir of infected or colonised patients
- c) The selective pressure exerted by antimicrobial use
- d) The effectiveness of local IPC measures

It is best for all healthcare institutions, whether a hospital or a non-acute facility, to perform an MDRO Risk Assessment annually. Institutions should be familiar with risk assessment principles such as the use of likelihood and impact analyses to support prioritization and action.

Steps to performing an MDRO risk assessment include:

- a) Establish the baseline incidence and/or prevalence MDRO rates for the whole healthcare facility or for specific unit(s) in the facility.

- b) Identify high-risk populations and/or units based on incidence and/or prevalence rates, local demographic risk data, and known risk factors from scientifically based evidence.
- c) Evaluate MDRO data for the facility and/or the specific unit(s) over time to characterize MDRO prevalence or transmission rates to determine if enhanced interventions are needed.
- d) Conduct appropriate surveillance for MDROs, taking into account the above risk factors and MDRO data, in order to identify MDRO cases early for infection control.
- e) Identify clusters in MDRO transmission in the patient population and/or unit(s) to determine if enhanced interventions are needed.

Based on the institution's MDRO surveillance and risk assessment, the healthcare institution should develop and implement an appropriate IPC programme that targets MDROs in the facility.

This requires each institution to have the following IPC components:

- a) IPC Department staffing and/or hours assigned to IPC
- b) Knowledge of IPC interventions current in place in the institution (e.g. Hand Hygiene Programme, Contact Precautions, etc.)
- c) Status of IPC interventions e.g. measurement parameters and compliance rates
- d) Comprehensive line list of identified patients with MDROs (colonization and infection)
- e) Facility antibiogram

Successful implement of an appropriate IPC programme in the healthcare facility is strongly dependent on the availability and timeliness of clinical diagnostic laboratory services. All healthcare institutions should ensure sufficient investment and support for their clinical diagnostic laboratories. Alternatively, resources and support should be available to enable timely access to such services beyond the healthcare facility. Likewise, in order to ensure timely management of clusters and outbreaks, all institutions should ensure that there is either surge capacity within the institution's clinical diagnostic laboratories, or there should be timely access to surge capacity in clinical diagnostic laboratories elsewhere.

In addition, all healthcare institutions should have the ability to mobilize the following resources to support their MDRO Surveillance, Risk Assessment and IPC programme:

- a) Administrative support
- b) Facility technical support
- c) IT support
- d) Pharmacy capabilities
- e) Support from the appropriate national agencies e.g. MOH or NPHL

The IPC programme should also detail a definite timeline for implementation, including sufficient time to communicate the IPC programme to all staff for maximum participation. Appropriate monitoring of programme at specific milestones in the timeline should be included to gauge the effectiveness of the IPC programme.

2 Precautionary Measures

In addition to setting up an Infection Prevention and Control Programme and putting in place appropriate risk assessment, precautionary measures are recommended for patients known to be colonised or infected with MDROs. All healthcare facilities should implement the appropriate interventions described in Appendix 17.1: Summary of Precautionary Measures for MDRO patients.

2.1 MDRO Bundle

Measuring the compliance with precautionary measures on a routine basis will provide the healthcare institution with information on its success in these interventions. For ease of implementation and monitoring, the following precautionary measures may be packaged into an MDRO Bundle:

- a) Active surveillance
- b) Antimicrobial management, including antimicrobial stewardship programmes
- c) Practice of isolation precautions such as contact precautions for patients or residents identified with MDROs
- d) Hand hygiene in accordance with institutional guidelines

- e) Environmental hygiene in accordance with institutional guidelines
- f) Antiseptic body baths (or wipes for bedridden patients or residents) to reduce bio-burden in patients or residents identified with MDROs

Details of the above measures are in Appendix 17.1: Summary of Precautionary Measures for MDRO patients. Institutional hand hygiene and environmental cleaning guidelines should be developed based on the World Health Organization's (WHO) Five Moments in the WHO Guidelines on Hand Hygiene in Health Care (2009) and the guidelines on environmental cleaning in chapter 9 respectively.

At least annually, a review of the MDRO Bundle and all other IPC outcomes and process measures will inform whether intensified efforts are needed (see Intensified Interventions to Prevent MDRO Transmission), as well as the areas where improvements can be made.

3 Specific Guidance on Emerging and Endemic MDROs

3.1 Emerging MDROs

For emerging MDROs with low prevalence, where the institution's risk assessment requires, the healthcare facilities should:

- a) Conduct a "Look Back" review of the preceding 6-12 months of microbiology records to detect whether there were any MDRO cases belonging to the emerging type that had gone unrecognized
- b) If the "Look Back" review identifies any MDRO cases belonging to the emerging type, the facility should perform a point prevalence survey in its high-risk units to determine the burden of MDROs belonging to the emerging type. Examples of high-risk units are ICUs, units with high antimicrobial utilization, as well as the units in which the previously unrecognized cases were identified during the "Look Back" review
- c) Conduct contact tracing for patients with epidemiologic links to these MDRO cases. The extent of such contact tracing should be determined in discussion with the IPC team of the healthcare facility and may include:
 - i. Patients within the same cubicle as the MDRO case during the inpatient stay

- ii. Patients within the same ward as the MDRO case during the inpatient stay, if the situation is such that there is a possibility of transmission across the ward
 - iii. Patients sharing a shared facility with the MDRO case during the inpatient stay, if the situation is such that there is a possibility of transmission through the shared facility e.g. gymnasiums
- d) Communicate urgently the findings of any previously unrecognized emerging MDRO cases to MOH. Refer to the section on communication (Communication Within and Between Healthcare Facilities)

3.2 Endemic MDROs

For endemic MDROs, specific interventions may include:

- a) Conducting active surveillance screening of patients admitted from settings or facilities with high prevalence of MDROs or with risk factors for MDROs
- b) Consider implementing antiseptic body wash or wipes in an effort to reduce bio-burden till screening specimens are known
- c) Consider conducting periodic point or period prevalence surveys of MDROs using cultures, to assess efficacy of control interventions
- d) Monitoring thoroughness of environmental cleaning efforts to ensure consistent environmental cleaning and disinfection of surfaces frequently touched by patients and healthcare professional (e.g. bedrails, tray table, etc.)

If MDRO rates do not decrease, healthcare facilities should implement intensified interventions to reduce and eliminate transmission (See Intensified Interventions to Prevent MDRO Transmission).

4 Intensified Interventions to Prevent MDRO Transmission

A decision to employ additional MDRO control measures within a healthcare facility may arise from an MDRO Risk Assessment, including a review of surveillance data and assessments of risk to patients, such as when:

- a) An MDRO is identified in a unit or facility with a highly vulnerable patient population (ICU, NICU, Burns Unit) that had not previously encountered that MDRO i.e. even if the MDRO is identified in just one patient
- b) There is failure to decrease the prevalence or incidence of MDROs, despite effective implementation of appropriate infection prevention and control interventions to limit transmission as well as identification of clusters

A risk assessment of the situation should be carried out along with an evaluation of the measures already in place. Compliance with IPC measures e.g. precautionary measures should be reviewed and correlated with IPC outcomes. This will inform the IPC team where to target intensified efforts and improvement activities. Feedback should also be given to the units and/or wards assessed.

Intensified efforts could include measures such as enhanced education, enhanced surveillance, more stringent environmental cleaning, cohorting and isolation.

5 MDRO-colonised Patients in Dialysis Centres

In general, patients colonised with an MDRO do not pose a risk to healthy members of the community (including family members). The management of patients of dialysis centres who are colonised with an MDRO is quite different to that in the acute care setting. When deciding the extent of IPC measures in a dialysis centre, the patient's individual situation, as well as the prevalence of MDROs in the facility, needs to be taken into account. However, all healthcare facilities should endeavour to prevent transmission of MDROs.

Generally:

- a) Standard precautions should be implemented by all healthcare professionals when dealing with all patients in all healthcare facilities regardless of whether they are infected or colonised with an MDRO
- b) Hand hygiene should be performed in accordance with institutional guidelines, which should be developed based on WHO guidelines

- c) Contact precautions when managing specific patients should be titrated to the patient's individual situation and the prevalence of MDROs in the institution

At dialysis centres, Standard Precautions are sufficient to manage relatively healthy independent patients colonised with an MDRO. Gloves and aprons are used when dealing with secretions, draining wounds, stool, ostomy bags or tubes and pressure ulcers.

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Appendix 17.1. Summary of Precautionary Measures for MDRO patients

Patient placement

- Patients known to be colonised or infected with a Multidrug-resistant Organism (MDRO) that is newly emerging (e.g. Carbapenemase-producing Carbapenam resistant *Enterobacteriaceae*)
- CP-CRE patients should be admitted to a single room where possible, where gown and gloves are to be used as PPE. Cohorted patients in general wards are to be cohorted with patients with the same MDROs; with emphasis on hand hygiene practices by both staff and visitors. Patients with diarrhoea or incontinence are at a higher risk of spreading MDRO known to colonise the intestinal tract (e.g. vancomycin-resistant *enterococcus* [VRE], CP-CRE) and should be given priority for single rooms. An *en-suite* room is preferable, but if one is not available, a commode should be dedicated for each patient's individual use
- Where placement in a single room or cohorting is not achievable, consider the patient population when determining patient placement. Consult Infection prevention and Control team for advice before placement
- The door to the patient's room should be kept closed to minimise spread to adjacent areas unless it is likely to compromise patient care
- The appropriate signage should be placed on the outside of the door indicating Contact Precautions
- Where possible and without compromising patient care, routine care of patients colonised or infected with MDRO should be carried out after attending to other patients. Healthcare institutions should have a policy on the use of shared facilities or equipment

Hand hygiene and personal protective equipment (PPE)

- Hand hygiene should be performed using an antimicrobial or alcohol hand rub agent before and after touching a patient
- Gloves are required as outlined for Standard Precautions, where there is potential contact with blood or body fluids. In addition, as part of Contact Precautions, they should be donned prior to entering an isolation room or cohort

space for all interactions that may involve contact with the patient or potentially contaminated areas in the patient's environment

- Gloves should be removed on completion of a task and before leaving the patient's single room or cubicle
- Hand hygiene should be performed immediately upon removal of gloves with an antimicrobial or alcohol-based hand rub
- A disposable apron or gown may be required for very close and more extensive contact (e.g. bathing, diaper change, turning patient etc.); advice on this should be obtained from the Infection Prevention and Control (IPC) Team. The apron or gown should be removed and discarded after use
- Masks may occasionally be necessary for healthcare professionals such as when performing splash or aerosol-generating procedures

Visitors

- Visitors to the cubicle or ward and staff from other wards and departments (e.g. physiotherapists, radiographers, other medical teams, students etc.) should only enter after permission and instruction from the nurse-in-charge. A signage detailing isolation precautions should be displayed prominently

Care givers training

- Hand hygiene and appropriate precautions for handling body fluids should be incorporated in caregiver training. Caregivers of patients colonised by MDROs should be instructed on relevant elements of Contact Precautions

Cleaning and decontamination of environment and patient-care equipment

- Local policies for environmental cleaning and equipment decontamination, waste and linen management should state the necessary standards, and should be applied rigorously
- Wards should be cleaned regularly as part of a general programme of environmental hygiene
- Adequate hand hygiene facilities and alcohol-based hand rub should be available for staff and visitor hand decontamination before and after contact with the patient or their immediate environment

- Instruments or equipment should preferably be single-patient use
- Multiple-patient-use items should be decontaminated appropriately before use on another patient in accordance with local policy or manufacturer's instructions
- All patient care equipment or supplies must be effectively cleaned and disinfected before use on another patient
- The room in which a patient with an MDRO has been cared for should be cleaned after the patient's discharge with a chlorine releasing agent, such as hypochlorite, with special attention to frequent-touch areas, horizontal surfaces and dust-collecting areas (e.g. ventilation grids). For equipment that could not withstand chlorine, alternatives may be considered with guidance from IPC team. Curtains should be removed and laundered if not single-use disposable curtains. Pillows and mattress covers should be checked for damage
- After an outbreak or incident of MDRO colonisation or infection, isolation rooms (or the whole of a ward after more extensive outbreaks) must be cleaned with appropriate disinfectant thoroughly to reduce environmental contamination.
- Documents including the nursing notes and patient's chart should not be taken into the room
- Only essential equipment and supplies should be taken into the patient's room. Stockpiling of supplies should be avoided

Antiseptic body wash or wipes

- Antiseptic e.g. 4% chlorhexidine, liquid chlorhexidine (2%) or 2% chlorhexidine-impregnated wipes, octenidine or equivalent products; are used to bathe patients daily in acute care setting. Chlorhexidine, if used, is usually not used above the jaw line or on open wounds
- In long-term care settings this type of an intervention might be used on targeted high-risk residents (e.g. residents that are totally dependent upon healthcare personnel for activities of daily living, are ventilator dependent, are incontinent of stool, or have wounds whose drainage is difficult to control) or high-risk settings (e.g. ventilator unit)

Linen

- All linen from patients infected with or colonised with MDRO should be considered to be contaminated or infected including bedding and adjacent curtains. Linen should be removed from the bed with minimal agitation and should be further managed in accordance with local policy and national guidance, where provided

Re-usable bedpans and urinals

- Dedicated bedpans or urinals are not required, provided that the bedpan washer or disinfector is in working order

Crockery and cutlery

- No special precautions are necessary with these items

Patient movement and transport

- When a patient with an MDRO is transferred to another healthcare facility, the clinical team is responsible for the patient and should inform the receiving clinical and infection prevention and control team of the patient's MDRO Clinical Record Information
- During actual transportation between departments, it is important to maintain patient confidentiality
- As the patient is not normally in direct contact with surrounding environmental surfaces or the staff members clothing during transportation, aprons or gloves are not required unless directed by Standard Precautions

Ambulance transportation

- Ambulance staff should adhere to Standard Precautions with all patients
- To minimise the risk of cross infection with any infectious agent, ambulance staff should use an alcohol based hand gel or rub after contact with all patients as part of standard precautions
- If ambulance transfer is required, the ambulance service should be notified in advance of any infection risk by the responsible ward staff

- The patient may travel with other patients unless notified to the contrary; transport should not be shared if the patient is deemed at high risk of transmission of MDRO, e.g. if they have diarrhoea, discharging lesions which cannot be covered with an impermeable dressing, or if the other patients requiring transport are especially vulnerable e.g. immunocompromised or if recommended by the IPC team
- Unnecessary equipment and linen should be removed before transporting patient
- Patients on stretchers should be covered in a clean sheet before leaving the ward
- Blankets and sheets should be placed into a separate laundry bag after transport of patient
- Local areas of patient contact e.g. chair and stretcher should be cleaned and disinfected as per local decontamination policy
- After patient contact, protective clothing (apron or gown) and gloves should be removed and hands decontaminated using an alcohol-based hand rub if visibly clean hands or antiseptic hand wash, if necessary
- Fumigation and prolonged airing of the ambulance is not necessary

Deceased patients

- The Infection Control precautions for handling deceased patients are the same as those used in life. Any lesions should be covered with impermeable dressings. Plastic body bags are not necessary, but may be employed as part of general practice in accordance with standard precautions for all patients

Adapted from “Guidelines for the control and prevention of methicillin-resistant *Staphylococcus aureus* (MRSA) in healthcare facilities” *J Hosp Infect* 2006; 63S: S1-S44.

Chapter 18. Methicillin-Resistant *Staphylococcus aureus*

Although there are many multi-drug resistant organisms (MDROs) that cause patient infections, methicillin-resistant *Staphylococcus aureus*, commonly referred to as MRSA, is one of the most prevalent and persistent. All healthcare institutions should have a programme to monitor MRSA infections. All healthcare institutions should implement the MDRO Bundle so has to reduce MRSA infections. The MDRO bundle is mentioned in Chapter 17.

1 Active Surveillance Cultures for MRSA in Acute Care Institutions or Facilities

Active surveillance cultures help to identify colonised MRSA patients in a facility or in a specific unit. This is recommended for all acute care institutions or facilities in Singapore. Patient population groups with known low risk factors for MRSA colonisation e.g. psychiatric, paediatric and obstetric patients may be exempted from active surveillance.

2 Bed management of MRSA patients in Acute Care Institutions or Facilities

Each hospital should develop an appropriate bed management and prioritisation policy that is based on the institution's IPC risk assessment. For example, different MDROs may require a different priority in terms of isolation rooms in the healthcare facility. This should be done in consultation with the healthcare facility's IPC team.

3 MRSA Clinical Information Records and Criteria for Tagging and Untagging of MRSA Cases

3.1 MRSA Clinical Information Records

The MRSA Clinical Information Records to be shared across healthcare institutions for any patient includes the following information:

- a) All MRSA positive microbiology result [screening, culture or, PCR result etc.] within the last 2 years from the date of request, including the date of test, the specimen type and the laboratory that performed the test.

- b) All MRSA screening results (including positive and negative) within the last 2 years from the date of request, including the date of test and the laboratory that performed the test.

3.2 Tagging and Untagging of MRSA

The criteria for tagging and untagging of MRSA cases should be based on the IPC risk posed by patients with a particular MRSA Clinical Information Records in relation to the particular healthcare facility concerned (see Communication Within and Between Healthcare Facilities).

Such a risk differs from healthcare facility to healthcare facility. As such, tagging and untagging of MRSA cases should be done in consultation with the IPC team in charge of the healthcare facility. Tagging and untagging should be conducted in a timely manner upon ascertainment of MRSA Clinical Information Records so that appropriate and timely IPC measures can be implemented.

3.3 MRSA Tagging for Acute Care Institutions or Facilities

An acute care institution or facility should tag all patients who are found to be MRSA positive.

3.4 MRSA Untagging for Acute Care Institutions or Facilities

An acute care institution or facility can consider untagging patients with a past history of MRSA positivity, if the patient has either:

- a) Undergone decolonisation with Chlorhexidine bath or Octenidine wash and Mupirocin nasal cream for at least 5 days is completed in any healthcare facility OR
- b) 3 negative screening culture from nasal, axillae and groin (NAG), with first sample at least 1 week after completion of decolonisation therapy

Or if no decolonisation, the patient in an acute care institution or facility setting must meet one of the following criteria:

- a) More than 2 years since the last positive culture, OR
- b) 3 negative NAG screening cultures (at least 1 day apart)

Appendix 18.1. Laboratory Diagnosis of MRSA, VISA and VRSA

Staphylococcus aureus colonises 30% of healthy humans but may cause severe infections as well. Methicillin-resistant *S. aureus* (MRSA) is an important cause of healthcare-associated infections.

Vancomycin non-susceptible *S. aureus* has emerged likely as a result of increasing vancomycin use to treat MRSA. For serious MRSA infections e.g. bacteraemia, vancomycin susceptibility testing should be done via minimum inhibitory concentration (MIC) method. Vancomycin-intermediate *S. aureus* (VISA) i.e. *S. aureus* strains (MRSA) with vancomycin MIC \geq 2 g/L has been associated with treatment failure. VanA-mediated vancomycin-resistant *S. aureus* (VRSA, vancomycin MIC $>$ 16 mg/L) is rare but it is important to look out for it. Suspected VRSA strains should be sent to National Public Health Laboratory (NPHL).

Chapter 19. Vancomycin-Resistant *Enterococcus*

Vancomycin-resistant *Enterococcus* (VRE) was first recognised in large numbers in an acute hospital in 2005 and remained at relatively low levels until 2010. Since then, the numbers have steadily increased in acute care hospitals and may already be present in the ILTCs. Acute care institutions or facilities with low prevalence for VRE should aim to keep the rates low with stringent policies on surveillance, isolation or cohorting. Acute care institutions or facilities with higher prevalence or are endemic for VRE should still have measures to contain VRE and avoid increased transmission.

1 Infection Prevention and Control Measures

1.1 Active Surveillance for VRE

Screening patients for rectal carriage of VRE using active surveillance increases VRE detection rates approximately three-fold above detection rates from clinical specimens alone. Most studies reporting on the use of active surveillance cultures have used these in combination with other Infection Control interventions.

Active surveillance is recommended for dialysis patients and patients admitted to high-risk units, ICU, haematology or oncology and transplantation.

2 Criteria for Isolation for Patients with VRE in Acute Care Institutions or Facilities

Patients diagnosed with VRE should preferably be isolated or cohorted. In situations where patient numbers exceed isolation capacity, they may be kept in general wards and nursed with Contact Precautions.

3 Removal from Isolation or Cohorting of Patients in Acute Care Institutions or Facilities

For acute care institutions or facilities with low levels of VRE prevalence, e.g. lower than 2 standard deviations of the national rate, there is no indication to remove from isolation during admission.

4 VRE Clinical Information Records and Criteria for Tagging and Untagging VRE Cases

4.1 VRE Clinical Information Records

The VRE Clinical Information Records to be shared across healthcare institutions for any patient includes the following information:

- a) All VRE positive microbiology result [screening, culture or, PCR result etc] within the last 2 years from the date of request, including the date of test, the specimen type and the laboratory that performed the test
- b) All VRE screening results (including positive and negative) within the last 2 years from the date of request, including the date of test and the laboratory that performed the test

4.2 Tagging and Untagging of VRE

The criteria for tagging and untagging VRE cases should be based on the VRE Clinical Records Information of the patient (see Communication Within and Between Healthcare Facilities).

Tagging and untagging of VRE cases should be based on the IPC risk posed by patients with a particular VRE Clinical Records Information in relation to the particular healthcare facility concerned. Such a risk differs from healthcare facility to healthcare facility. As such, tagging and untagging of VRE cases should be done in consultation with the IPC team in charge of the healthcare facility.

Tagging and untagging should be conducted in a timely manner upon ascertainment of VRE Clinical Records Information so that appropriate and timely IPC measures can be implemented.

4.3 VRE Tagging for Acute Care Institutions or Facilities

An acute care institution or facility should tag all patients who are found to be VRE positive via laboratory culture.

4.4 VRE Untagging for Acute Care Institution or Facility

An acute care institution or facility can consider untagging patients with a past history of VRE positivity, if the patient has either:

- a) More than 2 years since the last positive culture; OR
- b) 3 negative rectal screening cultures (at least 1 month apart).

5 Specific Data Collection and Reporting Requirements for VRE

The national reporting requirements for includes:

- a) No. of VRE Clinical Cases;
- b) No. of VRE Cases from Surveillance (Based on Risk Factors);
- c) No. of VRE Cases from Contact Tracing;
- d) Total No. of VRE Cases (a+b+c);
- e) Total No. of Surveillance Patients Screened i.e. Denominator for (b);
- f) Total No. of Contacts Traced i.e. Denominator for (c).

6 References

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Appendix 19.1. Laboratory Diagnosis of VRE

VRE refers to vancomycin-resistant *Enterococcus faecium* or vancomycin-resistant *Enterococcus faecalis*.

The first isolate of glycopeptides (vancomycin or teicoplanin)-resistant *enterococcus* (GRE) in a patient should be identified to species level and antimicrobial susceptibility to vancomycin and teicoplanin performed to ascertain the phenotype (Van A or van B mediated resistance). Alternatively, PCR for vanA or vanB genes may be used. Molecular typing by PCR may be considered if an outbreak is being investigated. Selective agars and molecular assays are available to screen for rectal carriage of GRE.

Chapter 20. Carbapenemase-Producing Carbapenam-Resistant *Enterobacteriaceae*

1 **Background**

Enterobacteriaceae is a term used to describe groups of Gram-negative bacilli that commonly live in the enteric tract or bowel, and includes *Escherichia coli* (*E. coli*), *Klebsiella pneumoniae* (*K. pneumoniae*), *Enterobacter cloacae*, and *Citrobacter freundii*. β -lactam antimicrobials, such as penicillins, cephalosporins, monobactams and Carbapenam, are some of the most commonly used antimicrobials. The production of enzymes known as β -lactamases by *Enterobacteriaceae* is a key mechanism for the development of resistance to the various types of β -lactam antimicrobials. Today, many β -lactamases exist, including extended spectrum β -lactamases (ESBL), AmpC β -lactamases and Carbapenemase. These enzymes have varying spectra of hydrolytic activity, and are frequently located on mobile genetic elements, known as plasmids enhancing their transmissibility between bacteria including different species.

There are two major mechanisms by which Carbapenam-resistant *Enterobacteriaceae* (CRE) show this resistance:

- a) The production of a broad-spectrum β -lactamase enzyme (Carbapenemase) that cleaves the Carbapenam antimicrobial, rendering it irreparably damaged and ineffective. The gene coding for the enzyme production is found on plasmids
- b) The combination of broad-spectrum β -lactamase (ESBL or AmpC) production with decreased permeability of the bacterial cell wall for the antimicrobial due to porin loss.

The first group is emerging rapidly and is of particular concern. Such organisms are referred to as Carbapenemase-producing CRE (CP-CRE). The most commonly encountered Carbapenemase in CP-CREs are:

- a) *Klebsiella pneumoniae* carbapenemase (KPC)
- b) New Delhi metallo- β -lactamase (NDM)
- c) Oxacillinase (OXA)

- d) Others such as Verona Integron-encoded metallo- β -lactamase (VIM) and Imipenemase Metallo- β -lactamase (IMP)

In Singapore, CP-CREs were first recognized in 2011. In 2012, 70 cases were identified, of which 62 were clinical specimens and 8 were identified via contact tracing. Since then, identification via clinical and surveillance cultures have increased each year. The Figure below (MOH data) shows the number of CP-CRE cases detected and the total incidence of cases per 10,000 inpatient days.

This chapter aims to provide guidance on a national approach to control the increasing prevalence of CP-CRE in Singapore.

2 Risk Factors and Mode of Transmission

Common risk factors for acquisition of CRE include:

- a) Exposure to broad-spectrum antimicrobials, e.g. cephalosporins, β lactam- β lactamase inhibitor combinations, fluoroquinolones
- b) Prolonged or recurrent hospitalisation
- c) ICU admission
- d) Presence of central vascular catheters
- e) Long term urinary catheterisation

Carriage of CRE can be identified on or during admission. The gastrointestinal tract is the most likely site for asymptomatic colonisation with CRE in patients. Active surveillance cultures for rectal carriage of CP-CRE increases the detection rate of potentially infective patients, although the sensitivity of rectal surveillance swabs has not been determined.

Contaminated hands of healthcare professionals have been implicated in hospital outbreaks of CRE. CRE have been detected in hospital environments, and it is intuitive that environmental cleaning is useful in CP-CRE control.

3 Clinical Significance

Therapeutic options for the treatment of CP-CRE infections are limited and complex. These organisms are often resistant to many classes of antimicrobials such as aminoglycosides and fluoroquinolones. Carbapenam are currently the β -lactams of choice for the treatment of serious infections caused by ESBL and AmpC-producing organisms, but the increasing reliance on Carbapenam for the treatment of infections by these organisms adds to the selective pressure for the emergence of Carbapenam resistance. Options for treatment of CP-CRE infections include tigecycline, fosfomycin and polymixin B, but non-susceptibility to these antimicrobials is increasingly reported.

Infections are associated with a significantly increased risk of mortality in the range of 38-57%.

4 Infection Prevention and Control Measures for CP-CRE in acute care settings

The limited therapeutic options for infections by CP-CRE, as well as their propensity for spread, underscore the importance of active surveillance and infection prevention and control measures. Patients with unrecognised carriage of CP-CRE can serve as reservoirs and cause cross-transmission, healthcare-associated infections and outbreaks. CP-CRE patients in acute care institutions or facilities should be isolated in single rooms with en-suite toilet facilities using Contact Precautions. Provision for separate use of equipment and facilities should be arranged. Amongst other cases requiring isolation, the priority should be given to patients with CP-CRE. Healthcare professionals should wear appropriate PPE based on a risk assessment for potential exposure.

Active surveillance is recommended for high-risk patient groups (see Risk Factors and Mode of Transmission). Patients at high risk of being tested positive include those with prolonged ICU stay, and a history of hospitalisation overseas or in Singapore within the past 1 year. Each healthcare facility should have a targeted active surveillance programme aiming to have a high level of detection of positive inpatients. At the time of writing, new guidelines were under consideration by MOH

including scaled up active surveillance directives. Please refer to latest information from MOH directives.

All acute care institutions should have a policy for contact tracing of CP-CRE cases. The minimum standard for contact tracing shall be all existing inpatients who were in the same cubicle of the index case from time the case was admitted.

Enhanced cleaning of the environment of CRE patients should be established including regular daily and high touch cleaning as well as terminal cleaning. The efforts need to be meticulous and subject to detailed audits.

All CP-CRE cases should be notified to MOH. The patient surveillance form should be completed for each patient when CP-CRE is confirmed.

There is no evidence recommending decolonization regimens for CP-CRE.

5 Laboratory Identification of CP-CRE in Screening Samples

Identification of all CP-CRE cases should be timely to allow appropriate infection control measures and contact tracing to commence within 3 working days following its initial identification as a CRE case. It is reasonable to isolate all CRE cases if rooms permit in low prevalence facilities.

Rectal swab or faeces is the recommended specimen to be used in surveillance for resistant *Enterobacteriaceae*. Specimens taken from other sites (e.g. urine, swabs from skin breaks or manipulated sites) may also be suitable for surveillance purposes.

When a CP-CRE isolate with confirmed Carbapenemase production has been detected from a clinical specimen on a ward or unit, surveillance screening by a rectal swab is recommended for patients with epidemiological links (as defined by an individual institution) to the index case.

Affected patients should be informed of their positive status for colonisation or infection with CP-CRE and provided with an information leaflet.

Patients and their family members place trust in clinical teams caring for the patient during their in-patient stay. As such, the responsibility of informing patients of their MDRO colonisation status lies primarily with the clinical care team. Clinical teams must be apprised of these guidelines on MDRO management and must balance patient preferences and patient care considerations versus national public health considerations in order to achieve national control of MDROs. They should have access to infection prevention and control experts on CP-CRE within their facility or regional health system.

6 CP - CRE Clinical Records Information and Criteria for Tagging and Untagging CP - CRE Cases

6.1 Tagging of CP-CRE

All patients identified with culture and PCR proof of CP-CRE should be tagged by local systems and, when available, national systems. Tagging should facilitate identification of a patient who is detected positive for CP-CRE at a different hospital or a prior hospital stay. As necessary, the information should be shared manually at the time of transfer.

6.2 Untagging of CP-CRE

At this stage no patients infected with or carriers of CP-CRE should be untagged.

7 Specific Data Collection and Reporting Requirements for CP-CRE

The national reporting requirements for CP-CRE includes:

- a) No. of CP-CRE Clinical Cases;
- b) No. of CP-CRE Cases from Surveillance (Based on Risk Factors);
- c) No. of CP-CRE Cases from Contact Tracing;
- d) Total No. of CP-CRE Cases (a+b+c);
- e) Total No. of Surveillance Patients Screened i.e. Denominator for (b); and
- f) Total No. of Contacts Traced i.e. Denominator for (c).

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Appendix 20.1. Laboratory Diagnosis of CP-CRE

The presence of a Carbapenamase-producing Carbapenam resistant *Enterobacteriaceae* (CP-CRE) is first suspected when resistance to a Carbapenam is detected by antimicrobial susceptibility testing. (MICs of ≥ 0.5 mg/L for ertapenem and ≥ 1 mg/L for imipenem and meropenem). The most sensitive carbapenam for detecting CP-CRE is ertapenem. However, it is also the least specific because ertapenem resistance may also occur as a result of Extended-Spectrum Beta-Lactamase (ESBL) or AmpC production in combination with porin loss.

Selective media are available for screening CP-CRE from stool specimens. There are a number of tests that can detect the presence of a Carbapenamase and partially characterize the type of Carbapenamase. This is a rapidly developing field and the latest literature should be consulted.

Confirmation of the type of Carbapenamase is done by polymerase chain reaction (PCR) amplification and sequencing of the Carbapenamase gene. This is available by a number of hospital labs and the National Public Health Laboratory (NPHL).

Chapter 21. Mobilised Colistin Resistance-1

1 **Background**

In November 2015, China reported the emergence of mobilised colistin resistance (mcr-1), a new gene that resides on a plasmid and confers resistance to polymyxin, in *Enterobacteriaceae*. The carriage of mcr-1 was found in retail meat, food animal sources and human clinical specimens. The United States subsequently reported the discovery of the first mcr-1 carried in *E. coli* in a patient with no recent travel outside of the United States.

In June 2016, MOH reported that retrospective sampling of CRE and non-CRE isolates in Singapore had shown that mcr-1 was found to be present sporadically in clinical samples, even in organisms which were not multi-drug resistant. The background incidence of mcr-1 varied from 1 to 5%, and did not differ between CRE and non-CRE organisms.

2 **Enhancing surveillance**

As per the current protocol to send CP-CRE samples to the National Public Health Laboratory (NPHL) for typing, from 2 June 2016, all laboratory samples that are polymyxin resistant should be sent to the NPHL for mcr-1 testing. Hospitals should also screen all CP-CRE isolates for polymyxin resistance. If resistance is detected, isolates must be sent to NPHL for mcr-1 testing using the form in Annex A.

3 **Measures to minimise spread of MCR-1 in Acute Care Hospitals**

- a) Hospitals should comply with CP-CRE control measures to minimize antibiotic pressure selecting for MCR-1.
- b) Patients infected or colonized with MDRO(s) that also have MCR-1 resistance should be isolated, as per the protocol for CP-CRE.
- c) Hospitals should discourage empiric use of Colistin and polymyxin, unless the suspicion for Extensively Drug Resistant Gram Negative Bacilli (XDR GNB) infection is strong (e.g. based on hospital/clinical specialty area antibiogram, or if patient was previously colonized with XDR GNB). Even so, when negative cultures for XDR GNB are obtained, colistin and polymyxin should be discontinued.

- d) Hospitals should not use prophylactic colistin and polymyxin for clinical or research purposes in patients.

4 References

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PART V. SURVEILLANCE OF HEALTHCARE- ASSOCIATED INFECTIONS

Chapter 22. Surveillance of National Infection Prevention and Control Indicators

Chapter 22. Surveillance of National Infection Prevention and Control Indicators

MOH tracks Healthcare Associated Infection prevention and control indicators with the following objectives:

- a) To promote a standardized validated approach to HAI surveillance methods
- b) To provide aggregated risk-adjusted data on HAIs; this enables healthcare institutions to benchmark against aggregated national and international data.
- c) To promote the integration of HAI surveillance (including routine data collection) with strategic planning and continuous quality improvement systems for infection control.

The Technical Manual for the Surveillance of National Infection Prevention and Control Indicators describes the methodology for data collection for Infection Prevention and Control indicators tracked nationally in Singapore. The following Infection Prevention and Control Indicators data are collected monthly:

- a) Healthcare facility onset MRSA bacteremia
- b) Healthcare facility onset VRE
- c) Healthcare facility onset CP-CRE
- d) Healthcare facility onset Clostridium Difficile
- e) Ventilator Associated Events in ICUs
- f) Catheter Associated Urinary Tract Infection in ICUs
- g) Central Line Associated Blood Stream Infection in ICUs

Note: For Specific Data Collection and Reporting Requirements for Healthcare associated Infection please refer to the *Technical Manual for the Surveillance of National Infection prevention and Control Indicators*.