



Hospital Infection Control Guidelines





Foreword

It is my privilege to write this foreword for the manual on Hospital Infection Control Guidelines prepared by Indian Council of Medical Research Antimicrobial Stewardship Program. Proper implementation and practice of policies and procedures on infection control by healthcare providers is a highly effective strategy in reducing hospital acquired infections. The infection control policies and procedures, when consistently applied and integrated into all systems and processes result in significantly reduced infection rates thus reducing the morbidity and mortality due to Hospital Acquired Infections (HAIs). Practicing good infection control measures can significantly reduce patient morbidity and mortality in hospitals and has been proven to be cost-effective as well. Efforts at preventing healthcare associated infections in hospitals remain an ongoing and difficult challenge in the medical care settings in India. ICMR's Hospital Infection Control Guidelines document is intended to assist healthcare providers to adhere to best practices in the control of hospital acquired infections. The document covers the basic principles of infection control, role of health care workers, bio-waste management and elaborates on the steps to be followed for setting up of an effective infection control in hospitals.

It is my sincere hope that all relevant parties will adopt the various recommendations set out in this guideline for more efficient and effective infection control in our hospitals, thereby minimizing the healthcare-associated infection rates in our hospitals. I am optimistic that over the years this manual will become a reference document and will be followed by hospitals across the country to bring down their infection rates and enhance quality of patient care. I compliment the contributors and ICMR team for this effort.

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i. List of Abbreviations

%	-	Percentage
°C	-	Degree centigrade
ABC/3TC	-	Abacavir/lamivudine
Ag	-	Antigen
AIIR	-	Airborne Infection Isolation Room
ATV/r	-	Atazanavir/ritonavir
CA-MRSA	-	Community associated-methicillin-resistant <i>Staphylococcus aureus</i>
CDC	-	Centre for Disease Control and Prevention
cm	-	Centimetres
EFV	-	Efavirenz
ESBL	-	Extended-spectrum β lactamase
GNB	-	Gram negative bacilli
HAI	-	Hospital acquired infections
HCV	-	Hepatitis C virus
HCW	-	Health care workers
HEPA	-	High efficiency particulate air
HICC	-	Hospital Infection Control Committee
HIV	-	Human immunodeficiency virus
HME	-	Heat and moisture exchanger
ICU	-	Intensive care unit
IM	-	Intramuscular
IU	-	International unit
IV	-	Intravenous
kg	-	Kilograms

LPV/r	-	Lopinavir/ritonavir
MDRO	-	Multidrug-resistant organisms
MDRSP	-	Multidrug-resistant <i>Streptococcus pneumoniae</i>
MDR-TB	-	Multidrug-resistant tuberculosis
ml	-	Millilitres
MRSA	-	Methicillin resistant <i>Staphylococcus aureus</i>
NRL	-	Natural rubber latex
OSHA	-	Occupational Safety and Health Administration
PFGE	-	Pulse field gel electrophoresis
pH	-	Negative logarithm of hydrogen ion
PPE	-	Personal Protective Equipment
RAL	-	Raltegravir
RSV	-	Respiratory syncytial virus
SARS	-	Severe acute respiratory syndrome
SIRS	-	Systemic inflammatory response syndrome
TDF/FTC	-	Tenofovir/emtricitabine
TB	-	Tuberculosis
TGA	-	Therapeutic Goods Administration
v/v	-	Volume/volume
VAP	-	Ventilator associated pneumonia
VISA	-	Vancomycin intermediate <i>Staphylococcus aureus</i>
VRE	-	Vancomycin resistant Enterococci
VRSA	-	Vancomycin resistant <i>Staphylococcus aureus</i>
WHO	-	World Health Organization

1. Introduction

Health care associated infections are major burdens for patients, society and health care management. The emergence of life-threatening infections such as severe acute respiratory syndrome (SARS) and re-emerging infectious diseases like plague and tuberculosis have highlighted the need for efficient infection control programmes in all health care settings and capacity building for health care workers so they can implement them.

An infection control programme is considered efficient which, when used appropriately, restricts the spread of infection among patients and staff in the hospital. Good infection control programme also considerably reduces patients' morbidity and mortality, length of hospital stay and cost associated with hospital stay. This is achieved by the prevention and management of infections through the application of research based knowledge to practices.

2. Components of infection control programme:

1. Basic measure for infection control – Standard and additional precaution
2. Education and training of health care workers
3. Protection of health care workers
4. Identification of hazards and minimizing risks
5. Aseptic techniques
6. Use of single use device, reprocessing of instruments and equipment
7. Antibiotic usage, management of blood/body fluid exposure, handling of blood/blood products and hospital waste management.
8. Surveillance
9. Outbreak investigation
10. Incident monitoring

2a. Objectives

The main objective of these guidelines is to prevent the health care workers and the environment from the transmission of infections. The specific objectives of these guidelines are to provide directions and information in relation to:

- Facilities, equipment, and procedures necessary to implement standard and additional (transmission-based) precautions for control of infections
- Cleaning, disinfecting and reprocessing of reusable equipment
- Waste management
- Protection of health care workers from transmissible infections
- Prevention of HAI in patients
- Infection control practices in special situations

2b. Universal precautions

Universal precautions are a set of guidelines designed to protect the health care worker from exposure to infections such as HIV, hepatitis B and hepatitis C which are transmitted by blood and certain body fluids of the patient.

According to the universal precautions, all patients should be assumed to be infectious for bloodborne infections such as HIV, hepatitis B, hepatitis C and other bloodborne pathogens while being provided health care.

Components : Universal precautions consider only certain body fluids as capable of transmitting bloodborne diseases (Table 1). It advocates the use of barriers to prevent occupational exposure to blood and applicable body fluids.

Table 1: Precautions related to body fluids

Universal precaution apply to:	Universal precautions do not apply to:
Blood	Faeces
Semen	Nasal secretions
Vaginal secretions	Sputum
Synovial fluid	Sweat
Cerebrospinal fluid	Tears
Pleural fluid	Urine
Peritoneal fluid	Vomitus
Pericardial fluid	Saliva
Amniotic fluid	

2c. Barriers of infection:

Personal protective equipment (PPE) : PPE includes gloves, laboratory coats, gowns, goggles, glasses with side shields, shoe covers and masks. The purpose of PPE is to prevent blood and body fluids from reaching the worker's skin or mucous membranes.

Engineering controls: This includes removing hazards from the workplace. Examples are sharps disposal containers, biological safety cabinets, etc.

Work practice controls: This refers to practical techniques that reduce the likelihood of exposure by changing the way a task is performed. Examples include hand washing, proper handling and disposal of sharps and proper collection and transportation of fluids and tissues.

Thus the universal precautions give priority only to the health care provider. The sole aim of universal precautions is to prevent transmission of infections from the patient to the health care provider.

Table 2: Summary of precautions to prevent the spreading and transmission of infections

Purpose	Contact	Droplet	Airborne
Organism based precaution	MRSA, <i>Clostridium difficile</i> , lice, scabies	<i>N. meningitidis</i> , mumps, Pertussis, norovirus, influenza invasive group A Streptococcus	Pulmonary tuberculosis, measles, chicken pox, disseminated zoster
Syndromic precaution	Draining wound Diarrhea (not yet diagnosed) Infestation	Toxic shock	Fever, weight loss, cough, high TB risk
Private room	Preferred	Preferred	Yes
Negative pressure room	No	No	Yes
PPE- Staff	Gown + gloves	Gown + gloves + surgical grade fluid resistant mask	Gown + gloves + N95 mask
Visitor – PPE	Gown + gloves	Gown + gloves + surgical grade fluid resistant mask	Surgical grade mask
Transporting patient	Patient – No Staff – No	Patient – Yes Staff – Yes	Patient – Yes Staff – No
Cleaning	Precaution clean	Precaution clean	Precaution clean

2d. Categories of infection control practices:

i. **Standard precautions**: Applied to all patients at all times (Regardless of diagnosis and infectious status). It aims to prevent transmission of infections from:

- Patient to health care worker
- Health care worker to patient
- Patient to patient (cross-transmission)
- Hospital environment to patient
- Hospital waste to community spread

ii. **Additional (transmission based) precaution:** Specific to the mode of transmission which includes air-borne, droplet and contact

i. Standard precautions

Treating all patients in the health care facility with the same basic level of “standard” precautions involves work practices that are essential to provide a high level of protection to patients, health care workers and visitors which include the following :

- hand washing and antisepsis (hand hygiene)
- use of personal protective equipment when handling blood, body substances, excretions and secretions
- appropriate handling of patient care equipment and soiled linen
- prevention of needlestick /sharp injuries
- environmental cleaning and spills-management and
- appropriate handling of waste

i a. Hand hygiene

Appropriate hand hygiene can minimize micro-organisms acquired on the hands during daily duties and when there is contact with blood, body fluids, secretions, excretions and known and unknown contaminated equipment or surfaces.

Hands can become contaminated with infectious agents through contact with a patient, patient surroundings, the environment, or other health care workers. Cross-contamination can occur from one site to another in the same patient, between health care worker and patient, between patient or health care worker and the environment, or between health care workers. Practicing hand hygiene before every episode of patient contact (including between caring for different patients and between different care activities for the same patient) and after any activity or

contact that potentially results in hands becoming contaminated (such as removal of gloves) reduces the risk of cross-contamination.

Wash or decontaminate hands:

- after handling any blood, body fluids, secretions, excretions and contaminated items
- between contact with different patients
- between tasks and procedures on the same patient to prevent cross contamination between different body sites
- immediately after removing gloves and
- using a plain soap, antimicrobial agent, such as an alcoholic hand rub or waterless antiseptic agent

The hospital setting is a good setting for communication about personal hygiene, such as informing visitors and the general public about hygiene rules such as washing hands. The World Health Organization has developed the '5 moments for hand hygiene' in 2009 (Fig.1) to

- protect patients against acquiring infectious agents from the hands of the healthcare worker
- help to protect patients from infectious agents (including their own) entering their bodies during procedures
- protect healthcare workers and the healthcare surroundings from acquiring patients' infectious agents

Few key factors in effective hand hygiene and maintaining skin integrity include:

- the duration of hand hygiene measures
- the exposure of all surfaces of hands and wrists to the preparation used
- the use of rubbing to create friction
- ensuring that hands are completely dry

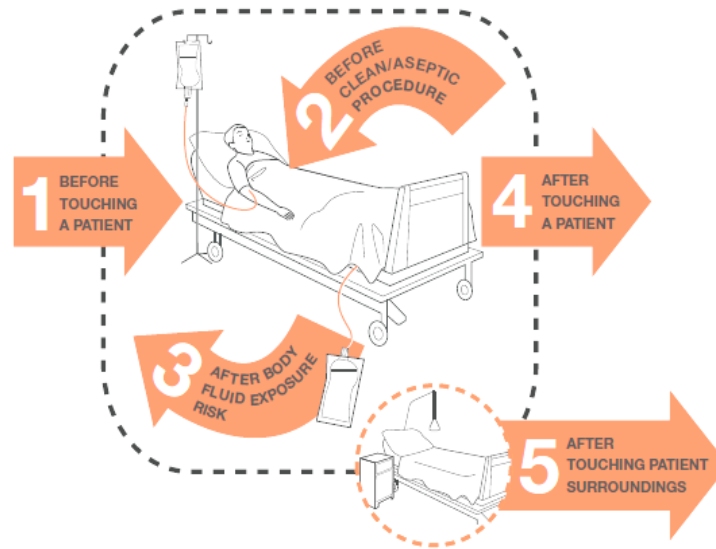


Fig. 1: The 5 moments for hand hygiene. *Source: WHO (2009).*

Procedure to use alcohol-based hand rub

Apply the amount of alcohol-based hand rub recommended by the manufacturer onto dry hands. Rub hands together so that the solution comes into contact with all surfaces of the hand, paying particular attention to the tips of the fingers, the thumbs and the areas between the fingers. Continue rubbing until the solution has evaporated and the hands are dry.

Advantages of alcohol-based hand rubs are that they have (Grayson and Russo, 2009):

- ease accessibility at point of care
- excellent antimicrobial activity against Gram-positive and Gram-negative vegetative bacteria, *Mycobacterium tuberculosis* and a wide range of fungi
- generally good antimicrobial activity against enveloped viruses

Disadvantages of alcohol-based hand rubs are :

- lesser and/or variable antimicrobial activity against non-enveloped viruses (such as norovirus)
- no activity against protozoan oocysts and bacterial spores (such as *C. difficile*).

The range of antimicrobial activity in alcohol-based hand rubs varies with the alcohol compound (ethanol, isopropanol or n-propanol) used. Different alcohol species have different levels of activity (60% v/v n-propanol is approximately equivalent to 70% v/v isopropanol and to 80% v/v ethanol) and many commercial formulations consist of blends of different alcohol species. Most

published clinical studies that have demonstrated reductions in HAIs with the use of alcohol-based hand rubs have been associated with products that contain at least 70% alcohol (isopropanol), 0.5% chlorhexidine and a skin emollient (Grayson and Russo, 2009). However the efficacy of alcohol-based hand hygiene products is affected by a number of factors including the type of alcohol used, concentration of alcohol, contact time, volume of product used, and whether the hands are wet when the product is applied. These factors are generally assessed through testing standards for skin disinfectants, for which Therapeutic Goods Administration (TGA) is the regulatory body responsible for approving products for use in Australia.

Procedure to use soap (including antimicrobial soap) and water

Wet hands under tepid running water and apply the recommended amount of liquid soap. Rub hands together for a minimum of 15 seconds so that the solution comes into contact with all surfaces of the hand, paying particular attention to the tips of the fingers, the thumbs and the areas between the fingers. Rinse hands thoroughly under running water, then pat dry with single-use towels.

Plain soaps act by mechanical removal of microorganisms and have no antimicrobial activity. They are sufficient for general social contact and for cleansing of visibly soiled hands. They are also used for mechanical removal of certain organisms such as *C. difficile* and norovirus. When *C. difficile* and non-enveloped viruses are suspected or known to be present, use of alcohol based hand rubs alone may not be sufficient to reduce transmission of these organisms. Alcohol based hand rubs are effective at removing vegetative forms of *C. difficile*, but not effective at removing spores. If gloves are worn during the care of patients in settings where *C. difficile* or non-enveloped viruses are suspected or known to be present, spore contamination of the hands will be minimal and alcohol-based hand rub remains the agent of choice for hand hygiene. However, if gloves have not been worn or the hands are visibly soiled, they must be meticulously washed with soap and water and patted dry, to facilitate the mechanical removal of spores.

Other aspects of hand hygiene

As intact skin is a natural defence against infection, cuts and abrasions reduce the effectiveness of hand hygiene practices. Breaks or lesions of the skin are possible sources of entry for

infectious agents and may also be a source of them. Similarly, the presence of fingernail disease may reduce the efficacy of hand hygiene and result in the transmission of pathogens (WHO 2009). To reduce the risk of cross-transmission of infectious agents, cuts and abrasions should be covered with waterproof dressings.

The type and length of fingernails can have an impact on the effectiveness of hand hygiene as artificial or false nails have been reported to be associated with higher levels of infectious agents, especially Gram-negative bacilli and yeasts, than natural nails. Hence, fingernails should be kept short (e.g. the length of the finger pad) and clean, and artificial fingernails should not be worn. Hand contamination with infectious agents is increased with ring wearing, although no studies have related this practice to health care worker-to-patient transmission. The consensus recommendation is to strongly discourage the wearing of watches, rings or other jewellery during health care; however if jewellery must be worn in clinical areas it should be limited to a plain band (e.g. wedding ring) and this should be moved about on the finger during hand hygiene practices. In high-risk settings such as operating suites/rooms, any jewellery, even a plain band, should not be worn. Each health care facility should develop policies on the wearing of jewellery, artificial fingernails or nail polish by healthcare workers.

i b. Personal protective equipment for health care personnel

Personal protective equipment (PPE) refers to a variety of barriers, used alone or in combination, to protect mucous membranes, airways, skin and clothing from contact with infectious agents. PPE used as part of standard precautions includes aprons, gowns, gloves, surgical masks, protective eyewear and face shields. Selection of PPE is based on the type of patient interaction, known or possible infectious agents, and/or the likely mode(s) of transmission. There have been few controlled clinical studies evaluating the relationship between the use of PPE and risk of Hospital Acquired Infections (HAIs). However, the use of barriers reduces opportunities for transmission of infectious agents. PPE also protects patients from exposure to infectious agents in the surrounding environment carried by healthcare workers.

Decision-making about personal protective equipment

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

Factors to be considered are:

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

Where to wear PPE

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

Using personal protective equipment provides a physical barrier between micro-organisms and the wearer. It offers protection by helping to prevent micro-organisms from contaminating hands, eyes, clothing, hair and shoes and being transmitted to other patients and staff.

Personal protective equipment includes:

- gloves
- protective eye wear (goggles)
- mask
- apron
- gown
- boots/shoe covers and

- cap/hair cover.

Principles for use of personal protective equipment

Personal protective equipment reduces but does not completely eliminate the risk of acquiring an infection. It is important that it is used effectively, correctly, and at all times where contact with blood and body fluids of patients may occur. Continuous availability of personal protective equipment and adequate training for its proper use are essential. Staff must also be aware that use of personal protective equipment does not replace the need to follow basic infection control measures such as hand hygiene. The following principles guide the use of personal protective equipment :

- Personal protective equipment should be chosen according to the risk of exposure. The health care worker should assess whether they are at risk of exposure to blood, body fluids, excretions or secretions and choose their items of personal protective equipment according to this risk.
- Avoid any contact between contaminated (used) personal protective equipment and surfaces, clothing or people outside the patient care area. Discard the used personal protective equipment in appropriate disposal bags, and dispose off as per the policy of the hospital.
- Do not share personal protective equipment.
- Change personal protective equipment completely and thoroughly wash hands each time you leave a patient to attend to another patient or another duty.

Gloves

Gloves can protect both patients and health care workers from exposure to infectious agents that may be carried on hands.

- Wear gloves (clean, non-sterile) when touching blood, body fluids, secretions, excretions or mucous membranes.
- Change gloves between contacts with different patients to prevent transmission of infectious material
- Change gloves between tasks/procedures on the same patient to prevent cross-contamination between different body sites.
- Change gloves if the patient interaction involves touching portable computer keyboards or other mobile equipment that is transported from room to room.

- Remove gloves immediately after use and before attending to another patient.
- Hand hygiene should be performed before putting on gloves and after removal of gloves.
- Use a plain soap, antimicrobial agent or waterless antiseptic agent.
- Disposable gloves should not be reused but should be disposed off according to the health care facility protocol.
- Prolonged and indiscriminate use of gloves should be avoided as it may cause adverse reactions and skin sensitivity.

Risk assessment for using gloves

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

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

Selection of glove type

Non-sterile single-use medical gloves are available in a variety of materials, the most common being natural rubber latex (NRL) and synthetic materials (e.g. nitrile). NRL remains the material of choice due to its efficacy in protecting against bloodborne viruses and properties that enable the wearer to maintain dexterity. However, sensitivity to NRL in patients, carers and health care workers may occur and must be documented. A local policy is required on using alternative glove types when patients have latex allergies. Factors involved in the selection of glove type for non-surgical use include the task to be performed (i.e. glove type should be fit for purpose and aim to avoid interference with dexterity, friction, excessive sweating or finger and hand muscle

fatigue); anticipated contact with chemicals and chemotherapeutic agents; and personal factors, such as latex sensitivity and size.

Gowns

Gowns are used as specified by Standard and Transmission-Based Precautions, to protect the health care workers' arms and exposed body areas and prevent contamination of clothing with blood, body fluids, and other potentially infectious material. The need for and type of gown selected is based on the nature of the patient interaction, including the anticipated degree of contact with infectious material and potential for blood and body fluid penetration of the barrier. The wearing of isolation gowns and other protective apparel is mandated by the OSHA Bloodborne Pathogens Standard (1991). Clinical and laboratory coats or jackets worn over personal clothing for comfort and/or purposes of identity are not considered PPE. When applying Standard Precautions, an isolation gown is worn only if contact with blood or body fluid is anticipated. However, when Contact Precautions are used (i.e., to prevent transmission of an infectious agent that is not interrupted by Standard Precautions alone and that is associated with environmental contamination), donning of both gown and gloves upon room entry is indicated to address unintentional contact with contaminated environmental surfaces. The routine donning of isolation gowns upon entry into an intensive care unit or other high-risk area does not prevent or influence potential colonization or infection of patients in those areas.

Isolation gowns are always worn in combination with gloves, and with other PPE when indicated. Gowns are usually the first piece of PPE to be donned. Full coverage of the arms and body front, from neck to the mid-thigh or below will ensure that clothing and exposed upper body areas are protected. Several gown sizes should be available in a healthcare facility to ensure appropriate coverage for staff members.

Selection of gown type

The type of apron or gown required depends on the degree of risk, including the anticipated degree of contact with infectious material and the potential for blood and body substances to penetrate through to clothes or skin. A clean non-sterile apron or gown is generally adequate to protect skin and prevent soiling of clothing during procedures and/or patient-care activities that

are likely to generate splashing or sprays of blood or body substances. A fluid-resistant apron or gown should be worn when there is a risk that clothing may become contaminated with blood, body substances, secretions or excretions (except sweat). Considerations in choosing a type of gown (e.g. long or short-sleeved) that is appropriate for the activity are :

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

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

Plastic aprons

Single-use plastic aprons are recommended for general use when there is the possibility of sprays or spills, to protect clothes that cannot be taken off. Unused aprons should be stored in an appropriate area away from potential contamination.

Removing aprons and gowns

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

Masks

- Wear a mask to protect mucous membranes of the mouth and nose when undertaking procedures that are likely to generate splashes of blood, body fluids secretions or excretions.
- Wear surgical masks rather than cotton material or gauze masks. Surgical masks have been designed to resist fluids to varying degrees depending on the design of the material in the mask.

- Do not reuse disposable masks. They should be disposed off according to the health care facility protocol.

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

Surgical masks can be placed on coughing patients to limit potential dissemination of infectious respiratory secretions from the patient to others. Considerations when using a surgical mask include :

- masks should be changed when they become soiled or wet
- masks should never be reapplied after they have been removed
- masks should not be left dangling around the neck
- touching the front of the mask while wearing it should be avoided
- hand hygiene should be performed upon touching or discarding a used mask.
- children should wear a specifically designed child mask and their oxygen saturation should be monitored.

Protective eye wear and face shield

Wear protective eyewear and face shields to protect the mucous membranes of the eyes when conducting procedures that are likely to generate splashes of blood, body fluids, secretions or excretions. If disposable, discard appropriately. If they are reusable, decontaminate them according to the manufacturers' instructions.

Eye protection

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

protection, goggles and safety glasses do not provide splash or spray protection to other parts of the face. Personal eyeglasses and contact lenses are not considered adequate eye protection.

Face shields

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

Removing face and eye protection

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

Cleaning reusable face and eye protection

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

Caps and boots/shoe covers

- Wear caps and boots/shoe covers where there is a *likelihood* that the patient's blood, body fluids, secretions or excretions may splash, spill or leak onto the hair or shoes.
- Launder caps and shoe covers appropriately if they are reusable, according to the hospital guidelines.
- Do not reuse disposable caps/shoe covers. They should be discarded according to the health care facility protocol.
- Clean and disinfect reusable boots.

Patient care equipment

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

Ensure all reusable equipment is cleaned and reprocessed appropriately before being used on another patient.

Linen

Handle, transport and process used linen that is soiled with blood, body fluids, secretions or excretions with care to ensure that there is no leaking of fluid.

i c. Prevention of needle stick/sharps injuries

- Take care to prevent injuries when using needles, scalpels and other sharp instruments or equipment.
- Place used disposable syringes and needles, scalpel blades and other sharp items in a puncture-resistant container with a lid that closes and is located close to the area in which the item is used. Take extra care when cleaning sharp reusable instruments or equipment.
- Never recap or bend needles.

Sharps must be appropriately disinfected and/or destroyed as per the national standards or guidelines.

Risk in sharps injuries

The use of sharp devices exposes health care workers to the risk of injury and potential exposure to bloodborne infectious agents, including hepatitis B virus, hepatitis C virus and human immunodeficiency virus (HIV) (CDC 2001). Sharps injuries can occur in any health care setting, including non-hospital settings such as in office based practices, home health care and long-term care facilities. Injuries most often occur (CDC 2008):

- during use of a sharp device on a patient (41%)
- after use and before disposal of a sharp device (40%) and
- during or after appropriate or inappropriate disposal of sharp devices (15%).

There are many possible mechanisms of injury during each of these periods. Hollowbore needles are of particular concern; especially those used for blood collection or intravascular catheter

insertion, as they are likely to contain residual blood and are associated with an increased risk for bloodborne virus transmission. Non-hollowbore sharps such as glass vials and butterfly needles have also been involved in sharps incidents. Examples of sharps associated with sharps injuries in health care settings include:

- Disposable needles/ syringes
- Steel-winged (butterfly) needles
- Intravenous catheter stylets
- Multi-sample blood collection needles
- Arterial blood collection syringe needles
- Aspiration needles
- Injector pen needles
- Glass vials
- Dental probes
- Scalpel blades
- Suture needles
- Retractors
- Skin or bone hooks
- Sharp electrosurgical tips

Handling of sharps

All health care workers should take precautions to prevent injuries caused by needles, scalpels and other sharp instruments or devices: during procedures; when cleaning used instruments; during disposal of used needles; and when handling sharp instruments after procedures. Standard measures to avoid sharps injuries include handling sharp devices in a way that prevents injury to the user and to others who may encounter the device during or after a procedure.

Examples include (CDC 2008):

- using instruments, rather than fingers, to grasp needles, retract tissue, and load/unload needles and scalpels
- giving verbal announcements when passing sharps
- avoiding hand-to-hand passage of sharp instruments by using a basin or neutral zone
- using round-tipped scalpel blades instead of pointed sharp-tipped blades.

The extent to which gloves protect health care workers from transmission of bloodborne infectious agents following a needlestick or other puncture that penetrates the glove has not been determined. Although gloves may reduce the volume of blood on the external surface of a sharp, the residual blood in the lumen of a hollowbore needle would not be affected; therefore, the effect on reduction of transmission risk is not quantifiable.

Isolation of patients :

Identification and isolation of patients infected with highly transmissible or epidemiologically important pathogens. The list of patients to be isolated:

- Undiagnosed rashes and fevers
- Chickenpox
- Measles
- Severe acute respiratory syndrome (SARS)
- Influenza
- Patients known to be colonized with MRSA, VRE and other multi-resistant bacteria
- Newly diagnosed (or suspected) open pulmonary tuberculosis
- Multidrug-resistant tuberculosis (MDR-TB)

ii. Transmission-based precautions

These are a set of guidelines proposed for hospitalised patients who are known (or suspected) to be infected or colonised with highly transmissible or epidemiologically important pathogens. As these patients carry a high risk of transmitting the pathogen to the healthcare worker and adjacent patients, further measures are needed in addition to standard precautions to prevent transmission of infection. Usually, these patients must be isolated and the appropriate transmission-based precaution must be used (Fig. 2)

Four categories of transmission-based precautions are available:

- Airborne precautions

- Droplet precautions
- Contact precautions
- Absolute (strict) isolation

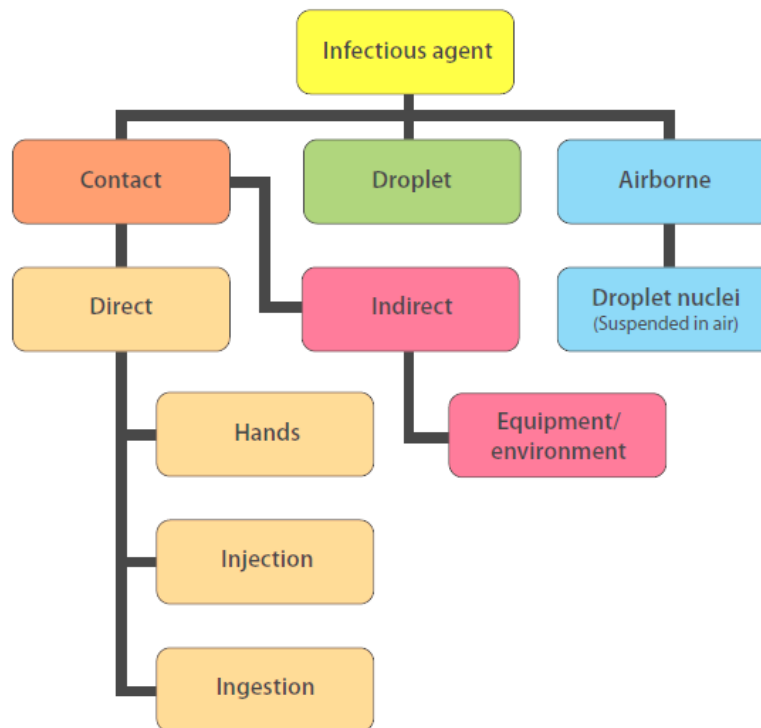


Fig 2. Transmission based infection sources. Source: Australian infection control guidelines

ii a. Airborne precautions

Airborne precautions are designed to reduce the transmission of diseases spread by the airborne route. Airborne transmission occurs when droplet nuclei (evaporated droplets) <5 micron in size are disseminated in the air. These droplet nuclei can remain suspended in the air for some time. Droplet nuclei are the residuals of droplets and when suspended in the air, dry and produce particles ranging in size from 1-5 micron. These particles can remain suspended in the air for long periods of time, especially when bound on dust particles. Diseases which spread by this mode include open/active pulmonary tuberculosis (TB), measles, chicken pox, pulmonary plague and haemorrhagic fever with pneumonia.

The following precautions need to be taken :

- Implement standard precautions

- Place patient in a single room that has a monitored negative airflow pressure, and is often referred to as a “negative pressure room”. The air should be discharged to the outdoors or specially filtered before it is circulated to other areas of the health care facility
- Keep doors closed
- Anyone who enters the room must wear a special, high filtration, particulate respirator (e.g. N 95) mask.

Patient placement

When patients have a confirmed or suspected airborne-transmissible condition or if nebulisation is to be performed, it is important to place them in an area that can be contained (e.g. placing them in a single room and, providing it is tolerated, asking them to wear a surgical mask while not in a single room, until advised to remove it by attending staff). It is important that the door to the room remains closed and that, where possible, only staff or visitors who are immune to the specific infectious agent enter the room. Non-immune staff should be provided with appropriate PPE. While there is a paucity of evidence to confirm their effectiveness, the use of correctly serviced/ maintained negative pressure rooms may reduce the transmission of airborne infection within health care settings. Visitors should be restricted and screened by nursing staff, with visitors’ names recorded either in a log book or in the case notes.

Transfer of patients

If transfer of the patient outside the negative pressure room is necessary, asking the patient to wear a correctly fitted surgical mask while they are being transferred and to follow respiratory hygiene and cough etiquette, as well as covering any skin lesions associated with the condition (e.g. chickenpox [varicella]) will reduce the risk of cross-transmission. Children should wear a correctly fitting mask when they are outside an isolation room. The child’s oxygen saturation should be monitored.

Emerging issues concerning airborne transmission of infectious agents.

Transmission from patients

The emergence of SARS in 2002, the importation of monkeypox into the United States in 2003, and the emergence of avian influenza present challenges to the assignment of isolation categories

because of conflicting information and uncertainty about possible routes of transmission. Although SARS-CoV is transmitted primarily by contact and/or droplet routes, airborne transmission over a limited distance (e.g. within a room), has been suggested, though not proven. This is true of other infectious agents such as influenza virus and noroviruses. Influenza viruses are transmitted primarily by close contact with respiratory droplets and acquisition by health care personnel has been prevented by Droplet Precautions, even when positive pressure rooms were used in one center. However, inhalational transmission could not be excluded in an outbreak of influenza in the passengers and crew of a single aircraft.

Observations of a protective effect of UV lights in preventing influenza among patients with tuberculosis during the influenza pandemic of 1957-'58 have been used to suggest airborne transmission. In contrast to the strict interpretation of an airborne route for transmission (i.e., long distances beyond the patient room environment), short distance transmission by small particle aerosols generated under specific circumstances (e.g., during endotracheal intubation) to persons in the immediate area near the patient has been demonstrated. Also, aerosolized particles <100 µm can remain suspended in air when room air current velocities exceed the terminal settling velocities of the particles. SARS-CoV transmission has been associated with endotracheal intubation, non-invasive positive pressure ventilation, and cardiopulmonary resuscitation. Although the most frequent routes of transmission of noroviruses are contact, food and waterborne routes, several reports suggest that noroviruses may be transmitted through aerosolization of infectious particles from vomitus or fecal material. It is hypothesized that the aerosolized particles are inhaled and subsequently swallowed.

Aerosol transmission is classified as when evaluating routes of SARS transmission: 1) *obligate* : under natural conditions, disease occurs following transmission of the agent only through inhalation of small particle aerosols (e.g., tuberculosis); 2) *preferential* : natural infection results from transmission through multiple routes, but small particle aerosols are the predominant route (e.g. measles, varicella); and 3) *opportunistic* : agents that naturally cause disease through other routes, but under special circumstances may be transmitted via fine particle aerosols. This conceptual framework can explain rare occurrences of airborne transmission of agents that are transmitted most frequently by other routes (e.g., smallpox, SARS, influenza, noroviruses). Concerns about unknown or possible routes of transmission of agents associated with severe

disease and no known treatment often result in more extreme prevention strategies than may be necessary; therefore, recommended precautions could change as the epidemiology of an emerging infection is defined and controversial issues are resolved.

Transmission from the environment

Some airborne infectious agents are derived from the environment and do not usually involve person-to-person transmission. For example, anthrax spores present in a finely milled powdered preparation can be aerosolized from contaminated environmental surfaces and inhaled into the respiratory tract. Spores of environmental fungi (e.g., *Aspergillus spp.*) are ubiquitous in the environment and may cause disease in immunocompromised patients who inhale aerosolized (e.g., via construction dust) spores. As a rule, neither of these organisms is subsequently transmitted from infected patients. However, there is one well-documented report of person-to-person transmission of *Aspergillus spp.* in the ICU setting that was most likely due to the aerosolization of spores during wound debridement. A Protective Environment refers to isolation practices designed to decrease the risk of exposure to environmental fungal agents in allogeneic HSCT patients. Environmental sources of respiratory pathogens (eg. *Legionella*) transmitted to humans through a common aerosol source is distinct from direct patient-to patient transmission.

ii b. Droplet precautions

Diseases, which are transmitted by this route, include pneumonias, pertussis, diphtheria, influenza type B, mumps, and meningitis. Droplet transmission occurs when there is adequate contact between the mucous membranes of the nose and mouth or conjunctivae of a susceptible person and large particle droplets (> 5 microns). Droplets are usually generated from the infected person during coughing, sneezing, talking or when health care workers undertake procedures such as tracheal suctioning. The following precautions need to be taken:

- Implement standard precautions.
- Place patient in a single room (or in a room with another patient infected by the same pathogen).
- Wear a surgical mask when working within 1-2 metres of the patient.
- Place a surgical mask on the patient if transport is necessary.

- Special air handling and ventilation are not required to prevent droplet transmission of infection.

Placement of patients on droplet precautions

Placing patients on droplet precautions in a single-patient room reduces the risk of patient-to-patient transmission. When single-patient rooms are in short supply, the following principles apply in decision-making on patient placement :

- Prioritise patients who have excessive cough and sputum production for single-patient room placement
- Place together in the same room (cohort) patients who are infected with the same pathogen and are suitable roommates.

If it becomes necessary to place patients who require droplet precautions in a room with a patient who does not have the same infection:

- Avoid placing patients on droplet precautions in the same room with patients who have conditions that may increase the risk of adverse outcomes from infection or that may facilitate transmission (e.g. those who are immunocompromised, have anticipated prolonged lengths of stay, have cystic fibrosis, cardiac conditions or muscular dystrophy)
- Ensure that patients are physically separated (> 1 metre apart) from each other and draw the privacy curtain between beds to minimise opportunities for close contact.

In all cases, the importance of respiratory hygiene and cough etiquette should be explained to patients on droplet precautions. In primary care and other office-based practice, examples of appropriate implementation of droplet precautions include segregation in waiting rooms for patients with violent or frequent coughing, and the availability of tissues, alcohol-based hand rub and a waste bin so that patients can practice respiratory hygiene and cough etiquette.

Transfer of patients on droplet precautions

When transfer of a patient on droplet precautions within or between facilities is necessary, there is the potential for other patients and healthcare health care workers to come in contact with infectious agents when the patient coughs or sneezes. This can be addressed by asking the patient to wear a mask while they are being transferred and to follow respiratory hygiene and cough

etiquette. Children should wear a correctly fitting mask when they are outside an isolation room. The child's oxygen saturation should be monitored.

ii c. Contact precautions

Diseases which are transmitted by this route include colonization or infection with multiple antibiotic resistant organisms, enteric infections and skin infections.

The following precautions need to be taken:

- Implement standard precautions.
- Place patient in a single room (or in a room with another patient infected by the same pathogen). Consider the epidemiology of the disease and the patient population when determining patient placement.
- Wear a clean, non-sterile gown when entering the room if substantial contact with the patient, environmental surfaces or items in the patient's room is anticipated.

Patient placement

A single-patient room is recommended for patients who require contact precautions. Rooms with ensembles and anterooms are preferred. Other points relevant to patient placement include the following:

- Keep patient notes outside the room
- Keep patient bedside charts outside the room
- Disinfect hands upon leaving room and after writing in the chart
- Keep doors closed
- Make sure rooms are clearly signed.

When a single-patient room is not available, consultation with infection control professionals is recommended to assess the various risks associated with other patient placement options (e.g. cohorting).

If it is necessary to place a patient who requires contact precautions in a room with a patient who is not infected or colonised :

- Avoid placing these patients with patients who are at increased risk of an adverse outcome from infection (e.g. patients who are immunocompromised, have open wounds or have anticipated prolonged lengths of stay)
- Change protective attire and perform hand hygiene between contact with patients in the same room, regardless of whether one or both patients are on contact precautions.

Transfer of patients

Limiting transfer of a patient on contact precautions reduces the risk of environmental contamination. If transfer within or between facilities is necessary, it is important to ensure that infected or colonised areas of the patient's body are contained and covered. Contaminated PPE should be removed and disposed off and hand hygiene performed before the patient is moved. Clean PPE should be put on before the patient is handled at the destination.

Other sources of infection

Transmission of infection from sources other than infectious individuals include those associated with common environmental sources or vehicles (e.g. contaminated food, water, or medications (e.g. intravenous fluids). Although *Aspergillus* spp. have been recovered from hospital water systems, the role of water as a reservoir for immunosuppressed patients remains uncertain. Vector-borne transmission of infectious agents from mosquitoes, flies, rats, and other vermin also can occur in health care settings. Prevention of vector borne transmission is not addressed in this document.

ii d. Absolute (strict) isolation

Absolute isolation is required where there is a risk of infection by a highly virulent or other unique agent of concern where several routes of transmission are implicated such as haemorrhagic fever, vancomycin resistant *S. aureus*. The precautions that need to be followed are,

- Individual room (isolation ward)
- Mask, gloves, gowns, cap, eye protection for all entering the room
- Hygienic hand washing at entry to and exit from the room
- Incineration of needles, syringes
- Disinfection of medical instruments

- Incineration of excreta, body fluids, nasopharyngeal secretions
- Disinfection of linen
- Restrict visitors and staff
- Daily disinfection and terminal disinfection at the end of the stay
- Use of disposable (single-use) equipment
- Appropriate transport and laboratory management of patient specimens.

Table 3: Chain of transmission and the recommended precautions to breakdown the chain.

Chain of transmission	Breaking the chain
Infectious agent	Hand hygiene Cleaning Disinfection/sterilization
Reservoir People Animals Inanimate environment	Environmental cleaning Waste management Disinfection/sterilization of surfaces/equipment Maintaining proper food temperatures Maintaining good health
Portal of exit Excretion and secretions Non-intact skin (ex: draining nose) Respiratory tract Gastrointestinal tract Mucous membrane	Hand hygiene, PPE Environmental cleaning Containing excretions and secretions
Mode of transmission Contact Droplet Airborne Contaminated food Vector Parenteral	Hand hygiene PPE Environmental cleaning Respiratory etiquette Spatial separations Air flow control
Portal of entry Non-intact skin Respiratory tract Gastrointestinal tract Mucous membrane Parenteral	Hand hygiene Use of PPE Preventing skin breakdown Safe use/handling of sharps Aseptic technique Catheter care
Susceptible host Elder persons Immunocompromised Invasive diseases Poor nutrition	Immunization Isolation Recognition of highly risk residents Treatment of underlying disease

3. Epidemiologically important organisms

Any infectious agent transmitted in healthcare settings may, under defined conditions, become targeted for control because it is or has become epidemiologically important. *C. difficile* is specifically discussed below because of wide recognition of its current importance in U.S. health care facilities. In determining what constitutes an “epidemiologically important organism”, the following characteristics apply:

- A propensity for transmission within health care facilities based on published reports and the occurrence of temporal or geographic clusters of > 2 patients, (e.g., *C. difficile*, norovirus, respiratory syncytial virus (RSV), influenza, rotavirus, *Enterobacter spp*; *Serratia spp*, group A streptococcus). A single case of healthcare-associated invasive disease caused by certain pathogens (e.g., group A streptococcus post-operatively, in burn units, or in a LTCF; *Legionella spp.*, *Aspergillus spp.*) is generally considered a trigger for investigation and enhanced control measures because of the risk of additional cases and severity of illness associated with these infections.
- Resistance to first-line therapies (e.g., MRSA, VISA, VRSA, VRE, ESBL-producing organisms).
- Common and uncommon microorganisms with unusual patterns of resistance within a facility (e.g., the first isolate of *Burkholderia cepacia* complex or *Ralstonia spp* in non-CF patients or a quinolone-resistant strain of *Pseudomonas aeruginosa* in a facility).
- Difficult to treat because of innate or acquired resistance to multiple classes of antimicrobial agents (e.g., *Stenotrophomonas maltophilia*, *Acinetobacter spp.*).
- Association with serious clinical disease, increased morbidity and mortality (e.g., MRSA and MSSA, group A streptococcus)
- A newly discovered or re-emerging pathogen

3a. *Clostridium difficile*

C. difficile is a spore-forming gram positive anaerobic bacillus that was first isolated from stools of neonates in 1935 and identified as the most commonly identified causative agent of antibiotic-associated diarrhea and pseudomembranous colitis in 1977. This pathogen is a major cause of health care - associated diarrhea and has been responsible for many large outbreaks in healthcare settings that were extremely difficult to control. Important factors that contribute to healthcare-

associated outbreaks include environmental contamination, persistence of spores for prolonged periods of time, resistance of spores to routinely used disinfectants and antiseptics, hand carriage by health care personnel to other patients, and exposure of patients to frequent courses of antimicrobial agents. Antimicrobials most frequently, associated include clindamycin, vancomycin, and fluoroquinolones.

Since 2001, outbreaks and sporadic cases of *C. difficile* with increased morbidity and mortality have been observed in several U.S. states, Canada, England and the Netherlands. The same strain of *C. difficile* has been implicated in these outbreaks. This strain, toxinotype III, North American PFGE type 1, and PCR-ribotype 027 (NAP1/027).has been found to hyperproduce toxin A (16 fold increase) and toxin B (23 fold increase) compared with isolates from 12 different pulsed-field gel electrophoresis (PFGE) types. A recent survey of U.S. infectious disease physicians found 40% perceived recent increase in the incidence and severity of *C. difficile* disease. Standardization of testing methodology and surveillance definitions are needed for accurate comparisons of trends in rates among hospitals.

It is hypothesized that the incidence of disease and apparent heightened transmissibility of this new strain may be due, at least in part, to the greater production of toxins A and B, increasing the severity of diarrhoea and resulting in more environmental contamination. Considering the greater morbidity, mortality, length of stay, and costs associated with *C. difficile* disease in both acute care and long term care facilities, control of this pathogen is now even more important than previously. Prevention of transmission focuses on syndromic application of Contact Precautions for patients with diarrhoea, accurate identification of patients, environmental measures (e.g., rigorous cleaning of patient rooms) and consistent hand hygiene. Use of soap and water, rather than alcohol based hand rubs, for mechanical removal of spores from hands, and a bleach-containing disinfectant (5000 ppm) for environmental disinfection, may be valuable when there is transmission in a health care facility.

3b. Multidrug-Resistant Organisms (MDROs)

In general, MDROs are defined as microorganisms – predominantly bacteria – that are resistant to one or more classes of antimicrobial agents. Although the names of certain MDROs suggest resistance to only one agent (e.g., methicillin-resistant *Staphylococcus aureus* [MRSA],

vancomycin resistant enterococcus [VRE]), these pathogens are usually resistant to all but a few commercially available antimicrobial agents. This latter feature defines MDROs that are considered to be epidemiologically important and deserve special attention in health care facilities. Multi-drug resistance (MDR) is also common and increasing among non-fermenting Gram-negative bacteria (e.g. *Pseudomonas aeruginosa* and *Acinetobacter baumannii*) and a number of strains have now been identified that exhibit resistance to essentially all commonly used antibiotics. These organisms are associated with treatment failure and increased morbidity. Other MDROs of concern include multidrug-resistant *Streptococcus pneumoniae* (MDRSP) which is resistant to penicillin and other broad-spectrum agents such as macrolides and fluoroquinolones, multidrug-resistant gram-negative bacilli (MDR-GNB), especially those producing extended spectrum beta-lactamases (ESBLs); and strains of *S. aureus* that are intermediate or resistant to vancomycin (i.e., VISA and VRSA).

MDROs are transmitted by the same routes as antimicrobial susceptible infectious agents. Patient-to-patient transmission in healthcare settings, usually via hands of HCWs, has been a major factor accounting for the increase in MDRO incidence and prevalence, especially for MRSA and VRE in acute care facilities. Preventing the emergence and transmission of these pathogens requires a comprehensive approach that includes administrative involvement and measures (e.g., nurse staffing, communication systems, performance improvement processes to ensure adherence to recommended infection control measures), education and training of medical and other health care personnel, judicious antibiotic use, comprehensive surveillance for targeted MDROs, application of infection control precautions during patient care, environmental measures (e.g., cleaning and disinfection of the patient care environment and equipment, dedicated single-patient-use of non-critical equipment), and decolonization therapy when appropriate.

The prevention and control of MDROs is a national priority - one that requires that all health care facilities and agencies assume responsibility and participate in community-wide control programs. A detailed discussion of this topic and recommendations for prevention was published in 2006 may be found at <http://www.cdc.gov/ncidod/dhqp/pdf/ar/mdroGuideline2006.pdf>

3c. Agents of bioterrorism

CDC has designated the agents that cause anthrax, smallpox, plague, tularaemia, viral haemorrhagic fevers, and botulism as Category A (high priority) because these agents can be easily disseminated environmentally and/or transmitted from person to person; can cause high mortality and have the potential for major public health impact; might cause public panic and social disruption; and require special action for public health preparedness. Category B and C agents are important but are not as readily disseminated and cause less morbidity and mortality than Category A agents.

Healthcare facilities confront a different set of issues when dealing with a suspected bioterrorism event as compared with other communicable diseases. An understanding of the epidemiology, modes of transmission, and clinical course of each disease, as well as carefully drafted plans that provide an approach and relevant websites and other resources for disease-specific guidance to health care, administrative, and support personnel, are essential for responding to and managing a bioterrorism event. Infection control issues to be addressed include : 1) identifying persons who may be exposed or infected; 2) preventing transmission among patients, health care personnel, and visitors; 3) providing treatment, chemoprophylaxis or vaccine to potentially large numbers of people; 4) protecting the environment including the logistical aspects of securing sufficient numbers of Airborne Infection Isolation Room (AIIR) or designating areas for patient cohorts when there are an insufficient number of AIIRs available; 5) providing adequate quantities of appropriate personal protective equipment; and 6) identifying appropriate staff to care for potentially infectious patients (e.g., vaccinated health care personnel for care of patients with smallpox). The response is likely to differ for exposures resulting from an intentional release compared with naturally occurring disease because of the large number of persons that can be exposed at the same time and possible differences in pathogenicity.

A variety of sources offer guidance for the management of persons exposed to the most likely agents of bioterrorism. Federal agency websites (e.g., <http://www.usamriid.army.mil/publicationspage.html> , www.bt.cdc.gov) and state and county health department web sites should be consulted for the most up-to-date information. Sources of

information on specific agents include: anthrax; smallpox; plague; botulinum toxin; tularemia; and hemorrhagic fever viruses.

4. Hospital-acquired Infections (Nosocomial Infections)

4a. Microbiology of Hospital Infections

Almost any pathogen can, on occasion, cause hospital infection but those that are able to survive in the hospital environment for long periods and develop resistance to antibiotics and disinfectants are particularly important in this respect. *S aureus* strains, resistant to multiple antibiotics, spread globally in the 1950s and 1960s, colonising hospitals and causing nosocomial infection. The original strains have since been replaced by other strains but staphylococci continue to be one of the commonest causative agents of hospital infection (MRSA).

In recent decades, the Gram-negative bacilli of the family Enterobacteriaceae – *E coli*, *Klebsiella*, *Enterobacter*, *Proteus* and *Serratia* – have become the most important group of hospital pathogens with multiple drug resistance.

P. aeruginosa and other *Pseudomonas* species have always been important causes of hospital infection because of their intrinsic resistance to most antibiotics and the ability to survive in the environment, multiply at low temperatures and even in disinfectant solutions! Tetanus spores can survive in dust for a very long time and may sometimes contaminate cotton, suture materials, plaster of paris and other items used in hospitals. Hospital tetanus is usually a result of faulty sterilisation techniques or other lapses in asepsis.

Human immunodeficiency virus (HIV) and hepatitis B and C viruses are the important infections transmitted through blood and blood products. The use of shared syringes and needles also carries the risk of transmission of these viruses.

Rotavirus, cytomegalovirus, herpesvirus, influenza viruses and enteroviruses may also cause hospital infection.

The range of hospital pathogens also includes yeasts (*Candida albicans*), moulds, (*Aspergillus*, *Rhizopus*) and protozoa (*Plasmodium*).

4b. Common types of nosocomial infections

Wound infection

This may range in severity from delayed wound healing or stitch abscess caused by *S. epidermidis* or other resident skin flora, to severe spreading infections due to exogenous pathogens. Most wound infections manifest within a week of surgery. *S. pyogenes* and clostridial infections appear within a day or two. While staphylococcal infections typically take four or five days, those due to Gram-negative bacilli take six or seven days to appear. In special cases where antibiotic cover is indicated, it should be given parenterally immediately before, during and following surgery.

Nonsurgical sites of wound infections include infection 'cut-downs', umbilical stumps, ulcers and burns. *P. aeruginosa* is the most important cause of infection in burns patients.

Urinary tract infections : Even with adequate precautions, catheterisation in hospitals leads to urinary tract infections; with indwelling catheters, the rate is significantly increased. *E coli*, *Proteus*, *P. aeruginosa* and other Gram-negative bacilli are the causative agents. Mixed infection is also common.

Respiratory infections : Aspiration in unconscious patients and pulmonary ventilation or instrumentation may lead to nosocomial pneumonia (ventilator associated pneumonia: VAP), particularly in those with pre-existing cardiopulmonary disease. Multidrug-resistant *S aureus* and Gram-negative bacilli like *P. aeruginosa* and *Acinetobacter baumannii* are the common pathogens. Postural drainage is useful in the prevention and management of such cases.

Bacteraemia and septicaemia : These may occur as a consequence of infections at any site, but are commonly caused by infected intravenous cannulae. The longer the cannulae are kept in situ, the greater the risk of infection. Gram-negative bacilli are the common pathogens.

4c. Diagnosis and control of nosocomial infection

Hospital infection may occur sporadically or as outbreaks. Causative diagnosis is by the routine bacteriological methods of smear, culture, identification and susceptibility testing. When an outbreak occurs, the source should be identified and eliminated. This requires the sampling of possible sources of infection such as hospital personnel, inanimate objects, water, air or food. Typing of outbreak organisms by phage, bacteriocin, antibiogram or biotyping from cases and sites may indicate a causal connection. Obvious examples of sources of hospital outbreaks are nasal carriage of staphylococci by surgeons or *Pseudomonas* growing in hand lotions. Carriers should be suitably treated.

Sterilisation techniques have to be tested. The cause of infection may be a defective autoclave or improper techniques such as boiling infusion sets in ward sterilisers. A careful analysis of the pattern of infection may often reveal the source, but sometimes even the most thorough search will not reveal the source.

Every major hospital should have 'infection control teams' (Hospital Infection Control Committee – HICC) consisting of infectious diseases physicians, microbiologists, medical and nursing staff and hospital administrators. Besides investigating and controlling outbreaks, their functions include formulating appropriate guidelines for admission, nursing and treatment of infectious patients, surveillance on sterilisation and disinfectant practices, determining antibiotic policies and immunisation schedules, and educating patients and hospital personnel on infection control. The hospital infection measures help in reducing the incidence of hospital infections, even if they do not eliminate them altogether.

Unfortunately, in many hospitals, infection control is attempted by the use of increasing numbers and variety of antibiotics. This is not only futile but may even be actively harmful by encouraging selective colonisation by multiresistant pathogens. Ultimately, prevention of hospital infection rests on a proper understanding of aseptic practices and meticulous attention to hygienic principles. Sir William Osler's wisdom that 'soap, water and common sense are the best disinfectants' applies even today in the context of hospital infection.

Table 4: Measures for prevention of infection (Adapted from: Hospital infection control, 2nd edition. Geneva:WHO, 2002)

Infection	Proven to be effective	Proven to be ineffective
Urinary tract infections	Limit duration of catheter use Aseptic technique at insertion Maintain closed drainage	Systemic antibiotic prophylaxis Bladder irrigation or instillation of normal saline, antiseptic or antibiotic Antiseptic added to drainage bag Antimicrobial-coated catheter Daily antiseptic perineal cleaning
Surgical site infections	Surgical technique Clean operating environment Staff attire Limiting preoperative hospital stay Preoperative shower and local skin preparation of patient Optimal antibiotic prophylaxis Aseptic practice in operating room Surgical wound surveillance	Fumigation of operating theatre Preoperative shaving
Pneumonia	<i>Ventilator-associated</i> Aseptic intubation and suctioning Limited duration Noninvasive ventilation <i>Others</i> Sterile water for oxygen and aerosol therapy Isolation policy	Digestive decontamination for all patients Changes of ventilator circuit every 48 or 72 hours
Vascular device infections	<i>All catheters</i> Closed system Limit duration of use Local skin preparation Aseptic technique at insertion Removal if infection suspected <i>Central lines</i> Surgical asepsis for insertion Limitation of frequency of dressing change Antibiotic-coated catheter for short term use	Antimicrobial creams for skin preparation

4d. Nosocomial respiratory infections:

These occur in different patient groups. Recommendations to prevent these infections include :

Ventilator-associated pneumonia in the intensive care unit :

- Appropriate disinfection and in-use care of tubing, respirators and humidifiers to limit contamination.
- No routine changes of respirator tubing.
- Avoid antacids and H₂ blockers.
- Sterile tracheal suctioning.
- Nurse the patient in head-up position.

In addition, the following recommendations can be followed in medical and surgical units.

Medical units :

- Limit medications which impair consciousness (sedatives, narcotics)
- Position comatose patients to limit the potential for aspiration.
- Avoid oral feeds in patients with swallowing abnormalities.
- Limit exposure of neutropenic or transplant patients to fungal spores during construction or renovation.

Surgical units :

- All invasive devices used during anaesthesia must be sterile.
- Anaesthetists must use gloves and mask when undertaking invasive tracheal, venous or epidural care. Disposable filters (for individual use) for endotracheal intubation effectively prevent the transmission of microorganisms among patients by ventilators.

Preoperative physiotherapy prevents postoperative pneumonia in patients with chronic respiratory disease.

4e. Bloodstream infections associated with intravascular devices :

Key practices for all vascular catheters include :

- Avoiding catheterisation unless there is a medical indication
- Maintaining a high level of asepsis for catheter insertion and care

- Limiting the duration of the use of catheters where possible
- Preparing fluids aseptically and immediately before use
- Training of personnel in catheter insertion and care

In addition, the following must be practised for peripheral venous catheters and central venous catheters.

Peripheral vascular catheters :

- Hands must be washed before all catheter care, using hygienic handwash or rub
- Wash and disinfect skin at the insertion site with an antiseptic solution.
- Frequent changes of intravenous line are not required. Exceptions are changes of line after the transfusion of blood and lipid formulations.
- A dressing change is not normally necessary.
- If local infection or phlebitis occurs, the catheter should be removed immediately.

Central vascular catheters :

- Clean the insertion site with an antiseptic solution.
- Do not apply solvents or antimicrobial ointment to the insertion site.
- Mask, cap and sterile gloves and gown must be worn for insertion.
- The introduction of the catheter and the subsequent catheter dressings require a surgical handwash or rub.

Follow appropriate aseptic care in accessing the system, including disinfecting external surfaces of hub and ports.

- Change of lines should normally not occur more often than once every three days. A change of line is necessary, however, after the transfusion of blood, blood products or intralipids.
- Change dressing at the time of the change of lines, following surgical asepsis.
- Use sterile gauze or transparent dressing to cover the catheter site.
- Do not replace over a guide wire if infection is suspected.
- An increased number of catheter lumens may increase the risk of infection. A single lumen catheter is preferred wherever possible.

- Antimicrobial impregnated catheters may decrease infection in high-risk patients with short-term (<10 days) catheterisation.
- Use the subclavian site in preference to jugular or femoral sites.

Maintenance of Intravascular and Indwelling Devices

Intravascular Devices

Intravascular devices are used to deliver sterile fluids, medications, nutritional products, blood products and central monitoring of blood pressure and for maintaining emergency vascular access.

The various types of intravascular devices are :

- Peripheral venous catheters
- Peripheral arterial catheters
- Midline catheter
- Central venous catheter : tunnelled or non-tunnelled
- Pulmonary artery catheter
- Peripherally inserted central catheter

Intravascular devices provide a route for the entry of microorganisms into the bloodstream at the following times :

- During insertion of the device
- Contamination of the device by fluids or medications
- Normal flora in the skin surrounding the insertion site

Infections associated with the intravascular devices can be divided into two broad categories:

Local infections

- Exit site infection : Infection at the exit site in which the discharge yields a microorganism on culture.
- Phlebitis : This is inflammation of the veins in which the catheter has been lodged. It is characterised by an area of swelling, redness, warmth and tenderness of the skin surrounding the affected vein.
- Pocket/Tunnel infection : Purulent discharge or aspirate from a tunnel or pocket site which is not continuous with the exit site.

Bloodstream infections :

The risk of infections associated with intravascular devices is dependent upon the following factors :

- Sites of insertion (lower extremity sites present a greater risk; sites with a high density of skin flora are associated with greater risk; inserting catheters over mobile joints increases risk)
- Catheter materials (for example, polyvinyl chloride and polyethylene catheters are associated with higher risks than Teflon catheters)
- Duration of placement
- Length and width of the catheter
- Virulence of the infecting organism

Organisms causing Local or Bloodstream Infections

Bacteria

Gram-positive cocci

- Coagulase-negative staphylococci including *Staphylococcus epidermidis*
- *Staphylococcus aureus*
- *Enterococcus* species

Gram-negative bacilli

- *Pseudomonas aeruginosa*
- *Klebsiella* species

Fungi

- *Candida albicans*
- *Candida tropicalis*

Role of the Nursing Staff in Infection Control

Nurses should be familiar with practices to prevent the occurrence and spread of infection, and maintain appropriate practices for all patients throughout the duration of their hospital stay.

The senior nursing administrator is responsible for :

- participating in the Hospital Infection Control Committee

- promoting the development and improvement of nursing techniques, and ongoing review of aseptic nursing policies, with approval by the Infection Control Committee
- developing training programmes for members of the nursing staff
- supervising the implementation of techniques for the prevention of infections in specialised areas such as the operating suite, intensive care unit, maternity unit and neonatal unit
- monitoring of adherence of nursing staff to policies.

The nurse in charge of a ward is responsible for :

- maintaining hygiene, consistent with hospital policies and good nursing practice on the ward
- monitoring aseptic techniques, including hand washing
- reporting promptly to the attending physician any evidence of infection in patients under the nurse's care
- initiating patient isolation
- limiting patient exposure to infections from visitors, hospital staff, other patients or equipment used for diagnosis or treatment
- proper segregation and disposal of waste
- maintaining safe and adequate supply of ward equipment, drugs and patient care supplies

The nurse in charge of infection control is a member of the infection control team and is responsible for :

- identifying nosocomial infections
- participating in training of personnel
- surveillance of hospital infections
- participating in outbreak investigation
- development of infection control policy and approval of patient care policies relevant to infection control
- ensuring compliance with local and government regulations
- hospital waste management
- liaison with appropriate personnel in relation to notifying hospital infections

- providing expert advice to staff and other hospital programmes relating to transmission of infections.

Restrictions for Nursing Staff Who Are Sick

Nursing staff who are sick present an infection control risk to patients. They should be restricted in their access to patients according to the illness they have. Recommended work restrictions are:

- **Infectious conjunctivitis** : No direct patient contact until discharge ceases
- **Diarrhoea** : Personnel with acute illness which is severe or lasts longer than 24 hours should be excluded from direct patient care pending further evaluation. Personnel with *Salmonella* should not care for high-risk patients until stool cultures are negative for *Salmonella*.
- **Group A streptococcal disease** : Anyone suspected of having a group A streptococcal infection (especially sore throat) at any site should be removed from direct patient care until infection is ruled out or until 24 hours after the start of antibiotic therapy.
- **Exposure to varicella (chickenpox) or zoster (shingles)** : The same virus (varicella-zoster) causes both diseases. If nurses do not remember having had an infection in the past, they need to inform their supervisor. The antibody titre needs to be checked. If they are not immune, then the nurse should refrain from patient care during the incubation period. Infection control should be informed.
- **Herpes simplex**
 - **Genital** : No work restrictions.
 - **Hands (herpetic whitlow)** : No direct patient contact until lesion heals.
 - **Orofacial** : Persons with multiple facial lesions should refrain from patient care until lesions are healed.
- **Respiratory infections**

Nurses are reminded that even mild colds in adults may be caused by viruses which can result in severe infections in others. Influenza is spread via the respiratory route, and you are most infectious at the beginning of the illness when you may not feel sick enough to stay at home.

5. Management of patient outcome

A care bundle is a collection of interventions usually 3- 5 which are evidence based. It means to measure the application of all interventions is consistent for all patients at all times thereby improving patient outcome. Care bundles are an effective means of reducing HCAI when they are implemented. The aim of the care bundle has set out in the high impact intervention to ensure appropriate and high quality patient care. Regular auditing of the care bundle actions will support cycles of review and continuous improvement in care settings.

Health care workers are committed to delivering high standards of care to all patients. Standards of care originally defined by evidence based guidelines. Care bundles to prevent specific infections are tabulated below (Table 5-10).

Table 5: Care bundle to prevent infections associated with peripheral IV cannula

Insertion care bundle	Maintenance care bundle
<ul style="list-style-type: none"> ◆ Avoid unnecessary cannulation 	<ul style="list-style-type: none"> ◆ Review need for catheter on a <i>daily basis</i>
<ul style="list-style-type: none"> ◆ Insert IV catheter using <i>strict aseptic technique</i> and use sterile items 	<ul style="list-style-type: none"> ◆ Inspect cannula on a daily basis for signs of infection
<ul style="list-style-type: none"> ◆ Disinfect skin with 2% chlorhexidine gluconate in 70% isopropyl alcohol and allow to it dry 	<ul style="list-style-type: none"> ◆ Use aseptic technique for daily care (e.g. hand hygiene before accessing the device and disinfect catheter hubs)
<ul style="list-style-type: none"> ◆ Use a sterile, transparent dressing to allow observation of insertion site 	<ul style="list-style-type: none"> ◆ Replace cannula in a new site after 72-96 hours or earlier if clinically indicated
<ul style="list-style-type: none"> ◆ Record date of insertion in medical notes 	<ul style="list-style-type: none"> ◆ Replace cannula immediately after administration of blood/blood products and 72 hours after other fluids

Table 6: Care bundle to prevent central venous catheter infections

Insertion care bundle	Maintenance bundle
<ul style="list-style-type: none"> ◆ Use single lumen unless indicated otherwise 	<ul style="list-style-type: none"> ◆ Review need for CVC on a <i>daily basis</i> and remove promptly if not required
<ul style="list-style-type: none"> ◆ Use maximal sterile barrier precautions during insertion 	<ul style="list-style-type: none"> ◆ Inspect CVC site on a daily basis for signs of infection
<ul style="list-style-type: none"> ◆ Avoid femoral site; subclavian vein is the 	<ul style="list-style-type: none"> ◆ Use aseptic technique for daily care (e.g.

preferred site	hand hygiene before accessing the device and use of sterile single use antiseptic solution to disinfect hub)
<ul style="list-style-type: none"> Disinfect skin with single use sterile solution of 2% chlorhexidine gluconate in 70% isopropyl alcohol and allow to dry 	
<ul style="list-style-type: none"> Use transparent dressing 	

Table 7: Care bundle to prevent catheter associated urinary tract infection

Insertion care bundle	Maintenance bundle
<ul style="list-style-type: none"> Avoid unnecessary catheterization 	<ul style="list-style-type: none"> Use aseptic technique for daily catheter care (e.g. hand hygiene, sterile items/equipment)
<ul style="list-style-type: none"> Use sterile items/equipment 	<ul style="list-style-type: none"> Don't break the closed drainage system. If urine specimen required, take specimen aseptically via the sampling port
<ul style="list-style-type: none"> Insert catheter using strict aseptic non-touch Technique 	<ul style="list-style-type: none"> Keep the drainage bag above the floor but below bladder level to prevent reflux/contamination
<ul style="list-style-type: none"> Use closed drainage system 	<ul style="list-style-type: none"> Review the need for the catheter on a daily basis. Remove catheter promptly when no longer Necessary
<ul style="list-style-type: none"> Chose catheters of appropriate size 	
<ul style="list-style-type: none"> Consider use of antimicrobial impregnated catheters in 'high-risk' patients requiring short-term catheterization (2 – 10 days) 	

Table 8: Care bundle to prevent ventilator associated pneumonia

Regular observations	Ongoing care
<ul style="list-style-type: none"> Elevation of the head of the bed to 30-45° 	<ul style="list-style-type: none"> Adherence to hand hygiene and aseptic Technique
<ul style="list-style-type: none"> Daily assessment of sedation with readiness to extubate 	
<ul style="list-style-type: none"> Gastric ulcer prophylaxis 	<ul style="list-style-type: none"> Oral hygiene
<ul style="list-style-type: none"> Management of ventilator tubing 	

<ul style="list-style-type: none"> Appropriate humidification of inspired gas 	<ul style="list-style-type: none"> Subglottic suctioning of respiratory secretions
<ul style="list-style-type: none"> Deep vein thrombosis prophylaxis 	

Table 9: Major interventions used in prevention of ventilator associated pneumonias

Procedure/device	Intervention to decrease to risk
Suctioning	<ul style="list-style-type: none"> Use single-use disposable gloves and wash hands before and after the procedure
	<ul style="list-style-type: none"> Use sterile suction catheter and sterile fluid to flush catheter
	<ul style="list-style-type: none"> Change suction tubing between patients
	<ul style="list-style-type: none"> Use closed suction system, if possible
Suction Bottle	<ul style="list-style-type: none"> Use single-use disposable, if possible
	<ul style="list-style-type: none"> Non-disposable bottles should be washed with detergent and allowed to dry or heat disinfect in washing machine or send to sterile supply department
Ventilator Breathing Circuits	<ul style="list-style-type: none"> Replace mechanical ventilators, if soiled or malfunctioning
	<ul style="list-style-type: none"> Periodically drain breathing tube condensation traps, taking care not to spill it down the patient's trachea; wash hands after the procedure
	<ul style="list-style-type: none"> Use Heat and moisture exchanger (HME) ventilator circuits, if possible
Nebulizers	<ul style="list-style-type: none"> Fill with sterile water only
	<ul style="list-style-type: none"> Change nebulizers between patients by using sterilization or a high-level disinfection or use single-use nebulizers, if possible
Humidifiers	<ul style="list-style-type: none"> Fill with sterile water which must be changed every 24 hours or sooner, if necessary
	<ul style="list-style-type: none"> Clean and sterilize humidifiers between patients. Single-use disposable humidifiers are available but they are expensive
Ventilators	<ul style="list-style-type: none"> After every patient, clean and disinfect ventilators
	<ul style="list-style-type: none"> Sterilize/disinfect(high-level) re-usable components as per the manufacturer's instructions

Table 10: Summary of strategies to prevent catheter-associated urinary tract infections

Entry points for bacteria	Preventative measures
1. External urethral meatus and urethra	
Bacteria carried into bladder during insertion of catheter	<ul style="list-style-type: none"> ◆ Pass catheter when bladder is full for wash-out effect ◆ Before catheterization prepare urinary meatus with an antiseptic (e.g. 0.2% chlorhexidine aqueous solution or povidone iodine) ◆ Inject single-use sterile lubricant gel or use 2% lignocaine anaesthetic gel into urethra and hold there for 3 min before inserting catheter ◆ Use sterile catheter ◆ Use non-touch technique for insertion
Ascending colonization/infection up urethra around outside of catheter	<ul style="list-style-type: none"> ◆ Keep peri-urethral area clean and dry; bladder washes and ointments are of <i>no</i> value ◆ Secure catheter to prevent movement in urethra ◆ After faecal incontinence, clean area and change catheter
2. Junction between catheter and drainage tube	
	<ul style="list-style-type: none"> ◆ Do not disconnect catheter unless absolutely necessary ◆ Always use aseptic technique for irrigation ◆ For urine specimen collection, disinfect sampling port by applying alcoholic impregnated wipe and allow it to dry completely, then aspirate urine with a sterile needle and syringe
3. Junction between drainage tube and collection bag	
Disconnection	<ul style="list-style-type: none"> ◆ Drainage tube should be welded to inlet of bag during manufacture
Reflux from bag into catheter	<ul style="list-style-type: none"> ◆ Drip chamber or non-return valve at inlet to bag ◆ Keep bag below level of bladder. If it is necessary to raise collection bag above bladder level for a short period, drainage tube must be clamped temporarily ◆ Empty bag every 8 hours or earlier, if full ◆ Do not hold bag upside down when emptying
4. Tap at bottom of collection bag	
Emptying of bag	<ul style="list-style-type: none"> ◆ Collection bag must never touch floor ◆ Always wash or disinfect hands with an alcoholic hand rub before and after opening tap ◆ Use a separate disinfected jug to collect urine from each bag ◆ Don't instil disinfectant/antiseptic into urinary bag after emptying

6. Patient placement and transportation of patients

6a. Patient placement

Appropriate or selective placement of patients is important in preventing the transmission of infections in the hospital setting. General principles in relation to the placement of patients include the following :

Spacing between beds

In open plan wards there should be adequate spacing between each bed to reduce the risk of cross contamination/infection occurring from direct or indirect contact or droplet transmission. Optimum spacing between beds is 1-2 metres.

Single rooms

Single rooms reduce the risk of transmission of infection from the source patient to others by reducing direct or indirect contact transmission. Where possible, single rooms should have the following facilities:

- hand washing facilities;
- toilet and bathroom facilities.

Anterooms

Single rooms used for isolation purposes may include an anteroom to support the use of personal protective equipment.

Cohorting

For infection control purposes, if single rooms are not available, or if there is a shortage of single rooms, patients infected or colonized by the same organism can be cohorted (sharing of room/s). When cohorting is used during outbreaks these room/s should be in a well-defined area (a designated room or designated ward), which can be clearly segregated from other patient care areas in the health care facility used for non-infected/colonized patients.

6b. Transportation of patients

Limiting the movement and transport of patients from the isolation room/area for essential purposes only will reduce the opportunities for transmission of micro-organisms in other areas of the hospital. If transportation is required, suitable precautions should be taken to reduce the risk of transmission of micro-organisms to other patients, health care workers or the hospital environment (surfaces or equipment). For example: when transporting a patient with pulmonary tuberculosis (open/active) placing a surgical mask on the patient while in transit is an appropriate precaution.

7. Care of Health Care Workers

Health care workers (HCW) are at risk of acquiring infection through occupational exposure. Hospital employees can also transmit infections to patients and other employees. Thus, an employee's health programme must be in place to prevent and manage infections in hospital staff. Employees' health should be reviewed at recruitment, including immunization history and previous exposures to communicable diseases (e.g. tuberculosis) and immune status. Some previous infections such as varicella-zoster virus may be assessed by serological tests. Immunization recommended for staff includes : hepatitis A and B, influenza, measles, mumps, rubella, tetanus, and diphtheria. Immunization against varicella, rabies may be considered in specific cases. The Mantoux skin test will document a previous tuberculosis (TB) exposure. Specific post-exposure policies must be developed, and compliance ensured for a number of infectious diseases for example: human immunodeficiency virus (HIV), viral hepatitis, severe acute respiratory syndrome (SARS), varicella, rubella and tuberculosis. Health care workers with infections should report their illnesses/incident to staff clinics for further evaluation and management.

Exposure to human immunodeficiency virus (HIV)

The route of transmission for HIV is person to person via sexual contact, sharing of needles contaminated with HIV, infusions that are contaminated with HIV, transplantation of organs or tissues that are infected with HIV. The risk of a health care worker acquiring HIV after a needlestick or other "sharps" injury is less than 0.5%. Risk reduction must be undertaken for all bloodborne pathogens, including: adherence to standard precautions using personal protective

equipment and appropriate use of safety devices and a needle disposal system to limit sharps exposure. Training for health care workers in safe sharps practice should be ongoing. Information on preventive measures must be provided to all staff with potential exposure to blood and blood products. Policies which are in keeping with the local and national guidelines must include screening of patients, disposal of sharps and wastes, protective clothing, managing inoculation accidents, sterilization and disinfection. Hospital policy must include measures to obtain serological testing of source patients promptly where necessary, usually with the patient's informed consent. Post exposure prophylaxis should be started as per local or national guidelines.

Exposure to hepatitis B virus

The route of transmission for hepatitis B virus is through body substances such as blood and blood products, saliva, cerebrospinal fluid, peritoneal, pleural, pericardial and synovial fluid, amniotic fluid, semen and vaginal secretions and any other body fluid containing blood. Following standard precautions is important, but immunization is the best way of preventing transmission to health care staff. All HCWs at risk must be vaccinated. Staff infected with blood-borne pathogens may transmit these infections to patients and require careful evaluation with respect to their duties. This status should not be used as cause for discrimination.

Exposure to hepatitis C virus

The route of infection is mainly parenteral. Sexual transmission does occur but is far less frequent. No post exposure therapy is available for hepatitis C, but seroconversion (if any) must be documented. As for hepatitis B viral infection, the source person must be tested for HCV infection. For any occupational exposure to bloodborne pathogens, counselling and appropriate clinical and serological follow-up must be provided.

Sharp injuries

Needlestick injuries are a common event in the health care setting. These can occur when drawing blood, administering drugs parenterally (IM and IV), or when performing other procedures involving sharps. Needlestick injuries usually occur during recapping of the needle, hand- to-hand transfer of sharps or as a result of failure to dispose off them in the approved

sharps container. Penetrating accidents by scalpels or other sharp instruments are also considered needlestick injuries. Needlestick injury can transmit HIV, HBV, HCV and other bloodborne viruses from the infected patient to the health care worker.

Recording Needlestick Injuries

It is a legal requirement that all needlestick injuries are recorded, as well as the actions taken as a result of the injury. Figure 3 shows a suitable form for recording this information.

Prevention

1. Reduction in use of sharps as much as possible
2. Good training programme
3. Provision of adequate resources like providing puncture-proof disposable containers to discard needles at the bedside
4. Modifying work practices like using instruments (not fingers) to grasp needles or to load and remove scalpels, avoiding hand-to-hand passing of sharps and other instruments.

The step by step procedure to be followed in case of needlestick injury is given in Figure 4.

Tuberculosis

Health care workers have varying risks for exposure to tuberculosis (TB). Health care workers at the greatest risk of exposure are those working in TB-risk areas such as medical wards, chest clinics, bronchoscopy units, radiology units, TB laboratories, HIV wards and autopsy rooms. If a staff member has been exposed to TB they should report to the Infection Control Practitioner or the Staff Health Nurse depending on the hospital protocol for health care worker exposures.

Meningococcal meningitis

Transmission of meningococci to health care staff is most likely within 24 hours of admission of the patient, prior to the patient receiving appropriate antibiotic/chemoprophylaxis. Health care workers in close respiratory contact with such cases should receive chemoprophylaxis with ciprofloxacin or an effective alternative agent. Close respiratory contact with the patient includes mouth-to-mouth contact, sharing of drink containers or cigarettes.

Figure 3: Form for recording needlestick injuries and action taken

ACCIDENTAL EXPOSURE RECORD

When completed, please return the form to the Staff Health Department

This form should be completed for every case of needle or **sharps injury, or when there has been mucocutaneous contamination of blood or body fluids**, by the Staff Health Department or the doctor in Accident and Emergency outside normal working hours.

Name _____ DOB _____
Occupation _____ Hospital _____ Ward/Dept. _____
Date _____ Time _____

Site of injury

Immediate management, eg. wound washed and bled? Yes No

Section A: Exposure

- 1. Accidental injection
- 2. Sharp instrument/ needlestick
 - Splash to eye/mouth
 - Suture needle
 - Splash to broken skin
 - Hollow needle
 - Bite/Scratch
 - Other (specify)

Material

- 1. Blood/Plasma
- 2. Serum rich fluid/CSF
- 3. Urine
- 4. Saliva
- 5. Bite/Scratch
- 6. Other (specify)

How it occurred

- 1. Giving medication
- 2. Surgery/Delivery
- 3. Bite/Scratch
- 4. Venepuncture
- 5. Re-capping

Comments:

Section B: Details of Recipient

Hepatitis B vaccination status

Full course Incomplete course No Vaccination

Date of last dose _____

Response to vaccine: Good (>100 IU) Partial (10–100 IU)

No response (<10 IU) Not known

Section C: Donor/Source

Source Unknown Source known

Patient's name _____ DOB _____

Hospital No. _____

Infective status already known

Hepatitis B positive Yes No

Hepatitis C positive Yes No

HIV positive Yes No

Or if infective status **not**
known

Risk Category of Donor: Hepatitis B Low High

(To be assessed by medical practitioner) Hepatitis C Low High

HIV Low High

Section D: Course of Action

1. Blood sample taken from donor (consent obtained for testing) Yes No

2. Initial counselling given: in person Yes No

via telephone Yes No

3. Hepatitis B vaccination given: 1st dose Booster

4. Blood taken from recipient for HBs AB titres + serum
saved Yes No

5. Anti-HB immunoglobulin ordered/given Yes No

6. HIV postexposure prophylaxis
commenced Yes No

7. Referral made to Staff Health Dept. Yes No

Signature of Nurse/Doctor _____ Date _____ Time _____

Test Results _____ Recipient _____ Source _____

Please return the form to Staff Health Department

Figure 4 : The procedure to be followed for sharp injury to healthcare worker

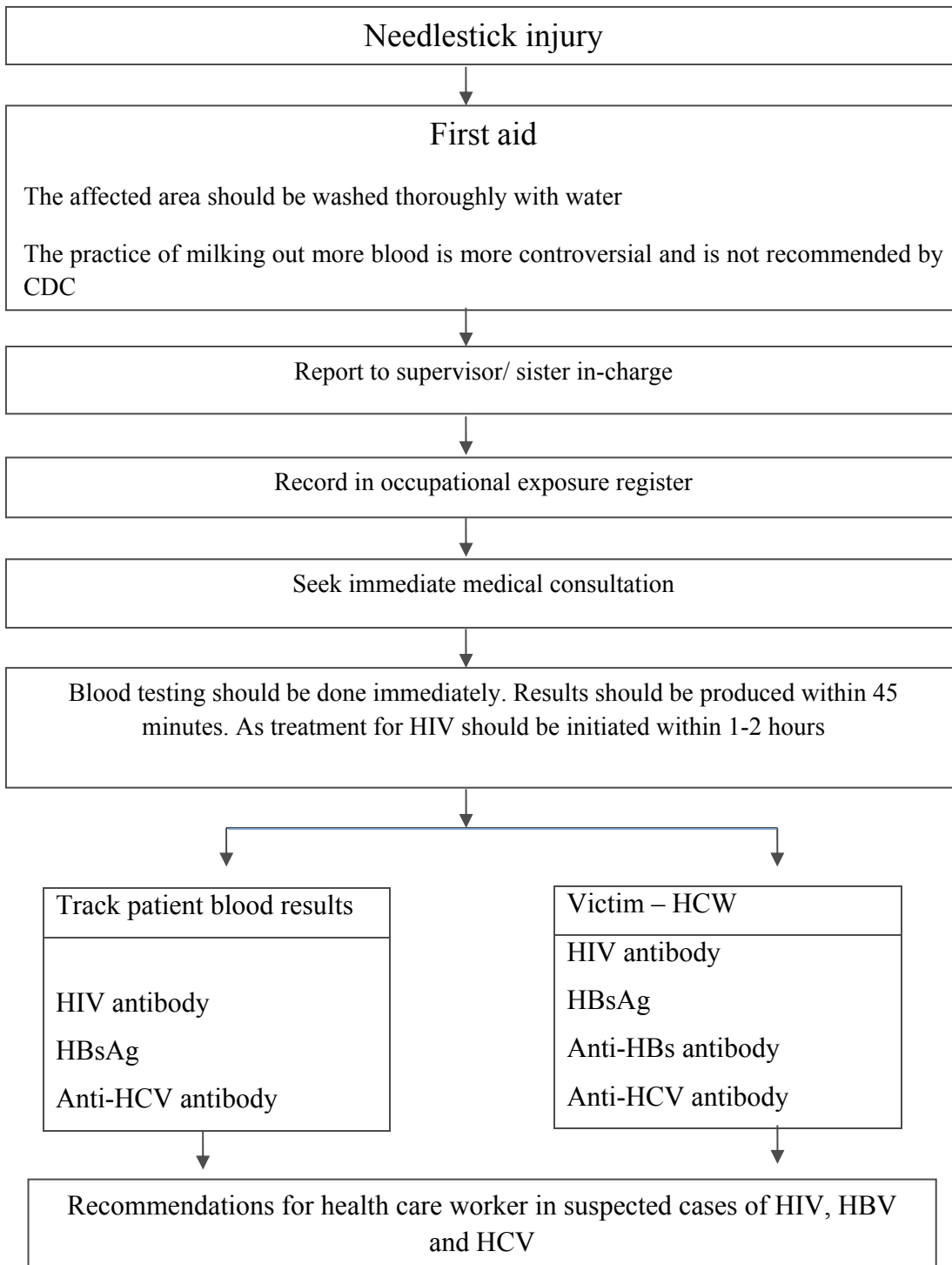


Table 11: Recommendations for health care worker in suspected cases of HIV, HBV and HCV

Serological status of index case	Status of index case	Recommendations for health care worker	Follow up of health care worker
HIV	if positive	<p>Counselling</p> <p>Initiate HAART within 1–2 hours and continue for 28 days</p> <p>HAART regimen is a combination of ATV/r + TDF/FTC or RAL + TDF/FTC or LPV/r (once or twice daily) + TDF/FTC or EFV + ABC/3TC (only for patients who are HLA-B*5701 negative)</p> <p>(Combination of ATV/r, RAL, LPV/r, with ABC/3TC only for patients who are HLA-B*5701 negative)</p>	<p>Check HIV antibody levels at 6 weeks 3 months and 6 months</p>
	if negative	<p>Counselling</p> <p>No prophylaxis needed</p>	<p>Check HIV antibody levels at 6 weeks 3 months and 6 months</p>
HBV	if positive	<p>Counselling</p> <p>Give HBIG prophylaxis (0.6 mIU/ml intramuscularly) within 24 hours</p> <p>Anti-HBs antibody levels in HCW > 100 mIU/ml - no vaccination needed 10–100 mIU/ml - Booster only < 10 mIU/ml - Full vaccination + HBIG</p>	<p>Follow up is not required</p>
	if negative	<p>Counselling</p> <p>No prophylaxis needed</p>	<p>Follow up is not required</p>
HCV	if positive	<p>No prophylaxis available</p> <p>Early identification of the disease by regular follow-up</p> <p>Treatment if disease occurs</p>	<p>Check anti-HCV antibody levels at 3 months and 6 months</p>

SARS

The health care facility should have a clear set of guidelines for preventing staff exposure to SARS. Health care workers in contact with suspected or probable SARS patients should be monitored daily for signs and symptoms of SARS, particularly for changes in temperature. If staff members indicate any signs or symptoms of SARS, they should be assessed by the infection control practitioner or the infection control team as to the appropriateness of home isolation.

Other infections; varicella, influenza, pertussis, diphtheria, rabies

Transmission of these micro-organisms may be uncommon, but policies to manage staff exposure should be developed. Vaccination of hospital staff against varicella is recommended. Influenza vaccinations should be given yearly. Rabies vaccinations may be appropriate in some facilities in countries where rabies is enzootic.

7 a. Responsibilities of health care facilities

Workplace Health and Safety Acts for the various states and territories place a duty of care on employers to ensure workplace health and safety, including where occupational infectious disease hazards exist. As part of its IPC program, each health care facility should develop, implement and document effective policies and procedures related to staff health and safety, including strategies to prevent occupational exposure to infection hazards; prevent occupational risks from chemicals or processes used for recommended infection prevention and control activities; and implement healthcare worker immunisation programs for infectious agents they may encounter in the course of their duties. At the start of their employment, all health care workers should be informed of the facility's policy on health screening and be counselled, as appropriate, about their work placement in accordance with these policies. As personal and organisational circumstances change over time, reassessment and additional education may be necessary. Similarly, training institutions should inform health care students before their course admission about policies and procedures for staff health and safety and their implications, and provide counselling for students who may be prohibited from completing any requirements of their course due to transmissible infections.

7 b. Risk associated with health care settings

In health care settings, adapting transmission prevention guidelines is challenging because patients remain in common areas for prolonged periods waiting to be seen by a health care provider or awaiting admission to the hospital, examination or treatment rooms are turned around quickly with limited cleaning, and infectious patients may not be recognized immediately. Furthermore, immunocompromised patients often receive chemotherapy in infusion rooms where they stay for extended periods of time along with other types of patients.

If transmission in outpatient settings is to be prevented, screening for potentially infectious symptomatic and asymptomatic individuals, especially those who may be at risk for transmitting airborne infectious agents (e.g., *M. tuberculosis*, varicella-zoster virus, rubeola [measles]), is necessary at the start of the initial patient encounter. Upon identification of a potentially infectious patient, implementation of prevention measures, including prompt separation of potentially infectious patients and implementation of appropriate control measures (e.g., Respiratory Hygiene/Cough Etiquette and Transmission-Based Precautions) can decrease transmission risks. Transmission of MRSA and VRE in outpatient settings has not been reported, but the association of community associated-MRSA (CA-MRSA) in healthcare personnel working in an outpatient HIV clinic with environmental CA-MRSA contamination in that clinic, suggests the possibility of transmission in that setting. Patient-to-patient transmission of *Burkholderia* species and *Pseudomonas aeruginosa* in outpatient clinics for adults and children with cystic fibrosis has been confirmed.

7 c. Vaccination of Health care Workers

Health care workers are frequently in contact with patients or infective material from patients; hence they are at constant risk of acquiring infection. Some of these can be prevented by prior vaccination. Optimal use of immunizing agents not only safeguards the health of workers, but also protects patients from becoming infected through exposure to infected health care workers.

In addition to the routine national immunization schedule, Table 12 shows the vaccines recommended for health care workers (HCW).

Table 12 : Vaccines recommended for healthcare workers

Vaccine	Dose and Remarks
Hepatitis B	<p>Three-dose series at 0, 1 and 6 months</p> <p>Test for hepatitis B surface antibody (anti-HBs) to document immunity 1–2 months after third dose</p> <p>If anti-HBs is at least 10 mIU/ml (positive), the patient is immune. No further serologic testing or vaccination is recommended</p> <p>If anti-HBs is less than 10 mIU/ml (negative), the patient is unprotected from hepatitis B virus (HBV) infection; revaccinate with a three-dose series. Retest anti-HBs, 1–2 months after dose 3</p> <p>If anti-HBs is negative after six doses of vaccine, patient is a non-responder</p>
Measles, Mumps and Rubella (MMR)	Two doses four weeks apart
Tetanus	Booster once every 10 years
Meningococcal	One dose to HCW who might contact patients with meningococcal infections
Varicella	For HCW who have no serologic proof of immunity, prior vaccination or history of varicella disease (chickenpox). Two doses of varicella vaccine, four weeks apart
Influenza	Appropriate dose of vaccine which confers protection from the current circulating epidemic strain must be given, as and when available, and recommendations by the Government of India must be followed

8. Collection and Transport of Specimens for Microbiological Investigations

Specific rules for the collection of material vary, depending upon the source of the specimen.

8 a. Collection, Transport and Storage Guidelines

- Specimens should be collected in the acute phase of infection.
- Make every effort to obtain specimens prior to the initiation of antimicrobial therapy.

- Wear gloves, gowns, masks and/or goggles, when appropriate, when collecting specimens from sterile sites.
- Use strict aseptic technique.
- Provide proper instructions to the patient when he himself has to collect the sample, for example, urine, faeces or sputum. In the case of sputum, the patient should be advised to collect a well coughed up, preferably early morning sample, directly into the container so that a thick, viscous sample is obtained, with minimal contamination of saliva.
- Obtain specimens from normally sterile sites, taking care to minimise contamination by the normal colonising flora of the skin or mucous membranes.
- Collect an adequate volume of specimen. In the case of fluid specimens, never fill the container to the brim, to prevent overflow and soiling of the outside of the container; send tissue or fluid whenever possible, rather than submitting a specimen collected on a swab.
- In the past, cotton swabs were used to collect specimens. Currently, calcium alginate swabs are preferred. In some situations, charcoal-coated swabs (for example, when culturing for *Neisseria gonorrhoeae*) may be used.
- Label all specimen containers with identifying information about the patient (name and hospital number) and the specimen source, date and time of collection.
- Fill out all requisition slips completely and precisely, including requested details on patient history, antimicrobial therapy and specimen source, so that the laboratory can best determine the appropriate method for processing the specimen.
- Notify the laboratory in advance if special tests are requested or if unusual pathogens, including potential agents of bioterrorism, are suspected.
- Place biohazard labels on specimens from patients suspected of having highly contagious diseases and notify the laboratory supervisor.

Transport all specimens to the laboratory as soon as possible. Specimens must be sent to the microbiology laboratory in sterile, leak-proof containers in sealed plastic bags. Material collected in a syringe (for example, paracentesis, joint aspirate, needle drainage of abscess) should be aseptically transferred to another sterile container prior to transport.

If the specimens cannot be transported immediately to the laboratory, then urine, exudate, fluids, throat swab, ear and nasal swab, sputum, bronchoalveolar lavage, for culture and blood for

serological testing can be refrigerated at 4 °C (except for cold agglutination and complement detection), while blood culture bottles and CSF can be left at room temperature.

8 b. Specific Procedures for the Collection of Specimens

From the Skin

1. The area of the skin from which the specimen is to be collected is first cleaned with soap and water. Avoid using antiseptics or topical antibiotics as these may suppress the growth of pathogens, thereby defeating the very purpose for which the specimen is being collected.

2. Swabs are firmly rubbed over the affected skin and sent at once to the laboratory for processing. Only swabs which have been moistened in sterile nutrient broth or saline should be used; dry swabs should never be used.

3. Crusts or scabs, if present, are collected aseptically in a sterile bottle. If a viral infection is suspected, crusts, scabs and vesicle fluid (in capillary tubes) are collected. If a fungal lesion is suspected, infected hairs and nails as well as scrapings from the affected part of the skin should be collected.

From the Upper Respiratory Tract

1. Oral cavity : Swabs are rubbed firmly over ulcerated or patch-like lesions.

2. Anterior nares :

- If pus is present, collect this on swabs.
- If no pus is present, moisten swabs and then swab the anterior nares.

3. Throat : The mouth is held wide open and the tongue depressed. Swabs are firmly rubbed over the tonsils and pharyngeal mucosa; an attempt should be made to collect any purulent material that is present.

4. Paranasal sinuses : If pus is present in these sinuses, it is collected on swabs or aspirated with a syringe and needle. If a viral infection is suspected :

- Paranasal aspiration of nasopharyngeal fluid can be done using a fine plastic tube.
- Swabs from the anterior nares and throat for culture of viruses can also be obtained.

From the Lower Respiratory Tract

1. Commonly, only sputum is collected. This should be coughed up from far down the bronchial tree and expectorated immediately and *should not be mixed* with saliva or oropharyngeal secretions; deliver to the laboratory as soon as possible. Culture of sputum will yield relevant results only if the sputum has been collected from the infected site and not been contaminated with oral flora.
2. An even better specimen is material that is aspirated directly from the bronchi or trachea. This is collected by using a flexible fiberoptic bronchoscope. An alternative is to collect bronchial washings. These procedures are not suitable for routine use since they need to be performed by an experienced pulmonologist or cardiothoracic surgeon.
3. In children who are too young to expectorate sputum, the causative organisms of bronchopulmonary infections can sometimes be recovered in swabs or aspirates from the nasopharynx. Alternatively, a laryngeal swab or gastric juice sample can be collected from children or patients who are unable to cough up a suitable sputum sample.

From the Gastrointestinal Tract

1. Faeces are collected in a sterile, wide-mouthed leak-proof container. If the faeces are semisolid (formed), a small quantity is sufficient; if liquid, as in the case of cholera, it should fill a third of the specimen container.
2. In young children and other patients from whom it may be difficult to collect a faecal specimen:
 - Fresh faeces may be collected by gently inserting a short catheter (10–15 cm in length and 6.8 mm in diameter) into the rectum.
 - A rectal swab is not satisfactory and should not be submitted.
3. In suspected parasitic infestations :
 - Segments of tapeworm may be easily seen in a faeces specimen, facilitating identification of the tapeworm involved. To ensure complete elimination of the infecting tapeworm, however, the head should be dislodged. This should be checked for in every specimen collected after treatment.

• The ova of many intestinal worms can be seen only microscopically; a fresh specimen of faeces should be sent to the laboratory in a suitable container for this purpose.

• Threadworms (*Enterobius vermicularis*) lay their ova on the perianal skin; swabs or cellotape mounts are pressed firmly on the perianal area, the material is transferred to microscope slides, and viewed under the microscope to establish the diagnosis.

• In suspected infestations due to amoebae, faecal specimens are sent to the laboratory as soon as they are passed and examined immediately; this is to ensure that the free-living motile forms of *Entamoeba histolytica* (which causes amoebic dysentery) are detected.

From the Urinary Tract

1. In suspected urinary tract infection due to Gram-negative bacilli : Contamination of the urine by bacteria colonising the distal parts of the urethra and the perineum is prevented by a clean-catch technique. Here, the periurethral area (tip of penis, labial folds, vulva) is carefully cleaned twice with soap and water; the soap is rinsed off with warm water and the prepuce or labial folds are then retracted. The urethra is flushed by voiding the first portion of the urine, which is discarded. The subsequent midstream urine, collected directly into a sterile container, is used for culture and colony counting. This is a mid-stream clean-catch urine specimen. It is absolutely essential for culture purposes that urine be processed within **1 hour of collection** or be stored in a refrigerator at 4 °C till it can be cultured.
2. In suspected urinary tract infection due to *Mycobacterium tuberculosis* : The entire quantity of a first (morning) urine specimen is collected since this is likely to be the most concentrated. This process is repeated for **three consecutive days**.

From the Genital Tract

In suspected infections due to *Neisseria gonorrhoeae*

- In women : The best specimen is a cervical (not a high vaginal) swab. A sterile bivalve speculum is moistened with warm water (not with antiseptic lubricants) and inserted into the vagina. The cervical mucus plug is removed with a cotton ball and forceps; the external surface of the cervix is then cleaned with a large cotton swab. Endocervical exudate may be collected by gently compressing the cervix between the speculum blades;

an alternative is to insert a sterile alginate or cotton-tipped applicator into the endocervical canal and to use a rotating movement to force exudates from the endocervical glands.

- Since gonococcal infection of the anal canal is also common in women, specimens should also be collected from the anus, especially when the cervical culture is negative. An alginate or cotton-tipped applicator approximately 11 inches long is carefully inserted into the anal canal and moved from side to side to obtain material from the crypts. If possible, material should be obtained under direct viewing at anoscopy. Discard the swab if faecal material is present.
- In special situations, where a cervical specimen is not indicated (for example, in children or hysterectomised patients), swabs may be collected from the urethra or vagina.
- In men : If the patient has a purulent urethral exudate, culture is not necessary; a Gram-stained direct smear suffices for clinical diagnosis of gonorrhoea if intracellular Gram-negative diplococci are seen (the smear is made by gently spreading the material on the slide to preserve cell morphology).
- If the patient is asymptomatic, culture must be performed. A 2 cm-long, thin calcium alginate urethrogenital swab (moistened with sterile water) is inserted into the urethra, gently rotated, removed from the urethra and then immediately inoculated onto plates.
- In men, uncentrifuged first-voided urine (10–20 ml) may be cultured for *N. gonorrhoeae*; the results compare favourably with those from urethral swab cultures.
- If material from other sites (throat swabs, freshly voided urine, joint fluid, eye swabs) is sent for gonococcal culture, inoculate the swab or sediments from centrifuged fluids onto the appropriate media.
- **In suspected infections due to *Treponema pallidum*:**
- Since *T pallidum* cannot be isolated in culture, material is collected from the lesion for direct microscopic examination, or else serological diagnosis is relied on.

From the Central Nervous system

- In infections suspected to be due to bacteria, fungi or protozoa: The specimen of choice is cerebrospinal fluid (CSF), which is usually collected by lumbar puncture. The dural sheath is pierced by a needle and CSF is allowed to drip from it into a sterile container. It

is essential to avoid introducing organisms either into the subdural space or into the specimen. Therefore, the procedure should be viewed as a minor surgical operation. The technique should be rigorously aseptic and the skin must be properly disinfected, with povidone-iodine.

- In a suspected viral infection : CSF, nose and throat swabs (and also faeces, if an enterovirus is suspected) are collected and used for viral culture.

From the Bloodstream

Blood is collected by a strict aseptic technique and care should be taken to avoid introducing organisms into the bloodstream as well as to prevent contamination of the specimen by the normal flora of the skin.

The vein from which the blood is to be taken should first be clearly seen and then distended by means of a tourniquet. The skin overlying the vein is then vigorously wiped with soap and water, starting from the centre and proceeding outwards. After this, the area is painted with povidone-iodine. Once the area is dry, the specimen is collected using a perfectly dry, sterile syringe and needle (preferably disposable). The blood specimen is directly inoculated into the medium in the 'blood culture bottle' after cleaning the bottle top with spirit. The blood specimen is preferably collected at the onset of fever, at which time the organisms are likely to be present in the blood stream and definitely prior to antimicrobial therapy. Where fever is intermittent, blood samples should be drawn for culture on more than one occasion.

From the Pleural and Peritoneal Cavities

These cavities are normally sterile. Hence, specimens have to be collected from these sites as carefully as for CSF and blood specimens.

From Abscesses, Wounds and Sinuses

1. Pus, if present in a large amount, should preferably be collected in a sterile bottle/test tube.
2. Pus sent on swabs tends to dry up quickly; pus swabs are totally unsuitable for the cultivation of anaerobic bacteria and tubercle bacilli.

3. A small piece of the wall of an abscess or a sinus is also a good specimen. The skin over the abscess should be cleaned with soap and water and not with an antiseptic. One should carefully avoid introducing commensals from the area into the pus specimen as these may be mistaken for pathogens.

From the Conjunctiva, Lid Margins, Cornea and Intraocular Structures

1. Material from the lid margin is collected by firmly rubbing a pre-moistened swab from the medial canthus to the lateral canthus (inferior lid margin) and then lateral to medial (superior lid margin). The swab is at once inoculated onto appropriate culture media.
2. Any visible purulent conjunctival discharge is collected on a swab and inoculated at once. If pus discharge is not present, smears can be made and culture media inoculated with material taken directly from the conjunctival surface by a sterile bacteriological loop (made of platinum, not of nichrome wire, because the latter is liable to injure the conjunctiva). Material for chlamydia culture should be sent in an appropriate transport medium. Conjunctival swabs for virology should be sent in a virus transport medium, together with a throat swab if adenovirus infection is suspected.
3. If the patient is suffering from a corneal ulcer, material is obtained from the base and edges of the ulcer by using a sterile blade or spatula; this material is at once inoculated onto appropriate bacterial and fungal culture media. Smears are made for staining by various methods.
4. If the patient is suffering from endophthalmitis or other intraocular lesions, material is aspirated from the vitreous or aqueous humour by a sterile syringe and needle, and processed as appropriate.

From the Ear

1. A swab can be used to collect material from the external ear, for example, from the otitis externa or from the otitis media that is discharging through a perforated eardrum.
2. In the absence of perforation, fluid may be present in the infected middle ear. However, this is not to be aspirated, as treatment can be based on probabilities.

3. Despite the communication between the healthy middle ear and the nasopharynx via the eustachian tube, swabbing of the nasopharynx does not help in determining the probable pathogens in otitis media.

Processing of Specimens

Once the appropriate specimens have been collected, they are processed as quickly as possible to ensure that the organisms do not die before being transferred to the culture media, and that the reports are available at the earliest. Generally, material is placed on slides, stained appropriately, and then examined under the microscope. If bacteria and fungi are swiftly detected, specific therapy can be started at once. Material is also inoculated onto appropriate culture media.

9. Biomedical waste management

Proper disposal of hospital waste is part of hospital infection prevention measures. Apart from its being a mandatory legal requirement, strict adherence to the Biomedical Waste Management Rules by the Government of India is a duty that should be carried out to protect the health and well-being, not only of the patients and staff of the hospitals, but also of the public at large, for the first rule in Medicine – **First, do no harm**.

9a. Waste generated in hospitals :

Biomedical or hospital waste means any waste generated during health care, research, testing or related procedures on human beings or animals conducted in hospitals, clinics, laboratories or similar establishments. This is far more dangerous and offensive than domestic waste. It contains infectious or other hazardous materials that may injure, infect or otherwise harm patients, visitors, hospital personnel and the public at large in several ways. Biomedical waste if kept untreated would ferment, attract flies and other insects, birds and animals, making the place filthy and unhygienic. It contains ‘sharps’ such as needles or broken glass that can cause injury and infection. Discarded waste attracts rag-pickers who may repack disposables or drugs and sell them. The waste may contain harmful chemicals and radioactive materials. Liquid waste can spread, deep into soil and contaminate wells and tanks, polluting them. Unless carefully managed, biomedical waste can be serious pollutants of soil, water and air.

Waste management should be conducted in coordination with the infection control team. Regardless of where waste is generated (e.g. isolation rooms/patient versus routine patient-care areas), the principles of determining whether it is to be treated as clinical or general waste remain the same.

9b. Quantity and types of biomedical waste

The amount of waste generated in hospitals under Indian conditions has been estimated as 1–2 kg per bed per day. This is composed of different types of waste, not all of which is infectious. On an average about 85 per cent is harmless and 15 per cent hazardous.

Harmless waste : paper, cardboard, cartons, flowers and ordinary office or kitchen waste akin to domestic waste.

Infectious waste : Carry and transmit any type of pathogenic microbes. This includes human tissues removed at biopsy, surgery or autopsy, placenta and other products of conception, any pathological fluid or discharges, dressing, swabs and other soiled items, laboratory samples sent for microbiology, pathology and biochemical tests, all microbial cultures, used syringe needles, used scalpel blades and other sharps.

Non-infectious hazardous : Chemical (toxic, corrosive, inflammable, reactive and otherwise injurious), radioactive (the handling and management of which are under the direction of the Bhabha Atomic Research Centre, Mumbai) or pharmacological (surplus or time-expired drugs).

The objectives of bio waste management are to prevent harm resulting from waste, minimise its volume, retrieve reusable materials, and ensure safe and economical disposal.

Steps in the management of hospital waste include :

- generation,
- segregation/separation,
- collection,
- transportation, storage,
- treatment,
- final disposal.

Waste management practices must meet national and local requirements; the following principles are recommended as a general guide

9c. Principles of waste management

- Develop a waste management plan that is based on an assessment of the current situation and which minimizes the amount of waste generated.
- Segregate clinical (infectious) waste from non-clinical waste in dedicated containers.
- Transport waste in a dedicated trolley.
- Store waste in specified areas with restricted access.
- Collect and store sharps in sharps containers. Sharps containers should be made of plastic or metal and have a lid that can be closed. They should be marked with the appropriate label or logo, e.g. a biohazard symbol for clinical (infectious) waste.
- Mark the storage areas with a biohazard symbol.
- Ensure that the carts or trolleys used for the transport of segregated waste collection are not used for any other purpose – they should be cleaned regularly.
- Identify a storage area for waste prior to treatment or being taken to final disposal area.

9d. Treatment of hazardous and clinical/infectious waste

Each health care facility should identify a method for the treatment of clinical /infectious waste. This may consist of transportation of infectious waste to a centralized waste treatment facility or on-site treatment of waste.

9e. Methods of disposal

Several methods of waste treatment are available and the choice of methods is based on the item of waste and the facilities available. The place of final disposal may be in the premises or preferably away from crowded areas.

Land filling : There are two types of land used for the disposal of waste – open dumps and sanitary landfills. Health care waste should not be deposited on or around open dumps. The risk of either people or animals coming into contact with infectious pathogens is obvious. Sanitary landfills are designed to have at least four advantages over open dumps – geological isolation of waste from the environment, appropriate engineering preparation before the site is ready to accept waste, staff present on site to control operation and organized deposit and daily coverage of waste.

Chemical disinfection : This is a very useful method for many items, particularly in small places

like clinics. It is also an important preliminary process before final treatment with some materials. For example, contaminated materials like sputum or pus are to be disinfected before being buried or autoclaved.

Deep burial : Where large areas of uninhabited land are available, this is convenient. Materials after chemical disinfection are put in deep trenches, covered with lime and filled with soil. This is a safe method for the disposal of sharp objects too.

Incineration : This is a safe method of treating large solid infectious waste, particularly anatomy waste and amputated limbs, and the like. The incinerator subjects them to very high heat, converting them to ash, which would be only about a tenth of the original volume. However, it is expensive and is generally used only by very large establishments.

Autoclaving : This is widely used in laboratories and clinics for treating infectious waste before disposal, called decontamination.

Shredder : Infected plastics are first autoclaved and then recycled.

Liquid waste : Pathological, chemical and toxic liquid waste should be appropriately treated with disinfectants or reagents and neutralised before flushing into the sewer.

Radioactive waste (should be dealt with according to national laws). For further details please refer to WHO's *Safe management of wastes from health-care activities* (1999) at: http://www.who.int/water_sanitation_health/medicalwaste/wastemanag/en/

9f. Management of blood and body substance spills

Prompt removal of spots and spills of blood and body substance followed by cleaning and disinfection of the area contaminated is a sound infection control practice and meets occupational health and safety requirements. Process of spills management and strategies for decontaminating spills of blood and other body substances (e.g. vomit, urine) differ based on the setting in which they occur and the volume of the spill :

- in patient-care areas, health care workers can manage small spills by cleaning with detergent solution
- for spills containing large amounts of blood or other body substances, workers should contain and confine the spill by :

- removing visible organic matter with absorbent material (e.g. disposable paper towels)
- removing any broken glass or sharp material with forceps
- soaking up excess liquid using an absorbent clumping agent (e.g. absorbent granules).

Appropriate PPE should be worn at all times. If spillage has occurred on soft furnishings, a detergent solution can be used to clean the area thoroughly. Do not clean soft furnishings with a disinfectant such as sodium hypochlorite. Soft furnishings can also be wet vacuumed. Following cleaning of soft furnishings, every effort must be made to air the room to allow drying of the furnishing before reuse. Alcohol solutions should not be used to clean spillages (HPS 2006).

Management of types of spills

Spot cleaning

- Select appropriate PPE
- Wipe up spot immediately with a damp cloth, tissue or paper towel
- Discard contaminated materials
- Perform hand hygiene

Small spills (up to 10 cm diameter)

- Select appropriate PPE
- Wipe up spill immediately with absorbent material
- Place contaminated absorbent material into impervious container or plastic bag for disposal
- Clean the area with warm detergent solution, using disposable cloth or sponge
- Wipe the area with sodium hypochlorite and allow to dry
- Perform hand hygiene

Large spills (greater than 10 cm diameter)

- Select appropriate PPE
- Cover area of the spill with an absorbent clumping agent and allow to absorb

- Use disposable scraper and pan to scoop up absorbent material and any unabsorbed blood or body substances
- Place all contaminated items into impervious container or plastic bag for disposal
- Discard contaminated materials
- Mop the area with detergent solution
- Wipe the area with sodium hypochlorite and allow to dry
- Perform hand hygiene

The use of sodium hypochlorite is not necessary for routinely managing spills but it may be used in specific circumstances. There is evidence supporting the use of sodium hypochlorite to inactivate various bloodborne and gastrointestinal viruses, and bacteria such as *C. difficile* (HPS 2008). The consideration to use sodium hypochlorite should be based on risk assessment of the environment, the spill, risk of transmission of disease, and the surface area and potential hazards with using the product. If a disinfectant is required, particularly during the implementation of transmission-based precautions, a TGA-registered hospital grade disinfectant must be used. The disinfectant chosen should have label claims against the organism of concern.

Spill kit

A spill kit should be readily available in each clinical area and should include a scoop and scraper, single-use gloves, protective apron, surgical mask and eye protection, absorbent agent, clinical waste bags and ties, and detergent. All parts should be disposable to ensure that cross contamination does not occur.

10. Cleaning, disinfection and sterilization

10a. Cleaning

Prior to any reprocessing to achieve disinfection or sterility all instruments and equipment **MUST** be cleaned. If not cleaned properly, organic matter may prevent the disinfectant or sterilant from having contact with the instrument/equipment and may also bind and inactivate the chemical activity of the disinfectant. If an instrument/equipment is unable to be cleaned then it is unable to be sterilized or disinfected. After an instrument has been used, prior to it drying, it

should be washed to remove any gross soiling. At this stage, detergent and water is appropriate to use. There are four main methods used for cleaning of instruments and equipment :

Manual cleaning

All surfaces of the instrument/equipment must be cleaned taking care to reach all channels and bores of the instrument. If instruments are being washed manually the following procedure should be followed : wear personal protective equipment (plastic apron, thick rubber gloves, eye protection, surgical mask and/or face shield),

- remove any gross soiling on the instrument by rinsing in tepid water (15-18 degrees)
- take instrument apart – fully and immerse all parts in warm water with a biodegradable, non-corrosive, nonabrasive, low foaming and free rinsing detergent or use an enzymatic cleaner if necessary
- ensure all visible soil is removed from the instrument – follow manufacturers' instructions
- rinse in hot water (unless contraindicated)
- dry the instrument either in a drying cabinet, or hand dry with clean lint-free cloth
- inspect to ensure the instrument is clean

Enzymatic cleaners

Used for fiberoptic instruments and accessories, and other items those are difficult to clean. These products are hazardous and care should be taken when in contact with them.

Ultrasonic cleaners and automated washers

Ultrasonic cleaners and automated washers are recommended for cleaning basic instruments that can withstand this process. Using a machine to wash the instruments will cut down on the handling of the instruments. These cleaners must be compliant with national guidelines and standards, and must be used according to the manufacturers' instructions. Ultrasonic cleaners do not disinfect the instruments. By causing high frequency, high-energy soundwaves to hit the instrument/equipment, the soiling matter drops off the instrument, or becomes easy to remove during the rinsing process. These cleaners are not appropriate for use on cannulated instruments

(they cannot clean inside the instrument), plastic materials, two or more different metals, or some glass instruments, syringes and lenses. Daily efficiency tests should be done.

10b. Disinfection

Disinfection removes micro-organisms without complete sterilization. Disinfection is used to destroy organisms present on delicate or heat-sensitive instruments which cannot be sterilized or when single use items are not available. Disinfection is not a sterilizing process and must not be used as a convenient substitute for sterilization. Thermal disinfection is not appropriate for instruments that will be used in critical sites as these instruments must be sterile. Certain products and processes will provide different levels of disinfection. These levels are classified as:

(a) High-level disinfection : Destroys all micro-organisms except some bacterial spores (especially if there is heavy contamination).

(b) Intermediate disinfection : Inactivates *Mycobacterium tuberculosis*, vegetative bacteria, most viruses and most fungi, but does not always kill bacterial spores.

(c) Low-level disinfection : Can kill most bacteria, some viruses and some fungi, but cannot be relied on to kill more resistant bacteria such as *M. tuberculosis* or bacterial spores.

The two methods of achieving disinfection are thermal and chemical disinfection.

Thermal disinfection (pasteurization)

If an instrument is able to withstand the process of heat and moisture and is not required to be sterile, then thermal disinfection is appropriate. By using heat and water at temperatures that destroy pathogenic, vegetative agents, this is a very efficient method of disinfection. The level of disinfection depends on the water temperature and the duration the instrument is exposed to that temperature.

Chemical disinfection

The performance of chemical disinfectants is dependent on a number of factors including : temperature, contact time, concentration, pH, presence of organic or inorganic matter and the numbers and resistance of the initial bioburden on a surface. Instrument grade disinfectants are classified as high, intermediate or low level. When used according to the manufacturers' guidelines, disinfectants will fall into one of these levels.

Selection of disinfectant

There is no single ideal disinfectant. Different grades of disinfectants are used for different purposes. Only instrument grade disinfectants are suitable to use on medical instruments and equipment. Hospital grade or household grade disinfectants must not be used on instruments, they are only suitable for environmental purposes. Monitoring of the disinfectant is important if it is a multi-use solution. It is important that it is stored correctly and according to the manufacturer's instructions. Be sure not to contaminate the solution when pouring out for use.

Glutaraldehyde is generally the most appropriate chemical disinfectant that will provide high-level disinfection. This chemical must be used under very strict controlled conditions and in a safe working environment. Glutaraldehyde 2% is an appropriate high level disinfectant for endoscopes, respiratory therapy equipment and for material that is destroyed by heat. An immersion time of > 20 min is required. Flexible endoscopes are very easy to damage and particularly difficult to disinfect. It is extremely important that meticulous mechanical cleaning must always precede sterilization or disinfection procedures. For the selection of disinfectants see APIC Guidelines for selection and use of disinfectants (1996).

Table 13 : Characteristics of the main disinfectant groups

Disinfectants	Bactericidal activity	Tuberculocidal activity	Fungicidal activity	Virucidal activity	Sporicidal activity	Local human toxicity	Applications
Alcohol	Very active	Very active	Very active	Very active	Not active	Moderate	<ul style="list-style-type: none"> • Skin antisepsis • Disinfection of small surfaces
Chlorhexidine	Less active against Gram-negative bacilli	Not active	Less active	Not active	Not active	Low	<ul style="list-style-type: none"> • Skin and wound Antisepsis
Chlorine compounds (chloramine, hypochlorite)	Very active	Active	Active	Very active	Less active	Moderate	<ul style="list-style-type: none"> • Skin and wound Antisepsis • Water treatment • Surface Disinfection
Formaldehyde	Very active	Very active	Very active	Very active	Less active	High	<ul style="list-style-type: none"> • Disinfection of inanimate objects and surfaces
Glutaraldehyde	Very active	Very active	Very active	Very active	Very active	High	<ul style="list-style-type: none"> • Disinfection of inanimate objects

Hydrogen Peroxide	Less active against staphylococci and enterococci	Active	Active	Active	Less active	Low	• Wound antiseptics
Iodophore	Active	Active	Less active	Active	Not active	Moderate	• Skin and wound Antisepsis
Peracetic acid	Very active	Active	Active	Active	Active	High	• Disinfection of inanimate objects
Phenolic compounds	Very active	Very active	Very active	Less active	Not active	High	• Disinfection of inanimate objects and surfaces
Quaternary Ammonium compounds	Less active against Gram-negative bacilli	Not active	Less active	Less active	Not active	Low	• In combination with other compounds

10c. Sterilization

Sterilization is the destruction of all micro-organisms and can be achieved by either physical or chemical methods. Sterilization is necessary for medical devices penetrating sterile body sites. Cleaning to remove visible soiling in reusable equipment should always precede sterilization. All materials must be wrapped before sterilization. Only wrapped/packed sterilized materials should be described as sterile. Before any instrument or equipment goes under the process of steam sterilization, the following should be checked :

- Ensure that the instrument can withstand the process (e.g. steam under pressure),
- Ensure that the instrument has been adequately cleaned,
- Ensure that the instrument does not require any special treatment,
- Ensure that records of the sterilisation process and for the traceability of instruments are kept.

The below mentioned sterilizing methods are designed to give a sterility assurance level of at least one in a million or 10^{-6} as long as the process is validated and is according to the manufacturers' guidelines. Ultraviolet light units, incubators, microwave ovens and domestic ovens must not be used for sterilizing.

Steam under pressure (moist heat) sterilization

This is the most efficient and reliable method to achieve sterility of instruments and equipment. This method sterilizes and dries the sterile packages as part of the cycle. This is recommended in office-based practice. There are several types of steam under pressure sterilizers (also called autoclaves) :

- Downward (gravity) displacement sterilizers (jacketed and non-jacketed) - these are designed for the sterilisation of waste, solutions and instruments.
- Self-contained (benchtop) sterilizers – these are recommended for office based practice as they are able to do small quantities or fairly simple items.
- Benchtop sterilizers do not take wrapped items and therefore items must be used immediately after they are removed from the sterilizer. There will be differences in the models and types of features that are offered may vary. These variations may include : drying stage, ability to take packaged and unwrapped items, systems to monitor temperature, pressure and holding time.
- Prevacuum (porous load) sterilizers – these are not suited for liquid sterilisation but are optimised for sterilisation of clean instruments, gowns, drapes, towelling and other dry materials required for surgery.

Dry heat sterilization

Dry heat sterilisation is caused by hot air that destroys pathogens by the process of oxidation. Dry heat sterilizers have had limited value because it is difficult to maintain the same temperature throughout the load, while the high temperatures and long time required to achieve sterility makes this method undesirable for many situations. The manufacturers' instructions must be followed and the door to the unit must not be opened while in sterilizing cycle.

Ethylene Oxide (EO)

Ethylene oxide gas is appropriate to use for sterilization of instruments/equipment made from heat labile materials or those devices that contain electronic components. The time required to process the instrument is dependent on the temperature, humidity and concentration level of the gas. The gas must penetrate the packaging and reach all surfaces of the instrument/equipment requiring sterilization. The time for such a process is between 12 hours to over 24 hours. Because

EO is toxic, this gas is restricted in health care facilities and must be used according to strict guidelines to ensure staff safety. The manufacturer's instructions must be followed for the packaging, sterilization process, validation and aeration process.

Automated chemical (low temperature) systems

Hydrogen peroxide plasma in a fully automated cycle can achieve low temperature, low moisture sterilization within a 45-80 minute cycle depending on the model of sterilizer used. The packaging used must be nonwoven/non-cellulose polypropylene wraps. Peracetic acid is a low-temperature sterilization method. Peracetic acid 0.2% is placed in an environmentally sealed chamber and fully automated processing system. The process achieves moist, low temperature sterilization within 25-30 minutes.

Irradiation

Gamma radiation is available from some commercial gamma irradiation facilities. However, it is not readily available for use in health care facilities. Only those instruments and equipment that have undergone the entire sterilizing process can be regarded as sterile. Items must be wrapped or packaged appropriately to be considered sterile.

Materials for packaging include :

- Paper - this prevents contamination if it remains intact. It maintains sterility for a long period, can act as a sterile field and can also be used to wrap dirty devices after the procedure.
- Non-woven disposable textiles.
- Containers - these can be used only if they contain material intended for a single treatment procedure for a single patient.
- The end-user must check the physical integrity of the package before use.

Quality control parameters for the sterilization process which also serve as a check list for the Sterilization Department include load number, load content, temperature and time exposure record chart, physical/chemical testing, and biological testing, e.g. using *Bacillus subtilis*. Regular engineering maintenance on sterilization equipment must be performed and documented. Boiling of medical devices for reuse is not recommended since it does not

guarantee sterility. However, in certain resource-poor situations where steam sterilization is not possible, these items should be thoroughly cleaned and subjected to a cycle in a pressure cooker for 30 minutes.

11. Measures of Environmental management

A clean environment plays an important role in the prevention of hospital associated infections (HAI). Many factors, including the design of patient care areas, operating rooms, air quality, water supply and the laundry, can significantly influence the transmission of HAI.

11a. Premises/buildings

Facility design and planning should ensure :

- adequate safe water supply
- appropriate cleaning practices
- adequate floor space for beds
- adequate interbed space
- adequate hand washing facilities
- adequate ventilation for isolation rooms and high-risk areas like operation theatres, transplant units, intensive care areas, etc.
- adequate isolation facilities for airborne, droplet, contact isolation and protective environment
- regulation of traffic flow to minimize exposure of high-risk patients and facilitate patient transport
- measures to prevent exposure of patients to fungal spores during renovations
- precautions to control rodents, pests and other vectors and
- appropriate waste management facilities and practices

11b. Air

Ventilation

Ventilation systems should be designed and maintained to minimize microbial contamination. The air conditioning filters should be cleaned periodically and fans that can spread airborne pathogens should be avoided in high-risk areas. High-risk areas such as operating rooms, critical

care units and transplant units require special ventilation systems. Filtration systems (air handling units) designed to provide clean air should have high efficiency particulate air (HEPA) filters in high-risk areas. Unidirectional laminar airflow systems should be available in appropriate areas in the hospital construction. Ultraclean air is valuable in some types of cardiac surgery/neurosurgery/implant surgery theatres and transplant units. For the operating room, the critical parameters for air quality include :

- frequent maintenance/validation of efficacy of filters (in accordance with manufacturer's requirements)
- pressure gradient across the filter bed and in the operation theatre
- air changes per hour (minimum 15 air changes per hour)
- temperature should be maintained between 20°C and 22°C and humidity between 30% and 60% to inhibit bacterial multiplication
- general areas should be well ventilated if they are not air-conditioned

Special air handling for airborne precautions

Negative air pressure vented to the air is recommended for contaminated areas and is required also for isolation of patients with infections spread by the airborne route. An air-handling system providing 6-12 air changes per hour with the air being discharged outside through a filtration mechanism is recommended. Systems must be checked by engineering services to ensure they are in fact offering negative pressure rooms. An air-conditioned single room with an exhaust or a well-ventilated room are adequate options for health care facilities without “negative pressure” rooms. If an air-conditioned single room is not available as in many resource poor settings, a fan can be placed in the room to direct airflow towards an outside window. The door/s to the aisle or other rooms should be kept closed at all times.

Protective environment

A protective environment may be required for some neutropenic patients. Ultra clean unidirectional air may be required in some units such as haematology or intensive care due to the level of immunosuppression of the patients. To minimize airborne particles, air must be circulated into the room with a velocity of at least 0.25m/sec through a high efficiency particulate air (HEPA) filter. The HEPA filter removes particles to a certain defined size. If

particles 0.3 microns in diameter are removed, the air entering the room can be classified as being clean and free of bacterial contamination. Other important ways of protecting patients with severely lowered immune systems include:

- Health care workers and visitors should avoid contact with the patient if they have any infections (for example, upper respiratory tract infections or herpes simplex blisters)
- Where appropriate, staff and visitors should wear personal protective equipment to protect the patient from micro-organisms
- Do not put flowers or plants in the room
- Ensure a tidy environment
- Environmental cleaning should be done twice daily and should consist of damp dusting only – do not create aerosols
- Use strict aseptic techniques for all clinical procedures

11c. Water

The health care facility should provide safe water. If it has water storage tanks, they should be cleaned regularly and the quality of water should be sampled periodically to check for bacterial contamination.

Safe drinking water

Where safe water is not available, water is to be boiled for 5 minutes to render it safe. Alternatively, water purification units can be used. Water should be stored in a hygienic environment. Do not allow hands to enter the storage container. Dispense water from storage container by an outlet fitted with a closure device or tap. Clean the storage containers and water coolers regularly.

12. Cleaning of the hospital environment

Routine cleaning is important to ensure a clean and dust-free hospital environment. There are usually many micro-organisms present in “visible dirt”, and routine cleaning helps to eliminate this dirt. Administrative and office areas with no patient contact require normal domestic cleaning. Most patient care areas should be cleaned by wet mopping. Dry sweeping is not recommended. The use of a neutral detergent solution improves the quality of cleaning. Hot

water (80°C) is a useful and effective environmental cleaner. Bacteriological testing of the environment is not recommended unless seeking a potential source of an outbreak. Any areas visibly contaminated with blood or body fluids should be cleaned immediately with detergent and water. Isolation rooms and other areas that have patients with known transmissible infectious diseases should be cleaned with a detergent/disinfectant solution at least daily. All horizontal surfaces and all toilet areas should be cleaned daily.

General surfaces can be divided into two groups—those with minimal hand contact (e.g. floors and ceilings) and those with frequent skin contact ('frequently touched' or 'high risk' surfaces). The methods, thoroughness and frequency of cleaning and the products used are determined by risk analysis and reflected in health care facility policy. Frequently touched surfaces in patient-care areas should be cleaned using a detergent solution and more frequently than surfaces with minimal hand contact. Infection control professionals typically use a risk-assessment approach to identify frequently touched surfaces and then coordinate an appropriately thorough cleaning strategy and schedule with the housekeeping staff. When MDROs are suspected or known to be present, routine cleaning is intensified and the use of a detergent solution is followed by the use of a disinfectant so that surfaces are cleaned twice.

Cleaning schedules

The recommendations outlined for cleaning should be justified by the risk of transmission of infection within a particular healthcare facility. All organisations should have a documented cleaning schedule that outlines clear responsibilities of staff, a roster of duties and the frequency of cleaning required and the products that should be used to clean specific areas. Organisations should also facilitate job or task-specific education and training by accredited bodies for general and special cleaning of the physical environment. If cleaning is outsourced to cleaning service providers, all cleaning service delivery procedures should be documented, including details of how the cleaning service will be undertaken. The procedures must include the following :

- *Minimum cleaning frequencies and methods* : cleaning service providers are required to provide cleaning services at whatever frequencies are deemed necessary in order to meet required standards.

- *Staffing* : including rosters for full-time, part-time and relief staffing members, as well as for management and supervisory positions.
 - *Equipment* : including provision of consumable items (such as cleaning fluids and toilet paper) and facilities to be used to deliver each cleaning service.
 - *Management of the cleaning service* : how the cleaning services will be managed and controlled at the service level, including specific details of the on-site management functions.
- The risk of transmission of particular infections should be assessed and the cleaning schedule should be adjusted if a known infectious agent is present (e.g. an outbreak of *C. difficile* requires surfaces to be disinfected with sodium hypochlorite after cleaning with detergent).

Cleaning

Most hard surfaces can be adequately cleaned with warm water and detergent as per manufactures instructions. Allowing the cleaned surface to dry is an important aspect of cleaning.

Minimal touch surfaces

A detergent solution (diluted as per manufacturer's instructions) is adequate for cleaning general surfaces (e.g. floors, walls), as well as non-patient-care areas (e.g. administrative offices). Damp mopping is preferable to dry mopping for routine cleaning. Walls and blinds in patient-care areas should be cleaned with detergent solution when they are visibly dusty or soiled. Window curtains should be regularly changed in addition to being cleaned when soiled or exposed to MDROs. Sinks and washbasins should be cleaned with a detergent solution on a regular basis as set by facility policy.

Frequently touched surfaces

Surfaces that are in close proximity to the patient and frequently touched surfaces in the patient care areas should be cleaned more frequently than minimal touch surfaces. Examples include door knobs, bedrails, over-bed tables, light switches, tabletops and wall areas around the toilet in the patient's room. Frequently touched surfaces can be cleaned with a detergent solution designed for general purpose cleaning. The exact choice of detergent will depend on the nature of the surface and the likely degree of contamination. Detergent-impregnated wipes may be used

to clean single pieces of equipment and small surface areas. This method is not normally used for general ward cleaning and should not be considered a replacement for clean cloths and detergent solution.

Routine cleaning of surfaces Grade

- Clean frequently touched surfaces with detergent solution at least daily, and when visibly soiled and after every known contamination.
- Clean general surfaces and fittings when visibly soiled and immediately after spillage.

Use of disinfectants

In acute-care settings where there is uncertainty about the nature of soiling on the surface (e.g. blood or body fluid contamination versus routine dust or dirt) or the presence of MDROs (including *C. difficile*) or other infectious agents requiring transmission-based precautions (e.g. pulmonary tuberculosis) is known or suspected, surfaces should be physically cleaned with a detergent solution, followed or combined with a TGA-registered disinfectant with label claims specifying its effectiveness against specific infectious organisms. This process must involve either :

- a physical clean using detergent followed by a chemical disinfectant (2-step clean) i.e. clean with detergent, then clean with a disinfectant
- a physical clean using a detergent and chemical disinfectant (2-in-1 clean) i.e. a combined detergent/disinfectant wipe or solution could be used if this process involves mechanical/manual cleaning
- Physical (mechanical or manual) cleaning is the most important step in cleaning. Sole reliance on a disinfectant without mechanical/manual cleaning is therefore not recommended. In office-based practice and less acute patient-care areas (e.g. long-term care facilities), the risk of contamination, mode of transmission and risk to others should be used to determine whether disinfectants are required.

High-level disinfectants or liquid chemical sterilants are not appropriate for general cleaning; such use is counter to manufacturers' instructions for these hazardous chemicals. Instrument disinfectants should not be used for surface disinfection. Alcohol should not be used to disinfect

large environmental surfaces, given the risk of additional hazards such as flammability. Technologies in this area are evolving and new technologies may replace the need for cleaning chemicals and disinfectants. Some current examples include ultramicrofibre cloths and hydrogen peroxide mist. More research is needed in these areas to assess the scope of organisms removed or killed and the practical application of these technologies.

Shared clinical equipment

While shared clinical equipment comes into contact with intact skin only and is therefore unlikely to introduce infection, it can act as a vehicle by which infectious agents are transferred between patients (Microbiological Advisory Committee to the Department of Health 2006). Examples of possible contaminated surfaces on shared medical equipment include knobs or handles on haemodialysis machines, x-ray machines, instrument trolleys and dental units. Surface barriers (e.g. clear plastic wrap, bags, sheets, tubing or other materials impervious to moisture) help prevent contamination of surfaces and equipment. Surface barriers on equipment (e.g. air water syringes, bedboards, computer keyboards) need to be placed carefully to ensure that they protect the surfaces underneath and should be changed and cleaned between patients. If surface barriers are unable to be used, cleaning clinical surfaces including equipment still applies.

Quality control norms for operation theatre environment

Surgical-site infection is the leading complication of surgery. Normal skin flora of patients or healthcare workers causes more than half all infections following clean surgery, but the importance of airborne bacteria in this setting remains controversial. Modern operating theatres have conventional plenum ventilation with filtered air where particles $\geq 5 \mu\text{m}$ are removed. For orthopaedic and other implant surgery, laminar-flow systems are used with high-efficiency particulate air (HEPA) filters where particles $\geq 0.3 \mu\text{m}$ are removed. The use of ultra-clean air has been shown to reduce infection rates significantly in orthopaedic implant surgery. Few countries have set bacterial threshold limits for conventionally ventilated operating rooms, although most recommend 20 air changes per hour to obtain 50 ± 150 colony forming units/m³ of air. There are no standardized methods for bacterial air sampling or its frequency. With the use of HEPA filters

in operating theatre ventilation, there is a tendency to apply cleanroom technology standards used in industry for hospitals. These are based on measuring the presence of particles of varying sizes and numbers, and are better suited than bacterial sampling.

Table 14 : Procedures and responsibilities for quality control of operation theatre environment:

Sl. No	Procedures	Responsibility
1.	Before bringing the patient to the OT complex, the fitness of the patient for undergoing surgery should be checked.	Surgeon
2.	PAC (Pre Anaesthesia Check up) should be done before surgery and the documents should be stored.	Anaesthetist
3.	All the happenings during the surgery should be properly documented for Medico Legal Purposes.	Anaesthetist
4.	Slipper stand should be stationed at the entrance of the OT complex and any entrance in outside slippers should be prohibited.	OT In - charge Nurse
5.	OT store Consumables and other supplies like gloves, catheters, Ryles tubes, Infant feeding tubes, suction cannula, mucus extractors etc should be kept in buffer as per the load. OT store register should be maintained properly.	OT In - charge Nurse
7.	Consent Form	
	Consent form for the surgery should be obtained from the relatives of the patient. The relatives should always be counselled regarding the type of surgery and its pros and cons.	Anaesthetist
	It should be clearly mentioned on the consent form that the jewellery and other valuables of the patients have been returned to the patient attendants. The list of valuables should be clearly mentioned.	OT In charge Nurse

8.	<p>Infection Control Measures in OT</p> <p>Fumigation should be done routinely and periodically.</p> <p>Separate fumigation register should be maintained.</p> <p>Swab culture and sensitivity test of OT (OT Table/ shadowless lamp/ floor/ OT trolley/ Shelf or platform over which sterilised drums are kept) has to be done.</p> <p>Register of the same as well as documents in case of any positive growth of organism is found, should be maintained Instruments should be sterilised and arranged properly on the drug trolley for ready use.</p> <p>Cleaning of floors and other area should be done as specified in the housekeeping SOP.</p> <p>Air Conditioner should be installed inside the OT. Split AC is better than Window AC.</p> <p>Blood spills should first be covered by 1% Sodium Hypochlorite Solution/ Bleaching solution for 10 mins and then cleaned.</p> <p>Hand Hygiene: Adequate hand washing facility should be available in all patient care areas. Elbow operated taps and washbasin and soap solution should be used.</p> <p>Standard Hand washing techniques as described in Infection control and BMW management SOP should be followed.</p> <p>Cleaning of OT tables: The tables should be covered with Macintosh.</p>	OT In charge Nurse
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13. Health care -associated infection surveillance

13a. Role of surveillance in reducing HAI

Surveillance is important for wider systems of quality management, but the main purpose of collecting reliable data is to improve quality within a service or facility. Collecting such data can provide the impetus for change and make it possible to evaluate the effectiveness of an intervention. For example, monitoring both hand hygiene compliance and the rate of bloodstream

infections, and disseminating the information within the facility, can improve hand hygiene practices. Surveillance of health care-associated infections draws information about the agent, host, environment and risk factors from a number of data sources :

- provides baseline information on the frequency and type of HAI
- enables breakdowns in infection prevention and control to be identified
- allows for timely investigation and appropriate infection prevention and control measures to be instituted.

There is a surveillance cycle, described as ‘data collection – data analysis and interpretation – data dissemination’. All health care facilities, including small acute-care facilities and office practices, should collect data on health care -associated infections, infection prevention and control breaches, outbreaks of infectious disease and antibiotic resistance. Post-discharge surveillance by community-based health care practices should also be considered. The surveillance system used by a health care facility depends on the type and size of the facility, its case mix, and the resources available.

13b. Types of surveillance programs

It is not feasible to conduct facility-wide surveillance for all events; therefore surveillance is often targeted, with a focus on specific events, processes, organisms, medical devices or high-risk patient populations. Health care - associated infections surveillance programs may focus on:

- specific sites of infection (e.g. bloodstream, surgical sites)
- specific populations (e.g. neonates, health care worker occupational exposure to blood and body substances)
- specific organisms or types of organisms (e.g. MRO, *C. difficile*, RSV, rotavirus)
- specific locations in the health care facility or community (e.g. intensive care unit, neonatal intensive care unit, long-term care facility).

There are two main methods of surveillance — process and outcome. Process measurements are usually easier to measure, less ambiguous and more widely applicable than outcome indicators. Process surveillance may be an adjunct to outcome surveillance; alternatively, it can entirely replace outcome surveillance for practices or locations that have too few adverse outcomes for statistical analysis (e.g. small facilities where the number of patients at risk of infection may be too small to calculate valid infection rates).

Process surveillance

Process surveillance involves auditing practice against a certain standard, guideline or policy. As no single intervention will prevent any health care-associated infection, packages of evidence-based interventions have been developed and are increasingly being used in process surveillance (e.g. care bundles).

Process measures that are linked by evidence to important outcomes :

- do not require risk adjustment
- can predict outcomes
- can easily be acted on because potential improvements are usually the responsibility of the clinical service
- can be captured quickly
- are sensitive because many episodes of inappropriate care do not cause harm.

Examples of published process indicators of high value include :

- aseptic insertion and management of peripheral or central intravascular devices
- health care workers' compliance with hand hygiene and the techniques they used
- perioperative and intraoperative practice such as antibiotic prophylaxis, normothermia, normoglycaemia and appropriate hair removal
- health care workers' uptake of immunisation.

Outcome surveillance

Outcome surveillance involves measuring adverse events, a proportion of which are preventable. The sensitivity and specificity of event definitions and the reliability of data collection need to be considered when developing methods to detect adverse events. It is important to create a balance between avoiding false positives (specificity) and picking up true positives (sensitivity), given that true positives are rare events in the overall patient population. Certain outcome measures—for example, the incidence of health care-associated MRSA bacteraemia appear to be reliable and have driven practice change, leading to significant improvements in patient safety.

The deaths are unlikely to be reported using existing mechanisms such as adverse event reporting systems. Mortality from infection may be seen as 'anticipated' even though the occurrence of the

infection that led to the death was unanticipated. A further challenge in measuring patient deaths is differentiating between patients who die with a health care-associated infection and those who die from a health care-associated infection or suffer serious injury due to a health care-associated infection (i.e. attributable injury or death). One new approach is to evaluate such patient deaths to determine whether mortality was unexpected, and then analyse the contributing factors to determine preventable root causes that might be modified in future. In this approach, infection events (usually deaths or BSI) are considered and investigated individually. Although mandated by the UK's National Health Service, evidence of the value of this approach is lacking.

Critical incidents

If there has been a breakdown in an infection prevention and control procedure or protocol, a 'lookback' investigation may be necessary to identify, trace, recall, counsel and test patients or health care workers who may have been exposed to an infection, usually a bloodborne virus. Lookback investigations must be managed with due regard to ethical and legal considerations. In the event of such an incident (e.g. failure of sterilisation or disinfection), the local public health unit should be advised immediately. Monitoring of critical incidents and other sentinel events is an important part of surveillance. Root cause analysis of sentinel events is a structured process for identifying the process and contributing factors, exploring and identifying risk reduction strategies and implementing solutions.

13c. Data collection and management

Surveillance involves :

- defining surveyed events precisely
- systematic collection of data
- analysis and interpretation
- communication of findings to relevant people.

The following epidemiologic principles should be applied during health care-associated infection surveillance:

- use standardised definitions of infection
- use laboratory-based data (when available)

- collect epidemiologically important variables (e.g. clinical service in hospitals and other large facilities, population-specific risk factors, underlying conditions that predispose to serious adverse outcomes)
- analyse data to identify trends that may indicate increased rates of transmission
- feedback information on trends in the incidence and prevalence of health care-associated infections, probable risk factors and prevention strategies and their impact, to the appropriate health care workers, administrators, and as required by local and state/territory health authorities.

Surveillance data for quality improvement must be of high quality. The characteristics that qualify data as evidence for action include :

- representativeness — the data fairly represent the thing measured
- accuracy — the data reflect what is intended to be measured
- precision — the data and the target of measurement correspond closely
- authoritativeness — the data are appropriate for drawing a meaningful conclusion
- clarity — the data are presented in a form that the target audience can understand.

Data of this nature are more likely to arise from surveillance processes :

- that involve all stakeholders in design and implementation
- for which there are agreed organisational objectives, and processes that are relevant to the population served
- that use trained staff to collect and manage data, and that provide them with appropriate information technology support
- that use definitions of surveillance events that are unambiguous, practical, specific and can be validated
- that have reliable and practical methods for detecting events
- for which the processes that determine an outcome are thoroughly understood
- for which appropriate denominators are collected for risk adjustment
- for which reporting links measurement to prevention efforts, and meets the needs of both clinicians and managers.

13d. Outbreak investigation

An outbreak may be defined as the occurrence of infections at a rate greater than that expected within a specific geographical area and over a defined period of time. Ideally, surveillance systems should facilitate the early detection of outbreaks. Increasingly, microbiological data are being relied on for this purpose, although outbreaks may be detected using other sources such as pharmacy records. In some instances, the occurrence of an outbreak is obvious, such as in an episode of foodpoisoning that affects both health care workers and patients. It is more usual, however, for the outbreak to have an insidious onset that is not immediately apparent. When an outbreak is detected, the infection prevention and control committee should be informed and an outbreak team formed. Depending on the size and severity of the outbreak, it may be necessary to involve occupational health and safety staff, facility administrators, engineers and public health officials.

Legislation requires that the relevant public health authority be informed of outbreaks related to notifiable infections. It may also be prudent to involve public health officers at an early stage, if an outbreak is likely to come to the attention of the media. The principles for investigating outbreaks in health care facilities are the same as for community-based outbreaks. There are three basic steps:

- describing the outbreak
- developing a hypothesis
- testing the hypothesis with analytical epidemiology.

The tasks involved in any investigation can be summarised as follows:

- Confirm that an outbreak is occurring.
- Determine the background rate of infection, as a temporal cluster of cases may be due to chance alone.
- Confirm the diagnosis using microbiological methods. If possible, confirm that cases are related by typing methods (which may require reference laboratory facilities).
- Define a case, and count cases. Develop a case definition that may include clinical and laboratory data. Start with a broad definition that can be redefined later. In health care establishments, case definition can be relatively easy, with data available through

laboratory records and infection prevention and control surveillance data. Remember that cases may have been discharged from the establishment.

- Describe the data in terms of time, place and person and construct an epidemic curve. In health care facilities, age, gender and underlying disease are the most useful ‘person’ attributes to record. The location may suggest risk factors.
- Determine who is at risk of becoming ill.
- Look at changes that may have affected the rate of infection (eg new staff, new procedures, new tests, new units and health care worker : patient ratios).
- Develop a hypothesis and test it by comparison with the facts.
- Undertake analytical epidemiology, such as a case–control or retrospective cohort study, to test the hypothesis quickly. After interim control measures are in place, a larger, more systematic study may be warranted, possibly with a different analytical methodology.
- Evaluate the data and prepare a written report.
- Implement longer-term infection prevention and control measures for the prevention of similar outbreaks.

In the interests of public safety (and because of the threat of litigation), all outbreaks, however minor, should be investigated thoroughly and the outcomes of such investigations documented. All institutions should therefore have adequate resources for the detection and control of outbreaks.

13e. Disease surveillance in office-based practice

All staff members in office-based practices need to be aware of the possibility that patients will present with suspected or confirmed infectious diseases. For certain diseases, timely notification to the relevant authority will be required, sometimes by telephone. Systems need to be in place so that authorities are able to trace those with whom infectious patients have been in contact. A staff member should be responsible for checking national and state websites for relevant guidelines (RACGP 2006). In most office-based practices, there will not be enough procedures performed to undertake outcome surveillance. Process surveillance can be used to evaluate processes and procedures and to monitor sentinel events. Systems should be in place for

monitoring for threats of outbreaks (e.g. chickenpox [varicella], measles [rubeola]) and emerging diseases (e.g. H1N1, CA-MRSA).

14. Principles for use of antibiotics

1. Before starting any empiric antibiotic treatment, minimum two sets of blood cultures should be taken from different sites.
2. Prior to initiation of antibiotic therapy, appropriate specimens should be sent for gram stain and culture. Antibiotic choice must be adjusted according to culture results once they are available.
3. Antibiotic doses recommended in the various guidelines are for patients with normal renal and hepatic function only. Dose adjustments should be made for patients with renal and hepatic function.
4. Convert patients to oral antibiotics once they fulfill the IV-to-PO switch protocol criteria stated in Fig. 3.
5. Antibiotics marked with asterisk (*) are restricted to ID, Respiratory & ENT physicians only. For physicians from all other departments, please call ID physician on-call to approve the empiric use of these restricted antibiotics.

Advantages of oral therapy:

- Drug cost savings
- Ease of administration
- Early discharge opportunity
- Decreased IV-related adverse events

Antibiotics suitable for IV-to-PO conversion (Bioavailability $\geq 90\%$):

- Ciprofloxacin (~80%)
- Levofloxacin
- Moxifloxacin
- Clindamycin
- Metronidazole
- Co-trimoxazole

- Fluconazole

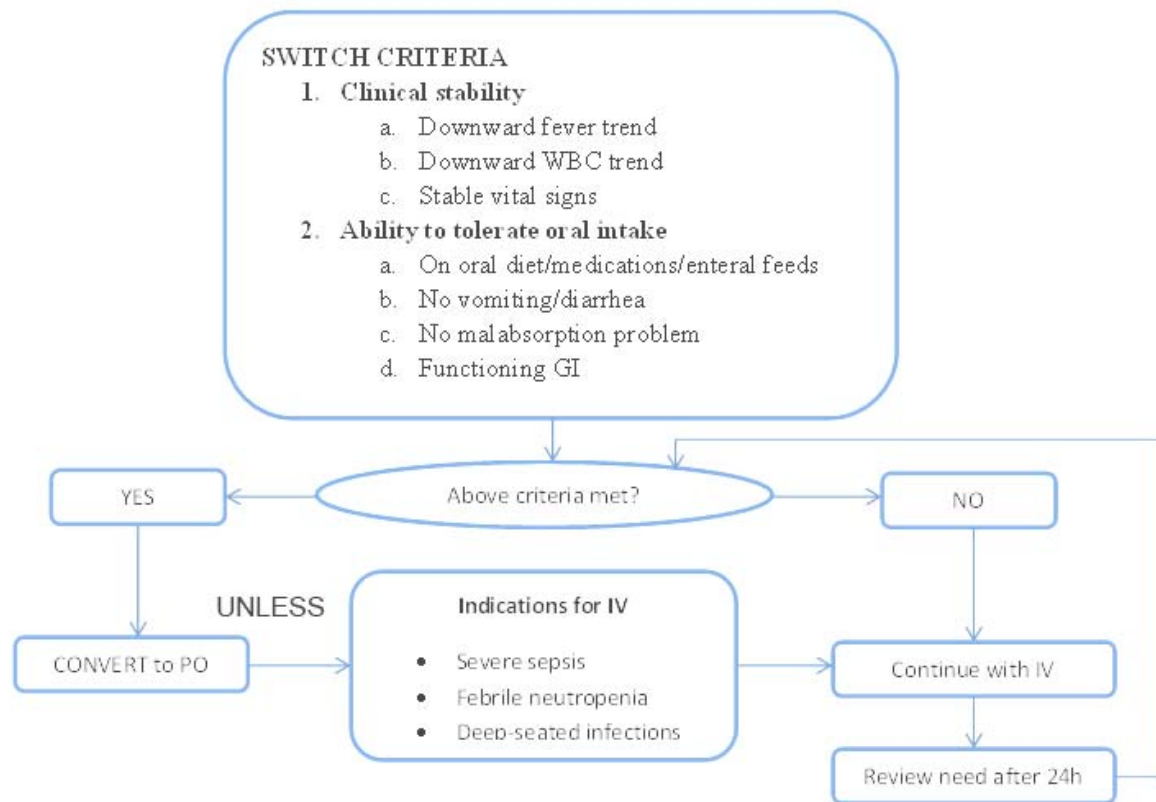


Fig 3: Intravenous-to-oral antimicrobials conversion

14a. Empiric use of carbapenems (Ertapenem should not be used for empiric therapy)

Appropriate criteria A (patients in ICU or HD) (must qualify all)

- Sepsis
AND
- Clinically unwell (drowsy/confused, saturation oxygen <92%, systolic blood pressure <90% OR
Respiratory rate >30 breaths/minute)
AND
- Onset of infection either nosocomial (>48 hours after admission) OR health care-associated

Sepsis is the systemic response to infection. In sepsis, the clinical signs describing systemic inflammatory response syndrome (SIRS) are present together with definitive evidence of infection. SIRS is defined as 2 or more of the following variables :

- Fever of more than 38 °C or less than 36 °C
- Heart rate of more than 90 beats per minute
- Respiratory rate of more than 20 breaths per minute or a PaCO₂ level of less than 32 mm Hg
- Abnormal white blood cell count (>12,000/ μ l or <4,000/ μ l or > 10% bands)

Appropriate criteria B (general ward) (must qualify all)

- a. Patients with severe nosocomial and health care-associated infections who failed to improve after 48-72 hours of empiric therapy
AND
- b. Appropriate cultures remain negative

Health care-associated infection can be defined as infection in a patient with at least one of the following risk factors:

- Hospitalization in an acute care hospital for two or more days in the last 90 days;
- Residence in a nursing home or long-term care facility in the last 90 days
- Receiving outpatient intravenous therapy (like antibiotics or chemotherapy) within the past 30 days
- Attending dialysis center in the last 30 days

Appropriate criteria C

Patients with:

- a. Febrile neutropenia
- b. Severe necrotizing pancreatitis
- c. Suspected severe melioidosis

Appropriate criteria D

Empiric therapy for nosocomial organ infection when delay in appropriate therapy could pose catastrophic risk (e.g. mediastinitis, brain abscess etc)

14b. Carbapenem definitive (culture directed) use guideline

1. Ertapenem should be used only for infections caused by ertapenem susceptible Gram negative bacteria that are resistant to other beta-lactam antibiotics or/and quinolones.
2. Meropenem/Imipenem is preferred agent for *Pseudomonas aeruginosa*, *Acinetobacter baumannii* and other Gram negative bacteria that are resistant to other beta-lactam antibiotics (including ertapenem).
3. Carbapenems can be used to treat other infections caused by Gram-negative bacteria in patients with non-severe allergy and/or intolerance to active penicillins and/or cephalosporins when isolate is resistant to other classes of antibiotics (eg. Quinolones). Antibiotic challenge should be conducted ONLY after consultation with allergy specialist. (Severe penicillin allergy is defined as bronchospasm, hypotension, angioedema, urticarial, bullous eruption and Stevens - Johnson syndrome.)
4. It is recommended that carbapenem antibiotics be endorsed by an ID physician within 48 hours of commencement and re-evaluated every 48 hours. For high end antibiotics such as colistin, tigecycline, fosfomycin, daptomycin, etc., they may be endorsed by an ID physician within 24 hours of commencement and re-evaluated every 48 hours.

14c. Considerations for use of antibiotics in pregnancy and pediatrics

Special considerations for the use of antimicrobial agents in pregnancy relate to both the mother and the fetus. In the case of the mother, increases in plasma volume and renal blood flow, especially by the third trimester, can result in more rapid clearance and lower serum levels of pharmaceutical agents, including antimicrobial agents. Higher antimicrobial doses are not routinely recommended in the third trimester of pregnancy. In the case of the developing fetus, many antimicrobial agents can be either teratogenic or otherwise toxic to the fetus. Most pediatric drug dosing is guided by weight.

Penicillins, cephalosporins, and macrolides have historically been the most commonly used antimicrobial agents considered safe in pregnancy, and a recent multicenter study of more than 13,000 women with pregnancies affected by birth defects found no association between adverse outcomes and these particular antimicrobial agents.

In pregnancy it is recommended to avoid tetracyclines, quinolones and high dose metronidazole (2g). Short-term use of trimethoprim (unless low folate status or taking another folate antagonist such as antiepileptic or proguanil) or nitrofurantoin (at term, theoretical risk of neonatal haemolysis) is unlikely to cause problems to the fetus. In general, however, human studies on the safety of many antimicrobial agents in pregnancy and lactation are limited, and antimicrobial agents should be prescribed with caution.

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