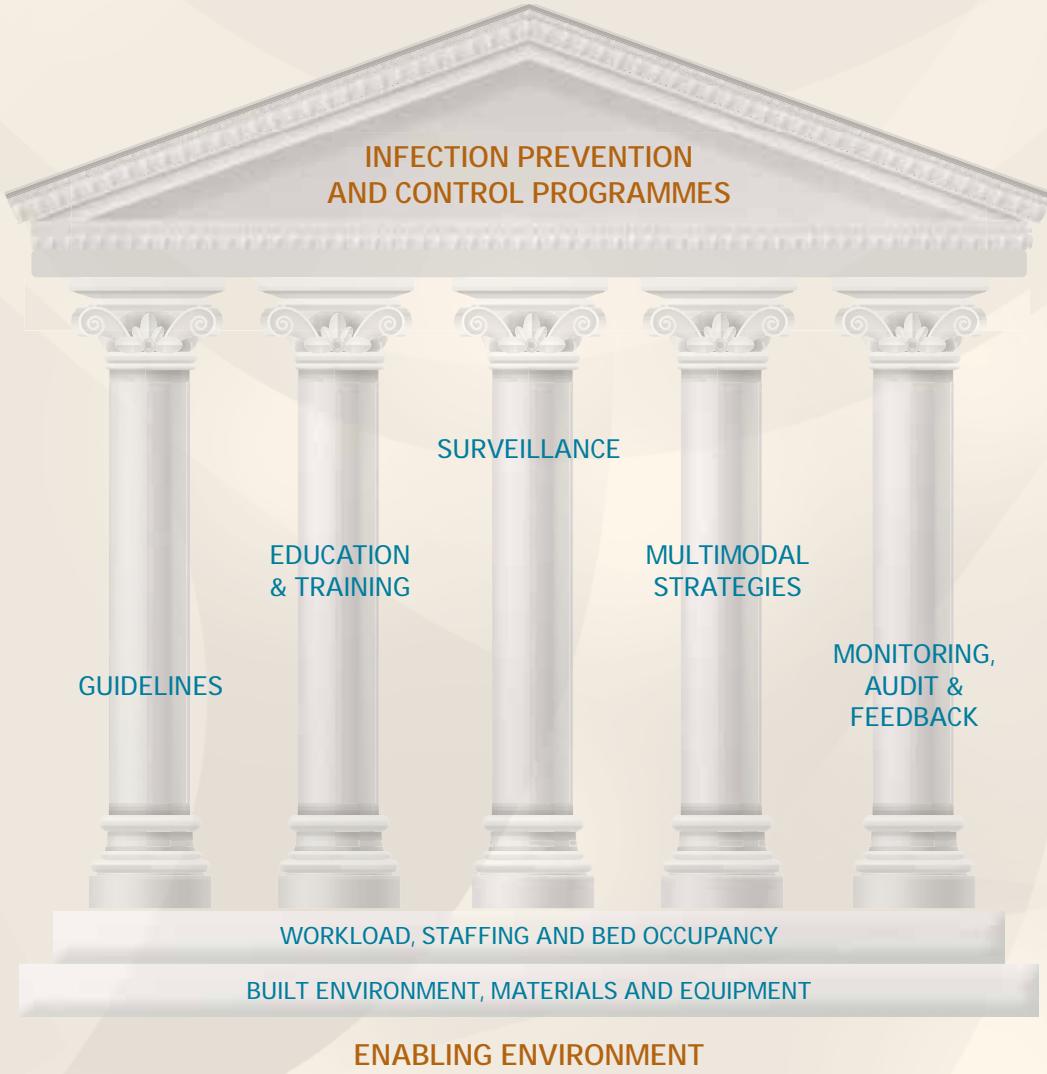




Ministry of Health and Family Welfare
Government of India

NATIONAL GUIDELINES FOR INFECTION PREVENTION AND CONTROL IN HEALTHCARE FACILITIES



National Guidelines for Infection Prevention and Control in Healthcare Facilities



National Centre for Disease Control, Directorate General of Health Services
Ministry of Health and Family Welfare, Government of India
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Message from Hon'ble Health Minister

Healthcare Associated Infections (HAI) are one of the most common adverse events in delivery of care and a major public health problem with an impact on morbidity, mortality and quality of life. At any one time, up to 7% of patients in developed and 10% in developing countries will acquire at least one HAI. These infections also present a significant economic burden for the health system.



2. However, a large percentage of HAIs are preventable through effective Infection Prevention and Control (IPC) measures. Infection prevention and control is also important to prevent the occurrence and spread of infections, thereby reducing the need for antibiotics. I congratulate the National Centre for Disease Control (NCDC) in taking the lead and developing these guidelines in collaboration with the World Health Organization (WHO) Country Office. These guidelines are intended to support hospitals and other healthcare facilities to establish their IPC protocols so as to provide safer healthcare services to the people.

3. These new National Guidelines for IPC in Healthcare Facilities will enhance patient safety and the capacity of health workers to prevent and control infections in Indian hospitals. These guidelines shall prevent current and future threats from infectious diseases such as Nipah, Ebola, and will help in strengthening health service resilience, combat antimicrobial resistance (AMR) and improve the overall quality of healthcare delivery.

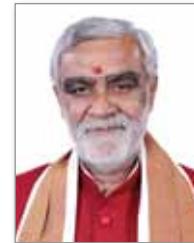
4. These guidelines are suitable for all those who are providing healthcare services, especially those who are delivering tertiary care. These can be adapted to local situations and patient profiles. I am sure that the guidelines will help in setting global standards for controlling the HAIs and will be found useful by all the stakeholders.

5. I convey my good wishes to NCDC and WHO for the release of the new guidelines and wish them all success in their future endeavours also.

(Dr HARSH VARDHAN)

Message from Minister of State for Health and Family Welfare

मैं राष्ट्रीय रोग नियंत्रण केंद्र एवं विश्व स्वास्थ्य संगठन (राष्ट्रीय कार्यालय, भारत) के सहयोग से विकसित “स्वास्थ्य देखभाल केन्द्रों में संक्रमण रोकथाम एवं नियंत्रण का राष्ट्रीय दिशा निर्देश” की स्वास्थ्य एवं परिवार कल्याण मंत्रालय, भारत सरकार की ओर से भूरि-भूरि प्रशंसा करता हूँ और इस दिशा निर्देश के प्रथम संस्करण के विकास में सम्मिलित सभी व्यक्तियों एवं संस्थाओं को साधुवाद देता हूँ।



स्वास्थ्य देखभाल सम्बन्धित संक्रमण एक प्रमुख जन स्वास्थ्य समस्या है, जिसके पूर्ण रूप से निराकरण में केन्द्र एवं राज्य सरकारों पर अतिरिक्त आर्थिक बोझ आता है। मैं अपेक्षा करता हूँ कि, यह दिशा निर्देश सम्पूर्ण भारत में “स्वास्थ्य देखभाल सम्बन्धित संक्रमण” के उचित देख-रेख में कारगर साबित होगा और खासकर तृतीयक देखभाल केन्द्रों में अत्यंत उपयोगी एवं महत्वपूर्ण होगा।

मैं आश्वस्त हूँ कि इस दिशा निर्देश के सम्पूर्ण रूप से पालन करने पर “एंटीबायटिक प्रतिरोध” में काफी हद तक कमी आएगी एवं “बीमारी दर तथा मृत्यु दर” भी कम होगा। मैं उम्मीद करता हूँ कि, यह दिशा निर्देश, उचित समयों पर संशोधित होता रहेगा एवं स्थानीय परिस्थितियों के आधार पर बदला जा सकेगा।

अंत में, मैं फिर से इस श्रेष्ठ कार्य के लिए, सभी को दिल से धन्यवाद देता हूँ, और इस श्लोक से अपना संदेश समाप्त करता हूँ।

ऊँ सर्वे भवन्तु सुखिनः
सर्वे सन्तु निरामयाः।
सर्वे भद्राणि पश्यन्तु
मा कश्छुःखभाग्भवेत।
ऊँ शान्तिः शान्तिः शान्तिः॥

(श्री अश्विनी कुमार चौबे)

Message from Secretary, Health and Family Welfare

Infection prevention and control (IPC) refers to measures aimed at preventing and controlling infections and transmission of infections in healthcare settings. Such healthcare-associated infections may be acquired in healthcare settings.

These National Guidelines on Infection Prevention and Control in Healthcare Facilities are endorsed by the Ministry of Health and Family Welfare to strengthen IPC practices in healthcare settings across the country.



This document lays down the protocols and guidance required for the practice of a nationally acceptable standard of IPC in healthcare settings. I am confident that this document will be valuable for improving the quality of services, not only because it was developed after extensive review of the relevant literature and consultation with experts, but also because its contents are realistic, practical, and designed to meet local needs.

These guidelines are aligned to the National Patient Safety Implementation Framework (2018–2025) as well as the National Action Plan on Antimicrobial Resistance. I promise the support needed from the Ministry of Health and Family Welfare in implementing these guidelines.

I request all stakeholders to ensure that these guidelines are widely implemented in healthcare facilities across the country to strengthen IPC systems thereby promoting safe healthcare practices.

(Ms PREETI SUDAN)

Message from Special Secretary, Health and Family Welfare

Healthcare-associated infections (HAI), also referred to as “nosocomial” or “hospital” infections, occur in a patient during the process of care in a hospital or other healthcare facility and were not present or incubating at the time of admission. HAI can affect patients in any type of setting where they receive care and can also appear after discharge; and include occupational infections among staff.



HAI are one of the most common adverse events in healthcare delivery and a major public health problem with an impact on morbidity, mortality and quality of life. At any one time, up to 7% of patients in developed and 10% in developing countries will acquire at least one HAI. These infections also present a significant economic burden to the society. However, a large percentage are preventable through effective infection prevention and control (IPC) measures.

This document outlines the broad principles and practices of infection control that are essential for the prevention of infection. It provides the framework to strengthen the infrastructure and human resources needed to address IPC. The Hospital Infection Control Team and Hospital Infection Control Committees are critical mechanisms to systematically address IPC in any healthcare facility. The infection control nurses are the key front-line professionals for implementing IPC in any healthcare facility. Capacity development and training to develop the skills of healthcare staff will also be crucial in implementing these guidelines.

I congratulate the National Centre for Disease Control for developing these guidelines in collaboration with the WHO Country Office for India and look forward to their implementation in all healthcare facilities in the country.

(Shri SANJEEVA KUMAR)

Message from WHO Representative to India

WHO is proud to be associated with the development of these National Guidelines for Infection Prevention Control in Healthcare Facilities, as well as the National Action Plan on Antimicrobial Resistance (NAP-AMR), National Patient Safety Implementation Framework (2018–2025) and the National Guidelines for National Patient Safety Implementation Framework – all of which identify infection prevention and control (IPC) as a strategic priority.



The first principle of patient safety is to do no harm and prevention is best! Infection control is key in prevention and is implemented through the infection prevention and control (IPC) committees in healthcare facilities. Preventing infections is at the core of public health and is also the best way to reduce the use of antimicrobials.

Hand hygiene is the simplest cost-effective intervention for preventing the spread of infections not only in healthcare facilities but also in the community. WHO launched the first Global Patient Safety Challenge – clean care is safer care – in 2005, focused on improving hand hygiene. It is also closely aligned to and can be integrated under the Government's Swachh Bharat Mission. Vaccines and the use of reuse prevention (RUP) syringes are other methods than can avert infections.

Infection control nurses are the frontline workers for IPC. WHO has designated 2020 as the "Year of the Nurse and Midwife", in honour of the 200th birth anniversary of Florence Nightingale. Nurses play an important role in the care of patients and preventing healthcare-associated infections, which includes educating the patients and their families, ensuring hand hygiene and supporting antimicrobial stewardship.

I look forward to these new guidelines being implemented in all healthcare facilities. I reiterate WHO's commitment and support for IPC and containment of antimicrobial resistance.

(Dr HENK BEKEDAM)

Message from Joint Secretary, Health and Family Welfare

Healthcare-associated infections (HAI) are one of the most common complications of healthcare management. These are serious health hazards as many are caused by serious antibiotic-resistant bacteria leading to increase in the length of hospital stay and the associated costs, and may even lead to death.



Healthcare facilities are high-risk environments for the development and spread of drug resistance and frequently have the highest burden of multidrug-resistant organisms (MDRO). Infection prevention and control (IPC) measures and practices reduce the opportunities for resistant pathogens to spread in healthcare facilities. They are therefore important in our efforts to contain antimicrobial resistance.

Standard precautions are the basics of IPC and should be observed in all health facilities. Hand hygiene, especially handwashing, is one of the simplest and cost-effective interventions to prevent infections and combat antimicrobial resistance.

Surveillance of HAI is important to assess the burden, monitor trends and develop evidence-based policies to address AMR and patient safety. Digital health and IT solutions to monitor the trends of HAI through the Integrated Health Information Portal of MoHFW will be one of our targets. Creating awareness about infections, controlling antimicrobial resistance and ensuring access to safe healthcare will need that these guidelines be implemented in letter and spirit across all healthcare facilities.

(Shri LAV AGARWAL)

Message from the Director, National Centre for Disease Control

Effective infection prevention and control is central to providing high-quality healthcare for patients and a safe working environment for those who work in healthcare settings. It is important to minimize the risk of spread of infection to patients and staff in hospitals by implementing a robust infection control programme.



Prevention of infections reduces the need to use antibiotics and thereby reduces the use of antibiotics and development of antimicrobial resistance. The National Centre for Disease Control (NCDC) is coordinating the National Programme for AMR Containment and one of the objectives of the programme is to strengthen infection prevention and control in state medical college hospitals.

This document has been meticulously prepared with inputs from various experts across India, with support from the WHO Country Office for India. The overall aim of this document is to provide evidence-based information on the prevention and control of infections in healthcare settings. It is relevant for all staff including doctors, nurses, other medical professionals and managers working in hospitals or clinics.

Surveillance of HAIs and monitoring and evaluation of HAIs in healthcare facilities is an important tool to measure the burden of HAI and we look forward to strengthening national data and information regarding HAIs to guide evidence-based policy making for safer healthcare in India.

(Dr SUJEET K. SINGH)

Acronyms

ABHR	alcohol-based hand rub
AIIMS	All India Institute of Medical Sciences
AMR	antimicrobial resistance
AMSP	Antimicrobial Stewardship Programme
ARI	acute respiratory infection
BAL	bronchoalveolar lavage
BARC	Bhabha Atomic Research Centre
BMW	biomedical waste
BSI	bloodstream infection
CAUTI	catheter-associated urinary tract infection
CDC	Centers for Disease Control and Prevention
CFU	colony-forming unit
CHG	chlorhexidine gluconate
CLABSI	central line-associated bloodstream infection
CME	continuing medical education
CMV	cytomegalovirus
CRBSI	catheter-related bloodstream infection
CRP	C-reactive protein
CSSD	central sterile supply department
CVC	central venous catheter
DGHS	Directorate General of Health Services
DVT	deep venous thrombosis
EtO	ethylene oxide
EVD	Ebola virus disease
FSSAI	Food Safety and Standards Authority of India

GBS	group B <i>Streptococcus</i>
GLP	good laboratory practices
Gol	Government of India
HAI	healthcare-associated infection
HAP	healthcare-associated pneumonia
HBV	hepatitis B virus
HCF	healthcare facility
HCV	hepatitis C virus
HCW	healthcare worker
HD	haemodialysis
HDU	high-dependency unit
HEPA	high-efficiency particulate air
HICC	hospital infection control committee
HIV/AIDS	human immunodeficiency virus/acquired immunodeficiency syndrome
HLD	high-level disinfectant
HVAC	heating ventilation and air-conditioning system
ICMR	Indian Council of Medical Research
ICN	infection (prevention and) control nurse
ICU	intensive care unit
IDSA	Infectious Disease Society of America
IPC	infection prevention and control
IPHS	Indian Public Health Standard
JCI	Joint Commission International
LAI	laboratory-associated infection
LMICs	low- and middle-income countries
MDRO	multidrug-resistant organism
MDR-TB	multidrug-resistant tuberculosis
MERS-CoV	Middle East respiratory syndrome coronavirus
MRSA	methicillin-resistant <i>Staphylococcus aureus</i>
MSU	mid-stream urine
NABH	National Accreditation Board for Hospitals and Healthcare Providers

NACO	National AIDS Control Organization
NCDC	National Centre for Disease Control
NDM	New Delhi metallo-β-lactamase
NHSN	National Healthcare Safety Network (US)
NICU	neonatal ICU
OPA	orthophthaldehyde
OPD	outpatient department
OT	operation theatre
PAPR	powered air-purifying respirator
PCT	procalcitonin
PEEP	positive end-expiratory pressure
PEP	post-exposure prophylaxis
PMN	polymorphonuclear
PPE	personal protective equipment
PUD	peptic ulcer disease
RA-RM	risk assessment and risk management
RO	reverse osmosis
RSV	respiratory syncytial virus
SAP	surgical antimicrobial prophylaxis
SARS	severe acute respiratory syndrome
SARS-CoV	severe acute respiratory syndrome coronavirus
SOP	standard operating procedure
SSD	sterile supply department
SSI	surgical-site infection
STG	standard treatment guideline
TB	tuberculosis
UTI	urinary tract infection
VAC	ventilator-associated condition
VAE	ventilator-associated event
VAP	ventilator-associated pneumonia
VHF	viral haemorrhagic fever

VRE	vancomycin-resistant <i>Enterococcus</i>
WASH	water, sanitation and hygiene
WHO	World Health Organization
XDR-TB	extensively drug-resistant tuberculosis

1. Introduction

Healthcare-associated infection (HAI), previously referred to as “nosocomial” or “hospital” infection, occurs in a patient during the process of care in a hospital or other healthcare facility (HCF), but was not present or incubating at the time of admission. HAIs include occupational infections among healthcare providers.

HAIs are one of the most common adverse events during healthcare delivery and a major public health issue affecting morbidity, mortality and quality of life. At any time, up to 7% of patients in developed and 10% in developing countries will acquire at least one HAI,¹ causing a considerable economic burden to the society. However, HAIs are largely preventable through effective infection prevention and control (IPC) measures.

It is evident that HAIs result in prolonged hospital stays, long-term disability, increased resistance of microorganisms to antimicrobials, additional cost on health systems, high cost for patients and their families, and preventable deaths.

HCFs are high-risk environments for the development and spread of drug-resistant bacteria and frequently have the highest burden of multidrug-resistant organisms (MDROs). IPC measures reduce the opportunities for resistant pathogens to spread in HCFs and contribute to the containment of antimicrobial resistance (AMR).

Global pandemics of severe acute respiratory syndrome (SARS), influenza and Ebola, and the role of the HCF as an epicentre and amplifier of outbreaks, have emphasized the importance of IPC. The 2018 Nipah virus outbreak in Kerala, and the death of a nurse who cared for an infected patient, has brought to the fore the urgent need to improve IPC practices and put in place effective IPC programmes both at the national as well as HCF levels.

Rising trends of AMR are a major concern. New Delhi metallo-β-lactamase (NDM)-producing bacteria first reported in 2008, are now found worldwide.² From 2008 to 2013, *Escherichia coli* resistance to third-generation cephalosporins increased from 70% to 83%, and resistance to fluoroquinolones increased from 78% to 85%. Ten per cent of *E. coli* isolates were resistant to carbapenems in 2008, increasing to 13% in 2013.³ In one tertiary-care hospital in New Delhi, resistance to carbapenem among *Klebsiella pneumoniae* increased from 2% in 2002 to 52% in 2009.⁴ Antibiotic

Box 1.1. Global and national initiatives for infection prevention and control

Global action

- International Health Regulations, 2005⁶
 - containment of AMR, a strategic priority
- United Nations Sustainable Development Goals
 - emphasis on safe water, sanitation and hygiene (WASH)⁷
- World Alliance for Patient Safety⁸
- WHO Patient Safety Programme⁹
 - “clean care is safer care”
- Regional Strategy for Patient Safety (2016–2025), WHO South-East Asia Region¹⁰
- WHO Guidelines on Core Components of Infection Control Programmes¹¹

National initiatives

- Biomedical Waste Management Rules in 1998 (revised in 2016 and 2018) by Ministry of Environment and Forests^{12,13}
- The “Kayakalp” programme by the Government of India, 2015¹⁴
- National Guidelines on Clean Hospitals (Swacchta Guidelines), 2015¹⁵
- National Quality Assurance Standards for Public Health Facilities, 2017¹⁶
- National Patient Safety Implementation Framework, 2018–2025¹⁷

use is a major driver of AMR. In 2010, India was the world’s largest consumer of antibiotics for human health at 12.9×10^9 units (10.7 units per person).⁵

The key global and national initiatives for IPC are given in Box 1.1. The WHO Guidelines on Core Components of Infection Control Programmes¹¹ have been formulated to help countries develop strategies to improve and strengthen IPC programmes (Box 1.2). The guidelines provide evidence- and consensus-based recommendations on the core components that are required to be in place at the national and acute facility level to prevent HAI, and to combat current and future infection threats and AMR through IPC good practices. The guideline document is supported by a practical manual for implementation.¹⁸

The development of national and facility level IPC guidelines and their implementation has been identified as an essential and core component of an IPC programme. These national IPC guidelines have been developed to fulfil this need.

The worldwide concern over the growing resistance to antimicrobials has emphasized the importance of IPC, making it one of the strategic priorities of the National Action

Box 1.2. The core components of IPC¹¹

- IPC programme at the national and health facility level
- National and facility level evidence-based guidelines on IPC
- Education and training
- HAI surveillance
- Multimodal strategies
- Monitoring and audit of IPC practices and feedback
- Workload, staffing and bed occupancy
- Built environment, materials and equipment for IPC

Plan on AMR.¹⁹ The National Centre for Disease Control (NCDC) and Indian Council of Medical Research (ICMR) have created a network of laboratories for AMR surveillance in the country. Many private hospitals and autonomous institutes have their own infection control systems. Network laboratories have been identified for the surveillance of common bacterial pathogens of public health importance to determine the magnitude and trends of AMR in different geographical regions of India.

Standards for IPC have been defined for accreditation of HCFs by the National Accreditation Board for Hospitals and Healthcare Providers (NABH).²⁰ A system of surveillance for HAI has been established but it is limited only to NABH-accredited hospitals.

The All India Institute of Medical Sciences (AIIMS) and ICMR have jointly established an HAI surveillance network of 35 centres from the public and private sectors. It has developed a software to track HAIs.²¹

This document on National Guidelines for IPC has been developed after due process of review by experts from across the country and keeping in view the guidelines developed by institutions/under various programmes, e.g. ICMR,²² National Health Mission (NHM),²³ the Hospital Manual by the Directorate General of Health Services (DGHS)²⁴ and National AIDS Control Organization (NACO).²⁵

Scope and purpose

This document integrates evidence-based, standard, internationally accepted IPC practices for HCFs in India. Its key purpose is to support improvement in IPC at the HCF level and control HAIs.

These guidelines are in alignment with the National Patient Safety Implementation Framework and the National Action Plan on AMR, which identify IPC and HAI control as priority areas to improve patient safety, healthcare quality and containment of AMR in the country.

At the facility level, these guidelines are intended to enable hospital administrators, clinical managers, doctors, nurses and allied professionals across the country to practise IPC and develop their own policies and standard operating procedures (SOPs).

The IPC methods and practice presented in these guidelines aim to control the development of AMR and prevent the spread of resistant organisms in HCFs. An important purpose of these guidelines is to serve as a resource for the development of training programmes, training modules and IEC (information, education and communication) materials for all levels of healthcare staff, as well as for patients as partners in care.

These are relevant for both private as well as public sector HCFs. Although the principal focus is on secondary and tertiary HCFs, the principles and practice of IPC are common to all healthcare settings and with suitable adaptation can be applied to primary care and community health centres.

At the national level, this document can serve as guidance to policy-makers responsible for developing and monitoring IPC activities in various national programmes, establishing HAI surveillance and framing national action plans for IPC and AMR. It is also relevant for national and facility level healthcare quality managers, regulatory and accreditation bodies, academic institutions and professional societies.

2. Fundamentals of healthcare-associated infections

Healthcare-associated infections (HAIs) are neither present nor incubating at the time of admission of a patient to the healthcare facility (HCF). The majority of HAIs manifest after 48 hours of admission.

HAIs should be identified on the basis of both clinical as well as laboratory criteria. Infection acquired in the hospital but not evident until after discharge is also considered as HAI. Infection in a newborn in a health facility may also be considered as an HAI. It is important to understand the mode of transmission of disease in an HCF so that appropriate measures can be taken to control the spread of infection. Figure 2.1 shows the chain of infection.

A variety of microorganisms – including bacteria, viruses, fungi and parasites – can either colonize or cause infection, depending on the susceptibility of the host. The ability of a microorganism to invade, establish and multiply in the cells and tissues of a host and produce signs and symptoms of disease depends upon the following factors.

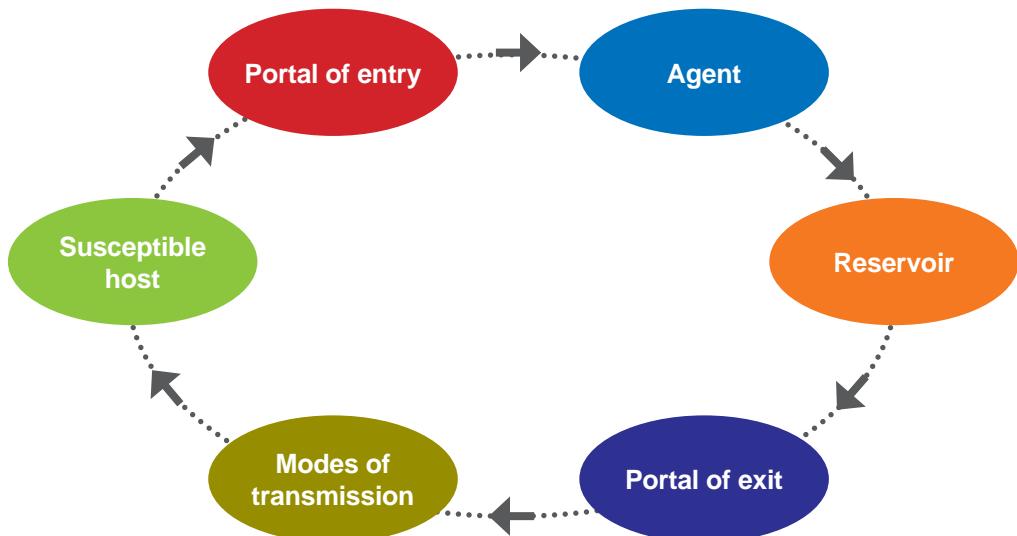


Fig. 2.1. Chain of infection

Agent

The microorganism capable of causing the infection is known as the infective agent. Infective agents include bacteria, viruses, fungi, protozoa, helminths and prions. The ability of a microorganism to cause infection depends upon its ability to invade, proficiency in overcoming the host defences, its pathogenicity, degree of virulence, and the infectious dose. Equally important is the agent's capability to survive in the environment, and its resistance to antimicrobials.

Reservoir

A reservoir is the source of the infectious agent where it lives and multiplies. These can be animate (humans, animals) or inanimate (the environment, contaminated food and water).

Human reservoirs can be symptomatic (exhibiting signs and symptoms of the disease) or asymptomatic (without signs and symptoms) or they can be carriers (presence of organisms for varying periods without signs or symptoms).

Asymptomatic cases and carriers are more likely to transmit the disease as precautions may not be taken since it is not known that the person is harbouring the organisms. Thus, standard precautions should be taken in all situations while dealing with patients even when the diagnosis is not known.

Portal of exit

Portals of exit are necessary for the organism to exit the body of one person and be transmitted to another person. The portal of exit can be the excretions/secretions of the respiratory tract, gastrointestinal tract, genital tract, blood or any other body fluid.

Modes of transmission

This is the way in which an agent is transmitted from a reservoir to a susceptible host. Transmission can occur by:

- *Portal of contact* – direct contact through hands or indirectly through an inanimate object;
- *Droplets* – large-sized droplets released by sneezing, coughing or even talking;
- *Airborne route* – through very small particles that can travel from room to room via air currents;
- *Common vehicle* – where a contaminated vehicle serves as the means of spreading infection to several persons such as food in a salmonella epidemic or blood in a blood-borne epidemic (hepatitis B); and

- *Inoculation* – a percutaneous injury with a contaminated needle or other sharp resulting in direct inoculation of the organism into the bloodstream.

Portal of entry

Similar to the portal of exit, it is the site of entry of the organism into the body such as the mucous membrane of the respiratory, genital, gastrointestinal or urinary tract, conjunctiva and skin.

Susceptible host

A susceptible host is a person who is susceptible to the infection or lacking in resistance to the infective organism. Host factors that influence susceptibility to infection are:

- Age – individuals at extremes of age are more susceptible to infection, e.g. neonates and old people;
- Socioeconomic status such as health literacy, nutritional status;
- Comorbidities such as diabetes, cancer;
- Immunization status;
- Medications such as immunosuppressive agents and chemotherapeutic agents
- Pregnancy;
- Interventions and devices – surgery, intubation, mechanical ventilation, urinary catheterization, vascular catheterization;
- Host factors – related to the host that prevent the entry and establishment of infective agents including:
 - endogenous organisms inhabiting body sites such as the gastrointestinal tract, skin, respiratory tract, genital tract that prevent the establishment of pathogenic organisms at that site;
 - natural antibodies;
 - natural barriers such as intact skin, mucous membranes, fascial planes, cough reflex and gastric acid secretion.

Colonization and infection

Colonization refers to the presence of organisms in the body without causing any cellular damage or any response on the part of the host. Infection occurs when the organism causes cellular damage and a host response. Colonization with one organism may prevent the establishment of another more virulent organism at that body site. Colonizing organisms can be a part of the normal flora for a particular body site but cause infection at another body site, for example, *E. coli* is a normal flora of the intestinal tract but it can cause infection in the urinary tract.

Removal of the normal flora can cause abnormal organisms to colonize a body site, e.g. antibiotics kill organisms such as drug-sensitive *E. coli* and allow drug-resistant organisms to colonize. Colonization can precede infection if the host defences are altered or impaired in some way, which can happen if the patient is on immunosuppressive drugs, has undergone surgery or interventions such as catheterization and intubation.

Types of healthcare-associated infections

Some common types of HAIs are:

- Bloodstream infection (Box 2.1)
- Urinary tract infection
- Pneumonia
- Surgical-site infection
- Gastrointestinal infection

Box 2.1. Common organisms causing bloodstream infections

Escherichia coli, *Enterococcus* spp., *Staphylococcus aureus*, *Klebsiella* spp., *Salmonella* spp., *Candida* spp., *Pseudomonas* spp., *Corynebacteria* spp., *Acinetobacter* spp., coagulase-negative *Staphylococcus* (CNS)

Healthcare-associated bloodstream infections

Healthcare-associated bloodstream infections are serious infections that can be associated with high mortality, which may be more than 50% for some microorganisms. These infections are often associated with intravascular catheters. Infection can occur at the entry site of the catheter or along the subcutaneous tract of the catheter (line), known as tunnel infection. This type of infection is largely dependent on the care taken during insertion and handling of the intravascular catheter. The duration for which catheters are in place is also important. Both central and peripheral lines can be a source of infection.

(For the definition criteria of catheter-related bloodstream infections, see Chapter 7 on surveillance of HAI and Chapter 6 on bloodstream infections in the ICU.)

Diagnosis is made by blood culture and semi-quantitative culture of the catheter tip and catheter lumen.

Healthcare-associated pneumonia

Pneumonia is one of the most serious of HAIs. Ventilator-associated pneumonia

(VAP) is the most important infection in patients on ventilators in intensive care units. It has a high case fatality rate and is often associated with serious comorbidities.

It is defined as a lower respiratory tract infection that appears during or after hospitalization of a patient who was not incubating the infection on admission. The diagnostic criteria are:

- Fever;
- Cough with purulent sputum;
- New infiltrate on radiology; and
- Gram-staining of sputum/endotracheal (ET) aspirate and bacteria.

Healthcare-associated pneumonia is acquired by the inhalation of respiratory droplets or aerosols, or aspiration of colonized oropharyngeal and gastric secretions in conditions of low gastric acidity. Infection can also be acquired through the oropharynx during suction procedures, due to inadequate handwashing and inappropriate disinfection of respiratory devices.

Risk factors

- Age: very young or very old
- Coronary bypass surgery
- Abdominal surgery
- Existing pulmonary, neurological disease
- Decreased clearance of respiratory secretions due to coma, sedation, etc.
- Invasive devices bypassing natural defences as in mechanical ventilation, intubation, tracheostomy, enteral feeding
- Medications such as antibiotics, antacids, immunosuppressive agents and chemotherapy

Urinary tract infection

Urinary tract infections (UTIs) are the most common and account for 35–45% of all HAIs.^{26,27} The majority of these infections are associated with the use of an indwelling urinary catheter.

Diagnosis is based on the clinical symptoms of fever, suprapubic tenderness, frequency of urination and dysuria along with the presence of bacteria in the urine in significant quantity. The urine culture of the patient shows no more than two species of organisms identified, at least one of which is a bacterium of $\geq 10^5$ CFU/ml.²⁸ The presence of an indwelling catheter in the urinary tract may give rise to bacteriuria or mild infection or may even result in severe infections such as pyelonephritis and septicaemia. The source of organisms can be the patient's own flora (endogenous

infection) or exogenous through the hands of staff or contaminated instruments (Box 2.2). Contamination of the drainage bag and retrograde flow of contaminated urine into the bladder can also cause UTI.

It is important that the urine specimen for culture be collected using aseptic precautions.²⁹ The urine specimen should be obtained aseptically from a sample port in the catheter tubing or by aseptic aspiration of the tubing. For non-catheterized patients, a clean voided specimen is acceptable. Catheter tips and specimen from the urine bag should not be cultured.

Box 2.2. Common organisms causing UTI

E. coli, *Klebsiella* spp., *Proteus* spp., *Enterococci* spp., *Pseudomonas aeruginosa*, *Serratia marcescens*, *Candida* spp., *Staph. aureus*, coagulase-negative *Staph.*

Risk factors

- Indwelling urinary catheter
- Instrumentation of the urinary tract
- Poor aseptic preparation during insertion of catheter
- Poor catheter maintenance
- Advanced age
- Female gender
- Severe underlying illness

Surgical-site infection

This is infection at the site of surgery, earlier called wound infection. The incidence of surgical-site infections (SSIs) varies from 0.5% to 15% depending on the type of operation and underlying status of the patient. The main risk factor is the extent of contamination during the procedure (clean, clean contaminated, contaminated, dirty), which is largely dependent on the site of surgery, length of the operation, and the patient's general condition.

SSI usually occurs within 30 days of the operative procedure. In some types of surgery, infection can appear even after 30 days of the operation. Since infection may occur late, all deep infections related to the operative site and to the implant within 1 year of an operation should be considered postoperative infections.³⁰ (For details and surveillance definitions see Chapter 7.)

SSI can be superficial, incisional, deep incisional or organ/space.

- Superficial SSI
 - Drainage of pus from the superficial incision
 - Pain, tenderness, localized swelling, redness or heat
- Deep/organ space SSI
 - Infection appears within 30 days of the procedure or within one year in the case of an implant or foreign body such as prosthetic heart valve, joint prosthesis
 - Pus discharge from deep incision
 - Spontaneous dehiscence or “gaping” of wound
 - Fever >38°C, localized pain or tenderness

Specimens for culture include pus, wound swabs, drainage fluid and exudate (Box 2.3).

Box 2.3. Common organisms causing SSIs

Staph. aureus, E. coli, Klebsiella spp., Enterococcus faecalis, Pseudomonas spp., anaerobic bacteria such as Bacteroides spp.

Risk factors

The non-modifiable variables include age and gender. A systematic review of 57 studies from both high-income countries and low- and middle-income countries (LMICs) identified the following factors associated with an increased risk of SSI in adjusted analysis.³¹

- High body mass index
- Severity score classification of wound
- Diabetes
- Prolonged duration of surgery

The following are other potential factors that can be improved to increase the likelihood of a positive surgical outcome.

- Nutritional status
- Cessation of tobacco use
- Correct use of surgical prophylaxis
- Intraoperative technique

Other potential sites of infection

- Skin and soft tissue
- Brain and meninges

- Eye and ear (sinusitis, conjunctivitis)
- Reproductive organs (endometrial and other infections following childbirth)

Gastrointestinal infections

These are common infections in paediatric wards and in the community. Introduced in the hospital through an infected patient, such infections can spread rapidly in the paediatric unit through a contaminated environment, toilets and inadequate handwashing.

Infectious diarrhoea is confirmed when a bacterial or viral aetiology is demonstrated. Diarrhoea may also occur due to non-infectious causes such as medications. In many cases the cause of diarrhoea cannot be diagnosed (for definition criteria, see Chapter 7).

The infection is transmitted through the faeco-oral route. It may be acquired from contaminated food or water, infected patients or staff, contact with environment contaminated with organisms or instruments entering the alimentary tract such as endoscopes. Box 2.4 gives some common organisms that cause gastrointestinal infections.

Healthcare-associated diarrhoea often presents as an outbreak. The index case or asymptomatic carrier introduces the infection in the ward which then leads to person-to-person spread.

Box 2.4. Common organisms causing gastrointestinal infections

Salmonella spp., *Shigella* spp., *Campylobacter* spp., *Clostridium difficile*, *E. coli*, *Aeromonas* and *Plesiomonas* spp., *Vibrio* spp., *Cryptosporidium* spp., *Giardia lamblia*, *Entamoeba histolytica*, rotavirus, Norwalk (Noro) and similar viruses (e.g. *Astrovirus*), adenoviruses

Risk factors

- Extremes of age, achlorhydria, antibiotic therapy oral or systemic, decrease in normal flora, overgrowth of resistant or sensitive pathogens, gastrointestinal procedures such as insertion of nasogastric tube, endoscopy
- Factors conducive to person-to-person spread such as overcrowding of unit, understaffing, inadequate handwashing facilities

Routes of transmission

Contact transmission

Contact is the most common mode of transmission, and usually involves transmission by touch or via contact with blood or body fluids or secretions. Contact may be direct or indirect.

- **Direct transmission** occurs when infectious agents are transferred from one person to another, e.g. a patient's blood entering a healthcare worker's (HCW's) body through an unprotected cut in the skin.
- **Indirect transmission** involves the transfer of an infectious agent through a contaminated intermediate object or person, e.g. an HCW's hands transmitting infectious agents after touching an infected body site on one patient without performing hand hygiene before touching another patient, or an HCW coming into contact with fomites (e.g. bedding) or faeces and then with a patient.

Examples of infectious agents transmitted by contact include MDROs such as methicillin-resistant *Staph. aureus* (MRSA) and carbapenem-resistant Gram-negative bacteria, *C. difficile*, Norovirus, Ebola virus, HIV, hepatitis B and C viruses, and highly contagious skin infections/infestations (e.g. impetigo, scabies), etc.

Droplet transmission

Droplet transmission occurs when an infected person coughs, sneezes or talks, or during certain procedures. Droplets are infectious particles >5 microns in size. The droplet distribution range is limited by the force of expulsion and gravity and is usually <1 metre.²⁵ Droplets can also be transmitted indirectly to mucosal surfaces (e.g. via hands). Examples of infectious agents that are transmitted via droplets include the influenza virus, *Bordetella pertussis* and meningococcus.

Airborne transmission

Airborne dissemination may occur via particles containing infectious agents that remain suspended in air over time and distance. Small-particle aerosols (<5 microns) are created during breathing, talking, coughing or sneezing and secondarily by evaporation of larger droplets in conditions of low humidity.

Certain procedures, particularly those that induce coughing, can promote airborne transmission. These include diagnostic sputum induction, bronchoscopy, airway suctioning, endotracheal intubation, positive pressure ventilation via facemask and high-frequency oscillatory ventilation.

Aerosols containing infectious agents can be dispersed over long distances by air currents (e.g. ventilation or air-conditioning systems) and inhaled by susceptible individuals who have not had any contact with the infectious person. Examples of infectious agents that are transmitted via the airborne route include measles virus, chickenpox (varicella) virus and *M. tuberculosis*.

Vector-borne transmission

Vector-borne transmission refers to transmission of microorganisms by vectors such as mosquitoes and can be prevented by appropriate construction and maintenance of an HCF, having closed or screened windows, and proper housekeeping. Examples of vector-borne diseases include malaria, dengue and chikungunya.

Basic concepts of prevention of HAI

HAs can be prevented by breaking the epidemiological triad. The most effective way to prevent HAI is by introducing a barrier between the susceptible host and the infecting organism. Most HAs can be prevented through readily available and relatively inexpensive strategies such as compliance with recommended infection prevention practices such as:

- Hand hygiene (see Chapter 4)
- Appropriate use of personal protective equipment (PPE) (see Chapter 4)
- Following aseptic techniques stringently (see Chapters 4 and 6)
- Paying attention to established practices for cleaning and decontamination of soiled instruments, followed by either sterilization or high-level disinfection (see Chapter 4)
- Appropriate disposal of biomedical waste (BMW) (see Chapter 5)
- Appropriate cleaning and disinfection of the environment (see Chapter 5)
- Improving safety in operating rooms and other high-risk areas where the most vulnerable patients are housed and there is a high risk of exposure to infectious agents (see Chapter 6)
- Maintaining a safe working environment and safe work practices (see Chapters 4 and 8)

Bundle approach for prevention and control of HAI

Care bundles include a set of evidence-based measures that need to be implemented together to show a significant improvement in patient care. Together they have a greater effect on the outcome than the isolated implementation of individual

measures. Adherence to bundles helps to deliver consistent and reliable patient care. Care bundles that have shown significant impact on the prevention of HAI include sets of bundles for the prevention of central line-associated bloodstream infections (CLABSIs), bundle for the prevention of catheter-associated urinary tract infections (CAUTIs), bundle for the prevention of VAP, and bundle for the prevention of SSIs.

Bundles need to be simple, clear and precise so that they can be followed easily and appropriately. The measures included in a bundle also have to be adapted to the local setting and suited to the patient care culture of the hospital. Adherence to the bundle should be recorded and evaluated to ensure compliance by all members of the involved healthcare team.

For details of bundles for the prevention of specific types of HAI, see Chapter 6.

3. Infection prevention and control programme

IPC and quality standards of healthcare are essential for the well-being and safety of patients, their families, health workers and the community. A well-organized IPC programme is a basic requirement in every HCF to assist HCWs in the provision of quality healthcare.

In 2016, WHO issued evidence-based guidelines incorporated in an implementation manual on the core components of IPC. The first step towards implementation is the establishment of an IPC programme at the HCF level.¹⁸

Objectives of the IPC programme

The objective is to minimize the risk of HAIs to patients, HCWs and visitors. This is achieved by:

- enabling and assisting all categories of HCWs to adhere to comprehensive IPC practices at all levels of care; and
- providing safe and quality healthcare and improving outcomes by reducing morbidity and mortality.

Structure of IPC programme

The head of the HCF or lead administrator should establish a hospital infection control committee (HICC) with well-defined composition, roles and responsibilities; and provide adequate resources for the effective functioning of the IPC programme.³²

Hospital infection control committee

The HICC is an integral component of the IPC programme of the HCF. It is responsible for establishing and maintaining the IPC programme and its various functions of monitoring, surveillance, reporting, research and education. The HICC

should have wide representation from all relevant disciplines or departments in the facility. The proposed structure and responsibilities of the HICC are given below.

Structure

- Chairperson: head of the institute
- Member-secretary/infection control officer
- Members
 - Representation from management/administration: Dean/Director of hospital; nursing services; medical services; operations
 - Representation from relevant medical and surgical disciplines
 - Representation from support services: operation theatre (OT), central sterile supply department (CSSD), housekeeping/sanitation, laundry, engineering, pharmacology/pharmacy, stores/materials department
 - Infection control nurse (ICN)

Responsibilities

1. Establish the IPC programme in the HCF and ensure the following.
 - Develop an action plan for strengthening IPC measures for the facility and individual units within the facility with priorities based on the risk matrix for that unit and appropriate review.
 - Constitute an infection control team.
 - Review and revise annually infection control guidelines with policies, recommendations and working protocols, including activities and practices under the programme, with standard precautions and hand hygiene as key components.
 - Organize training programmes on recommendations of the guidelines and IPC practices for staff and other HCWs.
 - Develop an antibiotic policy and antibiotic stewardship programme.
 - Conduct surveillance of AMR and HAI.
2. Analyse the surveillance data for HAI (including identification of common sources and routes of entry of infectious microorganisms) on a monthly basis (or more frequently in case an outbreak is suspected) and identify at-risk patients. Take appropriate action and implement recommendations where necessary.
 - Monitor the trends of HAI regularly and compare the rates of infections within the HCF and with other facilities wherever feasible.
 - Monitor and assess, on a regular basis, compliance with recommended practices such as hand hygiene, cleaning and decontamination, disinfection and sterilization through audits and quality control of IPC activities.

- Investigate outbreaks of HAIs in collaboration with medical, nursing and other staff.
- Evaluate the effectiveness of interventions for IPC.
- Participate in the selection of equipment and material and provide advice and focus on IPC measures.
- Help control environmental risks for infection by liaising with appropriate departments such as healthcare waste management, CSSD, provision of safe water (testing of water sources), pharmacy, housekeeping services, laundry and kitchen services.
- Establish links with related health programmes in the HCF such as injection safety programme, TB control programme and control of HIV/AIDS.
 - Ensure a multimodal approach to implementation of IPC, integrate 3–5 different activities for behaviour change.
 - Introduce system change (equipment/infrastructure), education, monitoring, communication as well as culture change (through champions/leaders).
 - Use tools such as care bundles or checklists.
- 3. Prepare an annual IPC plan with a detailed budget.
- 4. Organize periodic (monthly/quarterly) meetings of HICC and take minutes with clear action points to delegate responsibilities for implementation.
- 5. Appoint an IPC team responsible for day-to-day activities with the following members:
 - Infection control officer: usually a clinical microbiologist/clinical epidemiologist, infectious disease physician, who is the team leader;
 - ICN(s): a minimum ratio of one full-time ICN per 250 beds; and
 - One link nurse from every unit.

Roles and responsibilities

Infection control officer

The infection (prevention and) control officer is usually a clinical microbiologist or a clinical epidemiologist or physician specializing in infectious diseases or any other physician with training in IPC. The infection control officer should be the member-secretary of the HICC. As the leader of the IPC team she/he is responsible for monitoring day-to-day activities of the IPC programme. She/he should have direct access to the head of the HCF.

Responsibilities of the infection control officer

- Develop policies, guidelines and standard operating procedures (SOPs) on

IPC in collaboration with other members of the HICC and the IPC team.

- Initiate and maintain activities for HAI surveillance and analyse surveillance data.
- Provide trends of HAI to different patient care units.
- Advise staff on all aspects of IPC and maintain a safe environment for patients and staff.
- Liaise with the microbiology department for analysis of antibiograms (data regarding organisms isolated and their resistance pattern).
- Monitor rational use of antimicrobials.
- Oversee sterilization and disinfection.
- Investigate an outbreak, and advise on control measures and isolation procedures.
- Coordinate microbiological surveillance as decided by the HICC (testing of drinking water, dialysis water, biological monitoring of sterilization, and investigation of sources and modes of transmission in outbreak situations).
- Organize and conduct regular IPC educational and training activities for HCWs.
- Audit infection control procedures, worker safety and antimicrobial usage.
- Organize regular HICC meetings.

Infection control nurse

A full-time nursing staff should be appointed as the ICN. She/he should have training in IPC, preferably through an accredited course. The duties of ICNs are primarily associated with ensuring the practice of IPC by HCWs. She/he is a member of the IPC team and is responsible for liaising between the microbiology laboratory and the wards, ICU, OTs, etc. to identify problems and implement solutions. She/he is enabled by specifically designated link nurses in each ward, ICU, OT or unit of the HCF.

Responsibilities

- Visit the microbiology laboratory and conduct infection control rounds daily and track all infected cases and maintain surveillance data.
- Monitor implementation of IPC practices and SOPs, including hand hygiene, preventive bundles, sterilization and disinfection, and antimicrobial stewardship.
- Impart education and training to HCWs under the supervision of the infection control officer.
- Ensure compliance with the hospital's biomedical waste (BMW) management policy.
- Maintain data of sharps/needle-stick injuries and post-exposure prophylaxis (PEP).

- Initiate and facilitate immunization for hepatitis B virus (immunoglobulin use if needed after exposure, and hepatitis B vaccine), and vaccination for the staff, especially in high-risk areas.
- Facilitate provision of first aid and appropriate consultation in case of suspected exposure of any hospital worker.

Head of the healthcare facility/hospital administrator

The head of the hospital administration and/or management of the HCF is the chairperson of the HICC and provides leadership and support to the IPC programme.

Responsibilities

- Establish and support a multidisciplinary HICC and chair the committee.
- Identify appropriate resources for the IPC programme.
- Ensure availability of appropriate infrastructure, financial and human resources.
- Ensure implementation of the HAI surveillance system, and periodically review the status of HAI and effectiveness of interventions.
- Approve and review policies and guidelines for IPC.
- Support educational and training activities for all categories of staff.
- Establish an antibiotic stewardship programme.
- Establish a safety programme for HCWs – immunization, PPE and PEP.
- Ensure availability of safe food and drinking water, and sound waste management according to the BMW rules 2016, 2018.¹³

Microbiologist and microbiology department

The microbiologist manages the microbiology laboratory and plays a key role in the IPC programme. She/he is responsible for the identification and characterization of the causative agent responsible for an infection and provides guidance for appropriate antimicrobial treatment. The aim is to improve patient outcomes and limit the spread of infection and AMR.

Responsibilities

The microbiology laboratory contributes to the IPC programme by fulfilling its technical responsibilities and performing quality microbiology investigations through:^{30,33}

- Handling clinical specimens to maximize the likelihood of a microbiological diagnosis;
- Developing guidelines for clinical departments for appropriate selection, collection, handling and transport of specimens;

- Ensuring safe laboratory practices to prevent infections among laboratory staff;
- Ensuring rapid diagnosis of infections, identification of pathogens and antimicrobial susceptibility testing of isolated pathogens by standardized procedures;
- Communicating promptly about suspected cases of HAI to the HICC;
- Analysing and reporting the antibiogram of relevant pathogens in different units and in different specimens; and
- In accordance with the microbiological surveillance policy of the HICC, microbiological testing of drinking water, dialysis water, biological testing of sterilizers, and epidemiologically investigating outbreaks including the typing of organisms to detect the source, reservoirs and transmission of infection.

The laboratory should watch for clusters of pathogens that may indicate an outbreak, the emergence of multidrug-resistant organisms, and the isolation of highly infectious, unusual or virulent pathogens. These unusual events or trends must be reported early to the HICC.

Environmental cultures

The microbiology laboratory must not conduct random, undirected microbiological sampling of air, water and environmental surfaces in HCFs. Such culturing must be coordinated with the IPC programme to ensure that it is performed only when indicated and that the specimens are processed appropriately.

Environmental cultures, including personnel cultures, should be done only when clear epidemiological evidence indicates an environmental source of the pathogen.

Microbiological sampling and testing of the environment should follow existing standards.³⁴

Storage of isolates of epidemiological importance

In collaboration with the IPC programme, the laboratory should develop a system for storing epidemiologically important strains of HAI pathogens. The collection should be reviewed frequently, and isolates should be discarded when no longer needed.

Doctors

Physicians and surgeons have a natural leadership role in the HCF and in the community, especially in infection control.

Responsibilities

- Provide quality patient-care services to minimize infection in accordance with the recommended IPC practices as per HCF policy and guidelines (e.g. hand hygiene, standard precautions, aseptic procedures, isolation).
- Serve on the HICC.
- Support the IPC team.
- Ensure collection of appropriate microbiological specimens when an infection is suspected.
- Notify infected/HAI cases to the IPC team.
- Comply with the antibiotic policy and support the antibiotic stewardship programme.
- Advise patients, visitors and staff on measures to prevent the transmission of infection.

Pharmacist and pharmacology department

Hospital pharmacists are responsible for dispensing and procurement of medical products and supplies used in the hospital. The pharmacist should be an active member of the HICC and play a major role in the antimicrobial stewardship programme.

Responsibilities

- Dispense antiseptics and disinfectants and maintain relevant records (potency, incompatibility, conditions of storage and deterioration).
- Obtain and store vaccines or sera, and make them available as appropriate.
- Maintain records of antibiotics distributed to all departments, and the analysis of antibiotic consumption.
- Provide the HICC with summary reports and trends of antimicrobial use.
- Provide information on activity and side-effects of disinfectants and antiseptics.

Nursing staff

IPC practices for infection, prevention and control are mostly implemented by the nursing staff. Nurses should be familiar with the practices to prevent the occurrence and spread of infection, and maintain appropriate practices for various types of patients in their care.

Responsibilities of the nursing administrator

- Participate in the meetings of the HICC.
- Promote the development and improvement of nursing techniques, and

ongoing review of aseptic nursing policies, approved by the HICC.

- Develop and mandate continuing medical education (CME) and training programmes for members of the nursing staff.
- Supervise the implementation of nursing compliance with IPC policies and practices.
- Document, report and maintain suspected HAI cases based on records and information collected during routine visits and discussions with the staff.
- Empower the nurse in-charge of the ward/unit/OT for implementation, monitoring and adherence to HICC practices in the ward/unit/OT.

Responsibilities of the nurse in-charge of ward/unit

- Maintain hygiene, consistent with hospital policies and good nursing practices.
- Monitor aseptic techniques, including hand hygiene, standard precautions and other precautions.
- Report promptly any evidence of infection in patients to the attending physician.
- Initiate patient isolation and order culture specimens from any patient showing signs of a communicable disease, when the physician is not immediately available.
- Limit patient exposure to infections from visitors, hospital staff, other patients or devices/equipment used for diagnosis or treatment.
- Maintain adequate supply of ward equipment, drugs and patient-care supplies.
- Ensure safe storage of medicines and blood products in the ward. Such refrigerators should not be used for storing food and drinks.
- Participate in the training of HCWs and patient education and awareness programmes.
- Participate in investigation of outbreaks.

A nurse in every patient-care unit is designated as an infection control liaison or “link nurse”.³⁵ She/he is a useful adjunct to the ICN to implement infection control practices in the ward and to assist in surveillance of HAI by informing the ICN about suspected cases. The link nurse does not replace an ICN as the link nurse’s primary responsibility and area of work are the patients under her care in the ward.

Responsibilities of the link nurse

- Implement IPC practices in the ward and assist HAI surveillance by informing the ICN about suspected cases.
- Increase awareness about infection control at the unit level.
- Implement IPC practices in the ward.
- Receive training in basic infection control and be in regular touch with the ICN.
- Maintain a primary role as a ward nurse in the unit.

Central sterile supply department/sterile supply department

The central sterile supply department/sterile supply department (CSSD/SSD) serves all hospital areas, including the OT. It has a major role in IPC and patient safety.

Responsibilities of the CSSD/ SSD

- Receive clean, decontaminated packages, sterilize and distribute medical devices.
- Work in collaboration with the HICC and other relevant departments in the facility to develop and monitor policies on cleaning, decontamination and sterilization of reusable and contaminated devices for patient care including:
 - wrapping procedures, according to the type of sterilization;
 - sterilization methods, according to the type of device/equipment;
 - sterilization conditions (e.g. temperature, duration, pressure, humidity); and
 - monitoring of sterilization procedures.

An appropriately qualified individual must be responsible for managing the CSSD. The responsibility for day-to-day management may be delegated to an individual with appropriate qualifications or experience, and knowledge of medical device sterilization.

Responsibilities of the CSSD manager

- Develop a procedure manual to document SOPs for all processes carried out in the CSSD. The manual should be approved by the HICC and reviewed at regular intervals.
- Oversee the various processes carried out in the department, namely cleaning, decontamination, disinfection, wrapping, sterilization, storage and distribution.
- Monitor the processes by using different methods such as physical, chemical and bacteriological according to the policy of the HCF.
- Ensure technical maintenance of the equipment according to national standards and manufacturers' recommendations.
- Report any defect to the administration, maintenance, infection control and other appropriate personnel.
- Ensure appropriate separation of "clean" and "dirty" areas.
- Maintain complete records of each sterilizer run and preserve records as per standard recommendations.
- Organize collection of all outdated sterile units at regular intervals.
- Communicate, as needed, with the IPC team, the nursing service, the OT,

the hospital transport service, pharmacy service, maintenance and other appropriate services.

Laundry service

With the approval of the HICC and in accordance with policies of the HCF, the laundry is responsible for:

- Selection of fabrics for use in different hospital areas, working clothes for staff in different areas, and maintaining appropriate supplies;
- Distribution of working clothes and, if necessary, managing changing rooms;
- Collection and transport of soiled/dirty linen;
- Providing appropriate containers/bags to the wards for segregation of used and dirty/soiled linen;
- Disinfection of soiled linen, either before it is taken to the laundry or in the laundry itself;
- Protection of clean linen from contamination during transport from the laundry to the area of use;
- Ensuring appropriate flow of linen, separation of “clean” and “dirty” areas;
- Maintaining and monitoring the recommended washing conditions (e.g. temperature, duration); and
- Ensuring safety of the laundry staff through prevention of exposure to sharps or laundry contaminated with potential pathogens.

Housekeeping service

The housekeeping service is responsible for the regular and routine cleaning of all surfaces and maintaining a high level of hygiene in the facility in accordance with the policies defined by the HICC and HCF. The policies include the collection and transportation, treatment and disposal of waste generated in the facility. The policy for waste management should be in compliance with environmental protection rules, the Biomedical Waste Management and Handling rules, 2016 and 2018, and the Kayakalp programme. The housekeeping service manager, in collaboration with the IPC team, should develop a manual for all housekeeping procedures. The manual should be reviewed by the HICC and updated regularly.

Responsibilities of the housekeeping services manager

- Identify the varying needs for cleaning in different hospital areas.
- Implement the appropriate cleaning techniques as defined in the policy.
- Organize the collection, transport (treatment and disposal) of different types of waste according to the waste management policy.

- Ensure availability of soap and towel at all times.
- Inform the maintenance service of any building problems requiring repair.
- Organize pest control in the facility.
- Provide appropriate training for all new housekeeping staff and, periodically, for other employees, and specific training when a new technique is introduced. Training should stress on personal hygiene and adherence to SOPs.
- Report to the concerned authority if any cleaning staff has illness of the respiratory tract, digestive tract or skin infection, including wounds and cuts.

Facility/building maintenance committee/agency

Responsibilities of the maintenance manager

- Ensure regular building maintenance, including plumbing, heating, refrigeration equipment, electrical fittings, heating ventilation and air-conditioning systems (HVAC) and high-efficiency particulate air (HEPA) filters; and record-keeping of the same.
- Collaborate with the HICC, housekeeping, nursing staff or other appropriate groups in selecting equipment and ensuring their uninterrupted operation.
- Ensure environmental safety of the community from hospital activities such as waste disposal and protection of water sources.

Additional duties

- Participate in the choice of equipment, if maintenance of the equipment requires technical assistance.
- Inspect, clean and regularly replace filters of all appliances for ventilation and humidifiers; records to be shared with the HICC.
- Regularly inspect all surfaces of walls, floors, ceilings to ensure they are kept smooth and washable and monitor repairs of any opening or crack in partition walls or window frames.

Infection prevention and control manual

The IPC manual at the facility level should be developed by the IPC team, based on the IPC policy (as defined by the HICC) with inputs from the relevant departments followed by review and approval by the HICC. These national guidelines should be based on the basis of the IPC manual and can be adapted according to local conditions, type of facility, services provided, infrastructure and availability of human resources. The IPC manual should be widely distributed in the HCF and should be available in all relevant areas. Training programmes for all levels of staff should be based

on procedures and practices described in the IPC manual. It should be regularly reviewed and updated, preferably annually.

The IPC manual should include the following facility-specific protocols, policies, guidelines, SOPs and recommendations.

- IPC practices
- Control of the environment
- Surveillance of HAIs and management of outbreaks
- Guidelines for IPC in special areas/ situations (depending upon the services provided by the facility)
- Preventing infections among HCWs
- Monitoring and evaluation

Antimicrobial use and management

Appropriate antimicrobial use and management is an integral part of the IPC programme. Every HCF should establish an antimicrobial stewardship programme (AMSP), which aims to facilitate the establishment of effective and rational antibiotic use.³⁶ Antimicrobial stewardship includes the appropriate selection, dosing, route of administration, and duration of antimicrobial therapy to provide quality patient care, reduce AMR, and prevent development and transmission of MDRO.

Appropriate antimicrobial use may be achieved through the following:

- Formulate standard treatment guidelines (STGs)³⁷ or hospital antibiotic policy with a multidisciplinary approach using the local antibiogram.
- Provide ongoing education on rational use of antibiotics to clinicians and ensure implementation of antibiotic policies.
- Restrict use of selected antibiotics.
- Before initiating antibiotic treatment, submit appropriate specimens for bacteriological examination to the laboratory and select an antibiotic based on the clinical spectrum of disease, sensitivity pattern, patient tolerance and cost.
- Based on the culture results, use an agent with as narrow a spectrum as possible with appropriate dosage, frequency, administration time and duration of antimicrobial therapy.
- Discontinue antimicrobial therapy based on predefined criteria.
- Monitor surveillance of AMR and antimicrobial use.
- Carry out periodic prescription audits.
- Create a hospital formulary through the pharmacy and revise periodically.
- Develop strategic interventions through a collaborative approach to improve

infection control and rational antibiotic use.

- Use antimicrobial prophylaxis only when the benefits outweigh the risks. Some indications are: selected surgical prophylaxis, prophylaxis of bacterial endocarditis. Note that antibiotic prophylaxis is not a substitute for appropriate aseptic surgical technique and other infection control measures.

Role of the microbiology laboratory

The microbiology laboratory has a major role in the containment of AMR, which includes:

- Performing antibiotic susceptibility testing of significant microbial isolates as per SOPs, including the antimicrobials to be tested and following cascade reporting;
- Supporting the AMSP committee/drugs and therapeutic committee;
- Monitoring and reporting trends in prevalence of bacterial resistance to antimicrobial agents in a hospital antibiogram; and
- Providing microbiological support for IPC (role of microbiology laboratory in IPC), including prompt notification to the IPC team of any unusual AMR patterns in organisms isolated from relevant clinical specimens.

Specimen collection and transportation

Poor specimen collection and transportation is a major cause of wrong diagnosis and over-consumption of antibiotics. The following measures must be taken:

- Microbiologists must train nurses and phlebotomists to collect specimens properly and transport them rapidly to the laboratory. This requires the support of the hospital administration. Microbiologists must do periodic audits to give a feedback to the chief of nursing, head of laboratory and quality manager.
- Microbiology laboratories must follow strict sample rejection criteria for inappropriately collected samples, e.g. respiratory samples contaminated with saliva/oral secretions are inappropriate and must be rejected.
- Urine samples contaminated with vaginal or urethral commensal flora should be rejected. Only mid-stream urine (MSU) samples should be accepted.
- For clinical reporting the microbiology laboratory should report only significant pathogens (not colonizers and contaminants). Clinicians should correlate laboratory reports clinically before starting treatment.
- The laboratory should communicate results to the clinicians at the earliest.

Role of biomarkers in infections

- Biomarkers play a useful role in the managements of infections.³⁸ Use

biomarkers and point-of-care tests if feasible and cost-effective, and interpret in the clinical context.

- C-reactive protein (CRP) and procalcitonin (PCT) are useful biomarkers that are often used in the management of infections, especially in children under 5 years and critically ill patients.³⁹
- Elevated serum lactate levels ($>2.0 \text{ mmol/L}$) are a good risk stratification for mortality. Serial levels correlate with septic shock and multiorgan failure. This test is generally available as part of the routine arterial blood gas analysis done in ICUs.
- Absolute polymorphonuclear (PMN) count, immature vs mature PMN (shift to the left) and toxic granules in neutrophils in the peripheral smear are relatively low-cost methods to detect sepsis, but need trained human resources.

Educational programmes and strategies

- Appropriate educational material on IPC should be made available to all HCWs, patients and visitors.
- Continuing educational interactive programmes and awareness drives should be conducted periodically.
- Awareness programmes should be organized on the prevention and control of specific infectious diseases for different levels of staff of the HCF and for the community.

Risk assessment and risk management

A risk-based approach should be used in formulating the annual action plan. Procedures and processes associated with a risk of infection to patients and staff should be evaluated to assess the risk in the HCF (Table 3.1). The general approach to risk assessment and risk management (RA-RM) is as follows:

- The system for RA-RM needs to be divided into individual functional, structural and operational components.
- The hypothetical frequency of occurrence of a given event needs to be semi-quantified, e.g. unlikely, extremely rare, infrequent, frequent or imminent.
- Semi-quantification of the magnitude of impact of a given event needs to be done, e.g. mild, moderate, severe or catastrophic.
- The scales used in the semi-quantification of the frequency of occurrence and magnitude of impact are arbitrary and generally are 3-point or 5-point scales.
- The annual IPC implementation plan of an HCF should be based on the

Table 3.1. Example of RA-RM for IPC in a healthcare facility in a district hospital or medical college

	Frequency	Impact	Cumulative effect/ score	Action plan
IPC system not in place	Imminent (present)	Severe	Present/severe	Constitute HICC within 1 month; organize meeting within 2 months
Fire	Rare	Catastrophic	Rare/catastrophic	Mandatory fire safety audit and fire safety training
Flood	Rare	Catastrophic	Rare/catastrophic	Strategic plan for evacuation of staff, patient, visitors; mock drill
Inadequate microbiology laboratory support	Frequent	Severe	Frequent/severe	Better funding application; better inventory management; use of low-cost tests
Inadequate number of human resources for IPC	Frequent	Severe	Frequent/severe	Multi-tasking; application for HR planning/ recruitment
Inadequate supply of PPE	Frequent	Severe	Frequent/severe	Better inventory management; staff education about appropriate use of PPE; PPE wastage audit; application for funding
Inadequate supply of essential medicines (e.g. antibiotics)	Frequent	Severe	Frequent/severe	Hospital formulary development; AMSP; emphasis on IPC; staff training
Inadequate training for IPC	Frequent	Severe	Frequent/severe	Training of trainers programme; mandatory training in IPC; staff promotion/incentives based on IPC compliance

cumulative effect of frequency of occurrence and magnitude of impact of a hypothetical event, e.g.

- o *Imminent and catastrophic*: something needs to be done immediately;
- o *Rare and mild*: a strategic long-term plan needs to be in place;
- o *Frequent but mild*: root cause analysis needs to be done; and
- o *Infrequent but severe*: strategic long-term planning needs to be in place.

Planning, monitoring, audit and feedback

Based on the risk assessment, an annual plan of action should be charted out at the end of the current year and ratified by the HICC. Targets to be achieved on the lines of aims and objectives of the programme and strategies to be implemented to achieve these should be emphasized.

The main purpose of audit/monitoring practices and feedback is to achieve behavioural change or other process modifications to improve the quality of care and practices with the aims of reducing risk of HAI and spread of AMR.

Regular monitoring/audit of IPC practices and feedback (individual/team/unit) is effective in increasing adherence to IPC practices. Examples of indicators include:

- Compliance with processes such as hand hygiene, checklists, care bundles;
- Results of knowledge, attitude and practice (KAP) studies to indicate behaviour change;
- Compliance with rules and regulations such as the BMW management rules; and
- HAI rates obtained through the surveillance system.

Implementation strategies

WHO recommends a multimodal strategy for IPC activities to improve practices and reduce HAI and AMR.¹¹

The multimodal approach consists of three or more components implemented in an integrated way with the aim of improving outcomes (bundle approach), and includes tools (bundles and checklist) developed by multidisciplinary teams based on local conditions. An example of an effective multimodal strategy is one that has been shown to bring about significant improvement in IPC practices and reduce the risk of HAI.⁴⁰

- System change with appropriate infrastructures and supplies to enable IPC practice
- Education and training of relevant staff
- Monitoring of the infrastructure, practices, processes, outcomes and providing feedback
- Reminders in the workplace and communication
- Culture change within the establishment and strengthening the safety climate

Box 3.1 summarizes the prerequisites for an effective IPC programme.

Evaluation and feedback of the programme

- Evaluate the IPC programme periodically to assess the extent to which the objectives have been met.
- Ascertain whether the activities are being performed in accordance with the requirements.
- Identify aspects that need improvement.

Evaluation can be done using indicators, e.g.

- *Process indicators:* compliance with hand hygiene, care bundles;
- *Outcome indicators:* HAI rates, mortality and morbidity.

The results of the evaluation should be shared with the HICC.

Box 3.1. Prerequisites for an effective IPC programme

- Policies and guidelines, including best practices and standard operating procedures (SOPs)
- Adequately trained and motivated human resources
- Continuous and adequate supply of personal protective equipment (PPE)
- Antimicrobial use policy and links with the antimicrobial stewardship programme (AMSP)
- Integration with activities of the quality and safety department
- HAI surveillance and outbreak investigation
- Microbiology laboratory support
- Environmental protection
- Links with other patient safety programmes in the healthcare facility (HCF)
- Evaluation of the programme activities: monitoring and feedback
- Budget allocation for all the above
- Implementation through a multimodal approach

4. Procedures and practices for infection prevention and control

A two-tiered approach to precautions is used to interrupt the mode of transmission of infectious agents.

- **Standard precautions:** these refer to work practices that are applied to all patients receiving care in health facilities, regardless of their diagnosis or presumed infectious status so as to minimize the risk of transmission of infectious agents in all situations. Standard precautions minimize the likelihood of transmission of infectious agents between HCWs and patients, and from patient to patient.
- **Transmission-based precautions:** Transmission-based precautions are precautions required to be taken based on the route of transmission of organisms like contact precautions, airborne precautions, etc.

If successfully implemented, standard and transmission-based precautions prevent any infection from being transmitted. IPC precautions pending confirmation of diagnosis are given in Annex 2.

Standard precautions

The use of standard precautions is the primary strategy for minimizing the risk of transmission of microorganisms in HCFs.

Standard precautions are to be followed for all patients, irrespective of their infection status. These are to be used to avoid contact with blood, body fluids, secretions and excretions regardless of whether contaminated grossly with blood or not; non-intact skin; and mucous membrane. The key components of standard precautions are:⁴¹

1. Hand hygiene
2. Personal protective equipment (PPE)
3. Respiratory hygiene and cough etiquette
4. Prevention of injuries from sharps
5. Safe handling of patient-care equipment

6. Principles of asepsis
7. Environmental infection control
 - a. Patient placement
 - b. Environmental cleaning
 - c. Linen and laundry
 - d. Waste disposal

1. Hand hygiene

The WHO guidelines on hand hygiene in healthcare (2009) suggest that⁴² hand hygiene is the single most important measure for prevention of infection. Hands can become contaminated with infectious agents through contact with a patient, patient surroundings, the environment, or other HCWs. Hand hygiene removes dust/soil, organic material and transient microorganisms from the skin and reduces the risk of cross-contamination. Evidence suggests that the hands of HCWs are the most common vehicle for the transmission of healthcare-associated pathogens from patient to patient and within the healthcare environment (Box 4.1). Studies show a direct correlation between an increase in adherence to hand hygiene with decrease in HAIs.

Box 4.1. Hand decontamination

- Routine hand hygiene
 - Handwashing with soap and water is preferred when the hands are visibly dirty or soiled with blood or other body fluids or after using the toilet.
 - Hand rubbing with an alcohol-based preparation is the preferred method for routine hygienic antisepsis if the hands are not visibly soiled.
- Surgical hand scrub

Handwashing with soap and water

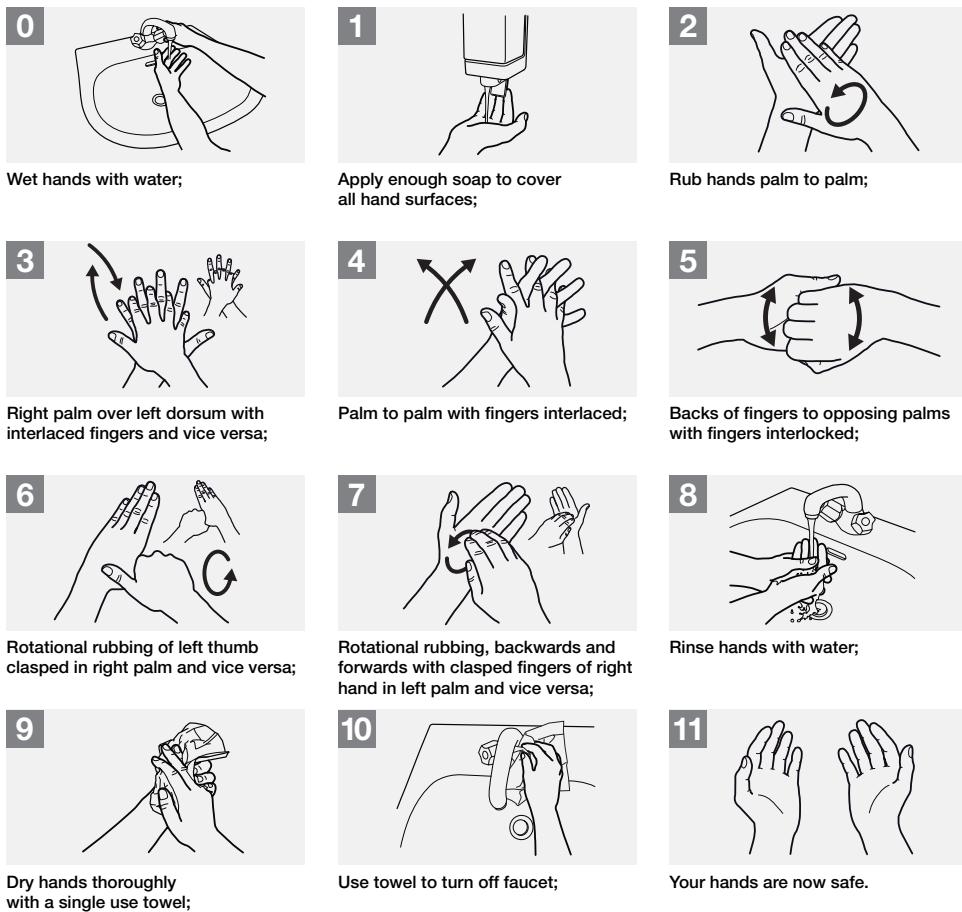
Indications: when there is visibly heavy contamination, e.g. with proteinaceous material, blood or body fluids (Fig. 4.1).

- After attending to a patient with suspected/confirmed *C. difficile* infection
- After using the toilet
- Before and after having food
- Adequate number of sinks with running water and soap should be available in the haemodialysis unit to facilitate handwashing.

How to Handwash?

WASH HANDS WHEN VISIBLY SOILED! OTHERWISE, USE HANDRUB

 **Duration of the entire procedure: 40-60 seconds**



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Clean Your Hands

Fig. 4.1. Steps of handwashing⁴³

Hand rubbing using alcohol-based preparation

Use alcohol-based hand rubs (ABHR), when the hands are not visibly soiled or tap and running water is not available (Fig. 4.2).⁴⁴

How to Handrub?

RUB HANDS FOR HAND HYGIENE! WASH HANDS WHEN VISIBLY SOILED

 Duration of the entire procedure: 20-30 seconds

1a



1b



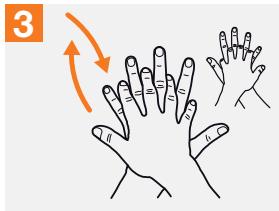
2



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

Rub hands palm to palm;

3



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

4



Palm to palm with fingers interlaced;

5



Backs of fingers to opposing palms with fingers interlocked;

6



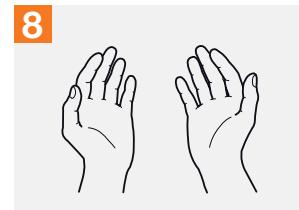
Rotational rubbing of left thumb clasped in right palm and vice versa;

7



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

8



Once dry, your hands are safe.



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Fig. 4.2. Steps of hand rubbing⁴⁵

- Advantages of ABHR
 - Easily accessible at point of care
 - Excellent antimicrobial activity against Gram-positive and Gram-negative vegetative bacteria, *M. tuberculosis* and a wide range of fungi

- Generally good antimicrobial activity against enveloped viruses
- Disadvantages of ABHR
 - Lesser and/or variable antimicrobial activity against non-enveloped viruses (such as norovirus)
 - No activity against protozoan oocysts and bacterial spores (such as *Clostridium difficile*)

Surgical hand scrub

Hand scrubbing with an antiseptic agent before beginning a surgical procedure reduces the number of microorganisms, and inhibits the growth of microorganisms on the hands under the gloves. Chlorhexidine or povidone-iodine-containing soaps are the most commonly used products for surgical hand scrub. The antimicrobial efficacy of alcohol-based formulations is superior to that of all other currently available methods of preoperative surgical hand preparation.⁴⁶

Improving the implementation of hand hygiene

Hand hygiene can be improved through a multimodal strategy suggested by WHO.⁴⁷

The key components are:

- **System change:** ensuring that the necessary infrastructure is in place to allow HCWs to practise hand hygiene. This has two essential elements:
 - Access to a safe, continuous water supply as well as to soap and towels;
 - Readily accessible alcohol-based hand rub at the point of care.
- **Training/education:** providing regular training on the importance of hand hygiene, based on the “My 5 moments for hand hygiene” approach (Fig. 4.3), and the correct steps for hand rubbing and handwashing, to all HCWs.
- **Evaluation and feedback:** monitoring hand hygiene practices and infrastructure, along with related perceptions and knowledge among HCWs, while providing performance and results feedback to staff.
- **Reminders at the workplace:** prompting and reminding HCWs about the importance of hand hygiene and about the appropriate indications and procedures for performing it.
- **Institutional safety climate:** creating an environment and perceptions that facilitate raising awareness about patient safety issues while guaranteeing improvement of hand hygiene as a high priority at all levels, including
 - active participation at both the institutional and individual levels;
 - awareness of individual and institutional capacity to change and improve (self-efficacy); and
 - partnership with patients and patient organizations.

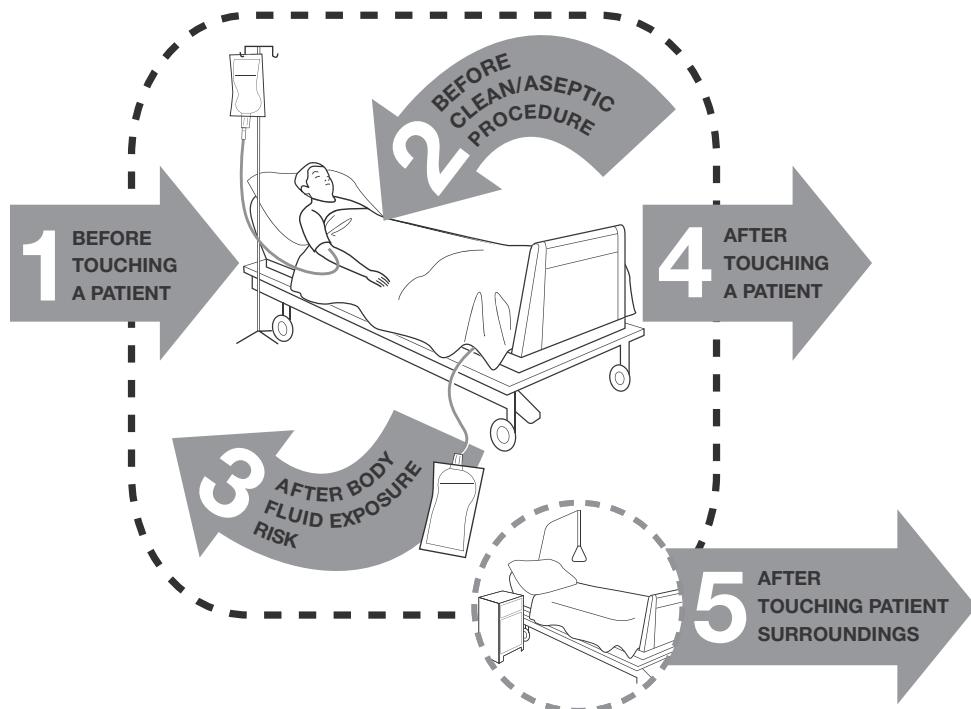


Fig. 4.3. Five moments for hand hygiene in clinical settings⁴⁸

The WHO hand hygiene direct observation audit tool is given in Annex 3. HCFs may adapt and use this tool locally for hand hygiene audits.⁴⁸

2. Personal protective equipment

Personal protective equipment (PPE) refers to physical barriers, which are used alone or in combination, to protect mucous membranes, airways, skin and clothing from contact with infectious agents. PPE should be used by:

- HCWs who provide direct care to patients and who may come in contact with blood, body fluids, excretions, and secretions;
- Support staff including cleaners, and laundry staff in situations where they may have contact with blood, body fluids, secretions, and excretions.
- Laboratory staff, who handle patient specimens;
- Family members who provide care to patients and are in a situation where they may have contact with blood, body fluids, secretions and excretions;
- HCWs in a haemodialysis unit, because of the high risk of transmission of blood-borne infections during the various activities associated with haemodialysis and handling of equipment; and

- Patients in a haemodialysis unit, in the form of a barrier over clothing during cannulation and decannulation, central line connection, disconnection/dressing change.

PPE includes gloves, aprons and gowns, facial protection, footwear and hair cover or cap.

Gloves⁴⁹

- Gloves should be worn as an additional measure, not as a substitute for handwashing.
- Gloves are not required for routine care activities in which contact is limited to a patient's intact skin.
- Wear gloves when touching blood, body fluids, secretions, excretions, mucous membranes, non-intact skin.
- Change gloves between tasks and procedures on the same patient after contact with potentially infectious material.
- If gloves become torn or heavily soiled and additional patient care tasks must be performed, then change them before starting the next task.
- Remove gloves immediately after completion of care or a specified task, at the point of use before touching non-contaminated items and clean environmental surfaces and before moving to another patient or using a mobile phone.
- Perform hand hygiene immediately after removing gloves.

Types and indications for wearing gloves

There are three types of gloves:

1. Clean, non-sterile gloves should be worn:
 - For examinations and non-surgical procedures;
 - For handling items visibly soiled with blood, body fluids, secretions or excretions when the HCW has open skin lesions on the hands; and
 - When the HCW has non-intact skin on the hands.
2. Sterile, single-use gloves should be used for aseptic procedures.
3. Heavy duty/utility gloves should be used for decontamination of large equipment, cleaning of floors, walls, HCF furniture such as beds, etc. These gloves can be reused after cleaning.

Gloves in haemodialysis units

1. Clean disposable gloves should be available for routine use.
2. Gloves must be worn in haemodialysis facilities whenever caring for a patient or touching the patient's medical equipment, handling lab specimens or used

dialysers, cleaning machines, cleaning stations, and wiping up blood or other body fluid spills.

3. They must be changed whenever moving from one patient or machine to another.
4. They must be changed after cannulation.
5. Sterile gloves must be available and used during procedures requiring aseptic technique such as central line insertion.
6. Remove gloves after caring for a patient. Do not wear the same gloves for the care of more than one patient, and do not wash gloves between use with different patients.
7. Perform hand hygiene after removing gloves.

Glove pyramid

The glove pyramid in Fig. 4.4 shows the indications for the use of sterile gloves, examination (clean) gloves and where gloves are not indicated.

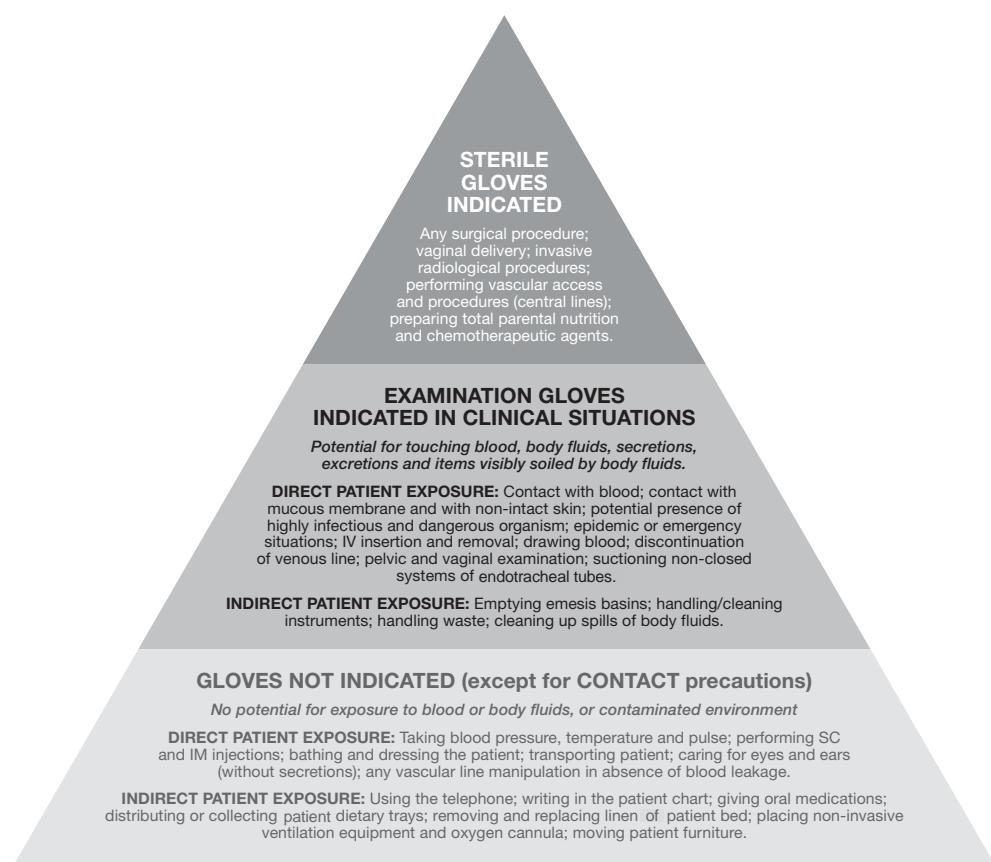


Fig. 4.4. Indications for using and not using gloves⁴⁹

Aprons and gowns

International guidelines recommend that protective clothing (apron or gown) should be worn by all HCWs when:

- there is close contact with the patient, materials or equipment that may lead to contamination of skin, uniforms or other clothing with infectious agents; and
- there is a risk of contamination with blood, body substances, secretions or excretions (except sweat).

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 bring contact with blood, body substances, secretions or excretions (except sweat).
- A fluid-resistant apron or gown should be worn when procedures are likely to generate splashing or sprays of blood or body substances and there is a risk that clothing may become contaminated with blood and body substances.
- Gowns and aprons preferably must be changed between patients.

Table 4.1 gives detailed characteristics of aprons and gowns.

Facial protection

Indications

Usual facial protection includes a medical/surgical mask (triple-layer surgical mask) and eye protection (face shield or goggles), to protect the conjunctivae and the mucous membranes of the nose, eyes and mouth during activities that are likely to generate splashes or sprays of blood, body fluids, secretions or excretions. Eye protection should also be used while providing care to patients with respiratory symptoms such as coughing and sneezing, since sprays of secretions may occur.

Types of facial protection

- Eye protection goggles protect the eyes. These should fit snuggly over and around eyes and personal prescription glasses – personal glasses are not a substitute for goggles.
- Face shield – when skin protection, in addition to mouth, nose and eye protection is needed; for example, when irrigating a wound or suctioning copious secretions, a face shield can be used as a substitute for a mask or

goggles. The face shield should cover the forehead, extend below the chin, and wrap around the side of the face.

- Masks are worn where appropriate to protect the mucous membranes of the nose and mouth during procedures and patient-care activities likely to generate droplets and splashes or sprays of blood, body fluids, secretions and excretions. Masks should fully cover the nose and mouth and prevent fluid penetration. Triple-layer surgical masks fitted tightly to the face should be worn, and discarded immediately after use. If the mask gets wet or dirty with secretions, it must be changed immediately.

Table 4.1. Characteristics of aprons and gowns

Plastic apron	<ul style="list-style-type: none"> Impervious/fluid-resistant Single-use, for one procedure or episode of patient care Disposable Worn when there is a risk that clothing may become exposed to blood or body substances (usually from the environment) during low-risk procedures and where there is low risk of contamination to the HCW's arms Worn when contact with the patient or the patient environment is likely to occur
Gown	<ul style="list-style-type: none"> Single-use* Disposable Worn 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 Choice of sleeve length depends on the procedure being undertaken and the extent of risk of exposure of the HCW's arms
Full-body gown	<ul style="list-style-type: none"> Fluid-resistant Single-use* Long-sleeved Worn when there is a risk of contact of the HCW's skin with a patient's broken skin, extensive skin to skin contact (e.g. lifting a patient with scabies or non-intact skin), or a risk of contact with blood and body substances which are not contained (e.g. uncontrolled vomiting or passage of stools) Worn when there is the possibility of extensive splashing of blood and body substances Worn when there is a risk of exposure to large amounts of body substances, e.g. in some operative procedures
Sterile gown	<ul style="list-style-type: none"> Pre-packaged Used for procedures requiring an aseptic field

* Reusable gowns can be laundered and sterilized as required before reuse. However, if handling risk group 4 organisms (see Annex 12) then single-use gowns are necessary. Single-use gowns should be disposed of appropriately in accordance with the Biomedical Waste Handling and Management Rules 2016, 2018.

A surgical mask becomes ineffective as a barrier if its integrity is damaged or if it becomes wet (i.e. from perspiration, or if splashed with blood or other potentially infectious material). If this occurs, remove the mask and replace with another.

Respirators: These protect from inhalation of infectious aerosols (e.g. *M. tuberculosis*). Some types are: particulate respirators, half- or full-face elastomeric respirators, and powered air-purifying respirators (PAPRs).⁵⁰

The most commonly used respirators in healthcare settings are N95 particulate respirators. The device filters particles more than 0.3 microns in diameter.

Indications for use

Particulate respirators should be used:

- by care-providers of patients with obligate and preferentially airborne-transmitted diseases such as TB;
- while performing aerosol-generating procedures that have been consistently associated with increased risk of pathogen transmission;
- if an aerosol-generating procedure such as bronchoscopy is performed on a patient with active TB; and
- if a particulate respirator is not available, whenever possible, avoid performance of aerosol-generating procedures associated with an increased risk of transmission of pathogens in patients with acute respiratory infections.

Training

Ensure that users of particulate respirators receive training on:

- How to put on a particulate respirator (e.g. N95 respirator);
- The need to perform the seal check every time the respirator is worn;
- Avoiding contamination during use, and removing and disposing of the respirator; and
- Changing the mask immediately if the respirator gets wet or dirty with secretions.

If patients with known or suspected airborne infections (e.g. pulmonary TB) are cohorted in a common area, and if multiple patients are to be visited sequentially, it may be advisable to wear a single particulate respirator for the duration of the activity. This type of use requires that the respirator should not be removed at any time during the activity, and that the user does not touch the respirator.

Footwear

- Closed footwear, which can be easily cleaned and disinfected, must be used whenever work processes or environments could cause foot injuries or spillage of blood or body fluids.
- Personal footwear should be changed when entering clean areas such as OTs, labour rooms, ICU.
- Shoe covers may be used over street shoes to protect clean areas from soil and dirt brought in by shoes.

Hair covers

- Long hair must be secured with a rubber band and hair cover worn to protect the hair and to protect the patient from falling hair.

Selection and safe use of PPE

The type of PPE should be selected on the basis of estimated risk of contamination of the HCW's hands, clothing or other areas of the body by blood, body fluid, excretions or secretions of the patient. The route of transmission of the infectious agent is an important factor in selecting the PPE.

Although PPE is the most visible control used to prevent transmission of infection, it must be used in conjunction with administrative and engineering controls. PPE must be correctly selected and used in a safe manner, and must be available and accessible to HCWs and visitors.

Ensure sufficient supplies of appropriate PPE

If resources are limited and disposable PPE items are not available, use reusable items (e.g. cotton gowns) and disinfect properly after each use. To avoid wastage, critically evaluate situations in which PPE is indicated, and maximize the provision of clinical care during each entry to the patient's room. However, use disposable PPE only while handling risk group 4 organisms or infection due to the same.

Before putting on PPE

- HCWs should be trained on the use of PPE as part of the IPC training.
- The training should address the protocols adopted by a specific facility and include practising both putting on and taking off procedures and performing care-related activities while wearing PPE.
- The competency of the HCWs in using PPE should be assessed and tested and, ideally, properly documented.

- Adequate resources (human, material and financial) must be made available.
- Management of the resources should include stock management, availability of different sizes and shapes of PPE, placement of items for easy access, quality of items purchased and line management for reporting shortages.
- Written protocols should be in place for step-wise procedures in putting on and taking off PPE, management of used and potentially contaminated PPE and associated medical devices, including safe discard and decontamination.
- Appropriate spaces should be designated so that PPE can be put on and taken off in separate areas.
- The use of trained observers to monitor the procedures for putting on and taking off PPE correctly is essential.
- PPE use should be restricted to areas where it is necessary and has a specific purpose.
- Any protective clothing worn by HCWs in an area with a high risk of contamination such as the laboratory or OT must be removed when leaving that area.
- Protective clothing or PPE which has been in contact with patients should not be worn outside the patient-care area.

When putting on PPE

- PPE must be put on in the proper order as it cannot be modified while in the patient-care area. An observer should check the integrity of the PPE, making sure it is well adjusted, and write the name and role of the person as well as the time of entry into the high-risk zone on the apron.
- The sequence of removal of PPE should be in the reverse order of putting on the PPE. Eye protection should be put on in a way that it can be taken off as late as possible during the PPE removal process.⁵¹
- Information and posters about PPE, demonstrating the sequence for wearing and removing PPE should be posted in all patient-care areas.

PPE should be put on and taken off in correct sequence and disposed in accordance with the Biomedical Waste Management and Handing Rules 2016, 2018.

3. Respiratory hygiene and cough etiquette⁵²

Respiratory hygiene and cough etiquette means the measures taken by a person having signs and symptoms of respiratory infection to contain respiratory secretions and prevent the transmission of the infection to other persons. The following measures are recommended:

- Cover the mouth and nose with a tissue when coughing or sneezing.
- Dispose the tissue after use in the nearest waste container.
- Perform hand hygiene after contact with respiratory secretions and contaminated objects or materials.
- If resources permit, HCFs should ensure the availability of materials such as tissues and foot-operated waste bins for adhering to respiratory hygiene and cough etiquette in waiting areas for patients and visitors.
- In the absence of handkerchief or tissues, patients should be instructed to cover their nose and mouth with their arm during coughing and sneezing.
- Provide conveniently located dispensers of ABHR.
- Where sinks are available, ensure that water and soap for handwashing are available at all times.
- Posters elaborating cough etiquette and hand hygiene must be displayed. Posters in the local language should be put up at appropriate locations such as the OPD entrance, emergency department and doctors' clinics with instructions for patients and their attendants to inform the healthcare staff if they have symptoms of respiratory infection and on how to practise respiratory hygiene and cough etiquette.

The following information must be displayed in patient-care areas for educating patients, staff and visitors:

- Respiratory infections, such as influenza (flu), whooping cough and severe acute respiratory syndrome (SARS), are spread by coughing, sneezing or unclean hands.
- To help stop the spread of germs:
 - Avoid close contact with people who are sick.
 - Stay at home when you are sick.
 - Cover your mouth and nose with a tissue or handkerchief when you cough or sneeze.
 - In the absence of a handkerchief or tissues, cover your nose and mouth with your arm during coughing and sneezing.
 - Wash your hands often with soap and water. If soap and water are not available, use an ABHR.
 - Avoid touching your eyes, nose or mouth.
 - Practise other good health habits. Clean and disinfect frequently touched surfaces at home, work or school, especially when someone is ill. Get plenty of sleep, be physically active, manage your stress, drink plenty of fluids and eat nutritious food.

4. Prevention of injuries from sharps

Handling sharps

Handling sharps (needles, scalpels, etc.) is one of the most hazardous activities carried out by HCWs in the course of their duties. Sharps should be handled with extreme caution to avoid injuries during use, disposal or reprocessing.

- Used needles must not be recapped by hand; if necessary, use the single hand “scoop” method.
- Used needles should not be bent or broken after use.
- Used sharps should be disposed of immediately in designated puncture-proof containers (labelled with a biohazard symbol) located in the area where the items were used, for transport to the incinerator or pit or as per HCF policy for waste disposal, given in Chapter 5. These containers must not be located in areas which are easily accessible to the public (see Annex 8.4).
- Sharps should be used only once. A handful of sharp instruments must not be picked up simultaneously.
- While handling sharps, the sharp end of instruments should be positioned away from oneself and others.
- If injured by sharps, contact the ward, clinic or unit supervisor immediately for further management.
- Sharps should be disposed of in a puncture-proof container, as recommended by the BMW guidelines.

5. Safe handling of patient-care equipment

Equipment that has been in contact with a patient should be disinfected or sterilized as appropriate before use on another patient.

- Equipment that has been soiled with blood or body fluids should be decontaminated and cleaned to prevent transfer of microorganisms to other patients and the environment.
- Cleaning of patient-care areas and equipment should be carried out by a team of dedicated personnel trained in the appropriate cleaning procedures. Responsibility and accountability for cleaning should be assigned.
- A hospital disinfection policy should be prepared for appropriate cleaning, disinfection and sterilization of patient-care devices that come in contact with mucous membranes and access sterile tissues. The policy should be strictly followed and monitored. Accountability and responsibility should be assigned.

- A new equipment or serviced and repaired equipment should be cleaned and disinfected before patient use as per hospital policy.
- Heavy duty or strong utility gloves must be worn during decontamination, cleaning and disinfection of instruments.
- Soiled patient-care equipment should be handled in a manner that prevents exposure of the skin and mucous membranes and contamination of clothing and environment.
- Disposable patient-care equipment should not be reused and must be discarded into an appropriate container in accordance with the hospital waste management policy and the Biomedical Waste Management and Handling Rules 2016, 2018.
- Patient-care supplies (e.g. lotion, cream, soap) should not be shared by patients.

Injection safety⁵³

Injection safety is an important component of standard precautions.

Use of injection devices

Practical guidance on the use of injection devices is given below:

- Use a new injection device for each procedure, including for the reconstitution of a unit of medication or vaccine.
- Inspect the packaging of the injection device to ensure that the protective barrier has not been breached.

Discard the device if the package has been punctured, torn or damaged by exposure to moisture, or if the expiry date has passed.

Single-dose and multi-dose vials

- Whenever possible, use a single-dose vial for each patient to reduce cross-contamination between patients.
- Open only one vial of a particular medication at a time in each patient-care area.
- If possible, keep one multi-dose vial for each patient, and store it with the patient's name on the vial in a separate treatment or medication room.
- Do not store multi-dose vials in the open ward or general patient-care area, where they could be inadvertently contaminated.
- Before use, examine the vial for turbidity, particulate matter or discolouration, and discard if any of these is present.

- Never leave a needle or cannula inserted into a medication vial via the rubber stopper.
- Discard a multi-dose vial:
 - if the sterility of the contents is compromised;
 - if the expiry date or time has passed;
 - if found to be without a specific date or time, improperly stored or contaminated regardless of the expiry date.
- The date of discard from the opening of a multi-dose vial should be decided by the HICC of the facility. Normally, it is 28 days from the date of opening, even if it is within the expiry date.
- Single-dose vials for reconstitution should be used instead of fluid or solution bags for routine injection.

Labelling

After reconstitution of a multi-dose vial, label the final medication container with:

- date and time of preparation;
- final concentration;
- expiry date and time; and
- name and signature of the person reconstituting the drug.

For multi-dose medications that DO NOT require reconstitution, add a label with:

- date and time of first piercing the vial;
- name and signature of the person first piercing the vial.

Injection preparation and administration

Injections should be prepared in a designated clean area where contamination by blood and body fluids is unlikely.

Practical guidance on preparing injections

The steps to be followed when preparing injections are:⁵⁴

- Before starting the injection session, and whenever there is contamination with blood or body fluids, clean the preparation surfaces with 70% alcohol (isopropyl alcohol or ethanol) and allow to dry.
- Assemble all equipment needed for the injection: sterile single-use needles and syringes, reconstitution solution such as sterile water or specific diluent, alcohol swab or cotton wool, sharps container.

Box 4.2. Injection safety in haemodialysis units

- Parenteral medications should be prepared in a designated clean area away from patient-treatment stations.
- Do not carry medication vials, syringes, alcohol swabs, or supplies in pockets. If trays are used to deliver medications to individual patients, they must be cleaned between patients.
- Single-dose vials should be dedicated to one patient only and should not be re-entered.
- Always use a sterile syringe and needle/cannula when entering a vial. Cleanse the access diaphragm of vials using friction and 70% alcohol. Allow to dry before inserting a device into the vial.
- Never pool or combine leftover contents of vials for later use.
- Use aseptic technique during all aspects of preparing, handling and administration of parenteral medication administration, medication vial use, injections, and glucose monitoring procedures.
- Scrub the hub of intravenous (IV) tubing and medication vials prior to accessing using friction and 70% alcohol, iodophor, or chlorhexidine/alcohol agent. Allow to dry prior to accessing.
- Never use infusion supplies such as needles, syringes, flush solutions, administration sets, or IV fluids on more than one patient. Never use IV solution containers (e.g. bags or bottles) for the purpose of IV flush solutions (or other purposes) for more than one patient.

- Do not use alcohol skin disinfection for administration of live attenuated vaccines.
- Do not pre-soak cotton wool in a container as these can become contaminated.

Procedure for septum vials

- Wipe the access diaphragm (septum) with 70% alcohol on a swab before piercing the vial, and allow to air dry before inserting a device into the bottle.
- Use a sterile syringe and needle for each insertion into a multi-dose vial.
- Never leave a needle in a multi-dose vial.

Practical guidance on administering injections

Aseptic techniques should be followed for all injections.

General

When administering an injection:

- perform hand hygiene;
- wipe the top of the vial with 70% alcohol (isopropyl alcohol or ethanol) using a swab or cotton-wool ball; and
- use a sterile syringe and needle, withdraw the medication from the ampoule or vial.

Reconstitution

- If reconstitution is necessary, withdraw the reconstitution solution from the ampoule or vial using a sterile syringe, insert the needle into the rubber septum in the single or multi-dose vial and inject the necessary amount of reconstitution fluid.
- Remove the needle and syringe and discard them immediately as a single unit into a sharps container.
- Mix the contents of the vial thoroughly until all visible particles have dissolved.

Needle-free system

- Wipe the rubber septum of the multi-dose vial with an alcohol swab.
- Insert the spike into the multi-dose vial.
- Wipe the port of the needle-free system with an alcohol swab.
- Remove a sterile syringe from its packaging.
- Insert the nozzle of the syringe into the port.
- Withdraw the reconstituted drug.

Box 4.3. Don'ts for injection safety

DO NOT:

- allow the needle to touch any contaminated surface;
- reuse a syringe, even if the needle is changed;
- touch the diaphragm after disinfection with 70% alcohol (isopropyl alcohol or ethanol);
- use the same needle and syringe for several multi-dose vials;
- use the same mixing syringe to reconstitute several vials;
- use bags or bottles of intravenous solution as a common source of supply for multiple patients (except in pharmacies using laminar flow cabinets);
- use a single loaded syringe to administer medication to several patients (i.e. ensure one needle, one syringe, one patient!);
- change the needle to reuse the syringe; and
- store leftover medications for later use.

Delay in administration

- If the dose cannot be administered immediately for any reason, cover the needle with the cap using a one-hand scoop technique.
- Store the device safely in a dry kidney dish or similar container.

6. Principles of asepsis

These are discussed in detail in Chapter 6.

7. Environmental infection control

a. Patient placement

Appropriate placement of patients is important in preventing the transmission of infections in the hospital setting.

General principles

- **Spacing between beds**

In open plan wards, there should be adequate space between each bed to reduce the risk of cross-contamination/infection occurring from direct or indirect contact or droplet transmission. The space between beds should be 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. Single rooms should have:

- o hand-washing facilities
- o toilet and bathroom facilities.

- **Anterooms**

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

Placement with regular admissions

- A room should be cleaned before admitting a patient. There should be a policy for cleaning the room (i) after patient discharge (terminal cleaning) and (ii) before admission.
- All patient-care items used by the previous patient should be removed and replaced with clean items, e.g. bed linen, waterproof covering, oxygen humidifiers, face mask, etc. as per the housekeeping policy.

- Patient-care equipment and articles should be cleaned, disinfected or sterilized according to the disinfection policy (see Annex 5.1).

Transport of patients

Movement and transportation of patients from the isolation room or area should be restricted to essential purposes only. This will reduce the possibility of transmission of microorganisms in other areas of the HCF.

Appropriate precautions should be taken during transportation to reduce the risk of transmission of microorganisms to other patients, HCWs or the hospital environment (surfaces or equipment).

Infection control precautions during transport of patients⁵⁵

- It is appropriate to place a surgical mask on the face of a patient with pulmonary tuberculosis during transit.
- Care should be taken of drainage and shunts and IV lines as these are potential sources for contamination of the environment, trolleys, etc. during transportation, and also a source of infection for the patient. Closed sterile drainage is to be maintained at all times. Shunts and IV lines should be covered with sterile dressing during transportation. A trolley should have the facility for hanging IV bottles, tying of urine bags below bladder level which helps in proper drainage of urine and prevents stagnation of urine.
- Change trolley cover between patients.
- Spills of blood and body fluids should be taken care of immediately.
- Routine cleaning schedules for trolleys and wheel-chairs should be maintained.

Policy for visitors

The HCF should have a visitors' policy depending upon the type of services and the

Box 4.4. Measures to improve adherence to standard precautions

- Staff education in hand hygiene, standard precautions
- Ready access to PPE
- Visual reminders at the patient's bedside in the form of posters, along with verbal reminders from supervising staff
- Bundling of supplies in designated supply carts or pre-organized packs to provide immediate access to PPE and facilitate their use in resuscitation settings
- Monitoring of adherence through "safety" rounds
- Possible disciplinary action if there are repeated lapses in adherence

type of patients in the hospital⁵⁶ (see Annex 6 for “Policy for visitors and attendants”).

b. Environmental cleaning

c. Linen and laundry

d. Waste management

The above three are discussed in detail in Chapter 5.

Transmission-based precautions

These precautions for aseptic techniques and device management for clinical procedures are applied in addition to standard precautions, depending upon the epidemiology and route of transmission of the agent/disease. These precautions are relevant to high-risk procedures (e.g. use of indwelling catheters and other devices, surgery, and other invasive procedures) and special settings (e.g. OTs, ICUs, neonatal wards, haemodialysis units and central reprocessing units). The following modes of transmission and appropriate transmission-based precautions should be adopted in HCFs (see Annex 7).

Airborne precautions

The airborne route of infection occurs through droplet nuclei of 1–5 micron that are disseminated through the air. These droplet nuclei can remain suspended in the air for varying periods of time and can travel long distances (>1 metre) and from room to room. Droplet nuclei arise from the drying of suspended droplets carrying the infectious agent.

Diseases that spread by the airborne route include: pulmonary or laryngeal tuberculosis, measles, chicken pox, pulmonary plague and viral haemorrhagic fever with pneumonia. Transmission of droplet nuclei within a short range may occur with SARS-CoV, human influenza, and other viral respiratory infections, during performance of aerosol-generating procedures.

Persons caring for patients with airborne infections should take the following precautions besides those related to patient placement and transport:

- **Respiratory protection:** persons entering the airborne infection isolation room should wear a particulate respirator, e.g. an N95 mask with a proper fit.

- **Restricted entry:** susceptible healthcare personnel should be restricted from entering the room of patients known or suspected to have airborne infections.
- **Immunize susceptible persons:** susceptible persons should be immunized as soon as possible following unprotected contact with vaccine-preventable infections.
- **Protection during aerosol-generating procedures:** for aerosol-generating procedures associated with pathogen transmission, appropriate PPE should be used in an airborne infection isolation room. N95 masks should be worn by persons performing aerosol-generating procedures (such as endotracheal suction and bronchoscopy) on patients with respiratory infections.

Droplet precautions

Droplet transmission occurs through large respiratory droplets >5 microns in size. Transmission occurs when infectious respiratory droplets are expelled by coughing, sneezing or talking, and come into contact with another person's mucosa (eyes, nose or mouth), either directly or via contaminated hands. Since these microorganisms do not travel over long distances, special air handling and ventilation are not required.

Infections transmitted through droplets include pneumonia, meningitis, group A streptococcal disease, pertussis, diphtheria and influenza, mumps.

During an influenza pandemic, the circulating human virus is expected to be transmitted in the same manner as seasonal influenza viruses. Hence, droplet precautions should be applied in addition to standard precautions.

Droplet precautions include:

- Patient placement: keep a minimum of 1–2 metre inter-bed distance.
- Cough etiquette: explain the importance of respiratory hygiene and cough etiquette to patients.
- Personal protective equipment: wear a triple-layered surgical mask within 1–2 metres of the patient. For practical purposes, it is advisable to use the mask when entering the patient's room. For aerosol-generating procedures, N95 masks should be used.
- Patient transport: the patient should wear a triple-layered surgical mask.

Contact precautions

Contact transmission of microorganisms during patient care is responsible for the majority of HAIs in patients and healthcare staff. Contact transmission can be direct or indirect.

Direct transmission

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

Indirect transmission

This involves the transfer of an infectious agent through a contaminated intermediate object (fomite) or person. These include:

- hands of HCWs;
- clothing after care of a patient colonized or infected with an infectious agent, which can then be transmitted to subsequent patients;
- patient-care devices that are shared between patients without cleaning and disinfection; and
- environmental surfaces that are inadequately disinfected.

Diseases transmitted through contact include:

- colonization or infection with multidrug-resistant organisms, enteric infections and skin infections;
- hand hygiene is important since contact transmission can occur in respiratory viral infections when respiratory secretions or droplets contaminate surfaces, which can contaminate the hands of HCWs.

Combination of contact, droplet and airborne precautions

Contact, droplet and airborne precautions may be combined for diseases that have multiple routes of transmission or in case of epidemiologically important organisms, risk group 4 organisms or where transmission routes are unknown. Combined precautions are recommended in case of Ebola and Nipah virus disease. They are always to be used in addition to standard precautions and should be applied to all suspects, probable and confirmed cases.

Triage and patient placement

A high index of suspicion is needed to identify potentially infectious individuals (including colonization of MDRO) in order to ensure their safe and timely placement.^{57,58}

Specific triage policies such as provision of visual alerts to remind patients to inform staff of fever or respiratory symptoms should be developed for early detection

and isolation, so as to minimize transmission of communicable diseases to other patients and HCWs in the outpatient setting. During triage, the following should be observed:

- Patients should be assessed for conditions that require transmission-based precautions to prioritize those who may require urgent care and isolation.
- Patients suspected to have transmissible infection should be accommodated in designated areas to minimize transmission of infection to other patients.
- Patients with respiratory symptoms should be provided a medical/surgical mask and educated in cough etiquette.
- Minimize the stay of infectious patients in the OPD by decreasing the waiting time before consultation and facilitating early departure from clinics.⁵⁹

Decision for patient placement

A decision on the placement of a patient suffering from a transmissible disease needs to be based on the transmissibility, route of transmission, condition of the patient, that is, whether the patient needs intensive care or end-of-life support.⁶⁰

Factors to be considered for a decision on patient placement are:

- mode and route of disease transmission;
- clinical factors
 - e.g. diarrhoea, cough, exudates, broken skin, mental impairment, incontinence
 - immune status of the patient or cohorts
- room availability;
- requirement as per public health advisory
 - e.g. pandemic influenza, Ebola and Nipah.

Placement in protective environment and isolation

A protective environment with ultra clean unidirectional air may be required for neutropenic patients and in some units such as transplant and oncology according to the level of immunosuppression of the patients.⁶¹

To minimize airborne particles, air must be circulated in the room with a velocity of at least 0.25 m/s through a HEPA filter. The HEPA filter removes particles of up 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 ways of protecting patients with severely lowered immune systems are:

- Visitors should avoid contact with the patient if they have infections (e.g. upper respiratory tract infections or herpes simplex blisters).
- Where appropriate, staff and visitors should wear PPE to protect the patient from microorganisms.
- Flowers or plants should not be put in the patient's room and a clean environment must be ensured.
- Environmental cleaning should be done twice daily and should consist of damp dusting and floor mopping to avoid creating aerosols.
- Strict aseptic techniques must be used for all clinical procedures.

Placement of patient with transmissible disease

Appropriate patient placement is a significant component of isolation precaution. A patient with a highly transmissible disease (e.g. chicken pox, TB, measles) should be placed in a single room with handwashing and toilet facility and airborne isolation.⁶²

- Cohorting patients: When a single room is not available, an infected patient is placed with another patient infected with the same microorganism. Only assigned HCWs must take care of those patients, especially during outbreaks.
- If a single room is not available, then arrangements can be made for isolating such patients at the corner of a ward where ventilation is adequate.
- Patient's relatives/attendants should be educated on the mode of transmission, hand hygiene and PPE.

5. Control of the environment

Air and ventilation

Introduction

Air is the source of airborne infections of which TB is the most common and endemic in India. Other airborne infections are measles and chicken pox. SARS and other serious respiratory viral infections can be transmitted through the air during aerosol-generating procedures such as intubation and bronchoscopy. Varicella (including disseminated zoster), highly pathogenic influenza, and smallpox may also be transmitted through the air route. Airborne infection occurs through droplet nuclei of less than 5 microns. These particles remain suspended in the air through various lengths of time and can travel over distances greater than 1 metre and at times even from room to room.

Ventilation can reduce the risk of infection through dilution and removal of infectious particles through air exchange. Improved ventilation in HCFs is essential in preventing transmission of TB and other airborne infections.

Ventilation systems

Table 5.1 gives a summary of the advantages and disadvantages of different types of ventilation systems for healthcare settings.⁶³

Natural ventilation

- Refers to fresh air that enters and leaves a room or other area through openings such as windows or doors.
- Natural ventilation is “controlled” when openings are fixed and unrestricted to maintain air flow at all times.
- Unrestricted openings (i.e. those that cannot be closed) on opposite sides of a room provide the most effective natural ventilation.
- In existing HCFs that have natural ventilation, when possible, effective ventilation should be achieved by proper operation and maintenance of openings, and by regular checks to see that openings remain free of obstruction at all times.

Table 5.1. Advantages and disadvantages of different ventilation systems

	Mechanical ventilation	Natural ventilation	Hybrid (mixed mode) ventilation
Advantages	Suitable for all climates and weather	Suitable for warm and temperate climates	Suitable for most climates and weather
	More controlled and comfortable environment	Lower capital, operational, maintenance costs for simple implementation	Energy saving relative to mechanical ventilation
	Occupants have limited control to affect ventilation	Capable of achieving very high ventilation rates	More flexible
Disadvantages	Expensive to install and maintain	Easily affected by outdoor climate and occupant's behaviour	May be more costly or difficult to design
	Can fail to deliver required ventilation rates through faulty design, maintenance or operation	May be difficult to plan, design, and predict performance	
	Noise from equipment	Reduced comfort level of occupants in extreme weather	
		Cannot achieve directional control of airflow, if required	

Source: Guidelines on Airborne Infection Control in Healthcare and Other Settings⁶³

- Simple natural ventilation can be optimized by maximizing the size of the windows, opening up fixed window panes and locating windows on opposite walls.
- Ventilation can also be optimized by the use of “mixing fans”. Types of mixing fans include ceiling fans, stand/desk mounted fans, or window/exhaust fans located in open windows.

Mixing of air can disperse pockets of high concentration of infectious particles, such as in the vicinity of patients.

The total number of infectious particles in the room will not change with mixing. Unless adequate ventilation is present, mixing fans will not be useful in dispersing infectious particles and reducing the risk of transmission.

A common problem with reliance on natural ventilation is that patients or staff close windows during cold weather or at night. Further, there is likely to be variability of airflow patterns due to varying weather. In colder climates where rooms are closed to keep the temperature adequately high even in winter, natural ventilation can be implemented by airing via windows at frequent intervals. If natural ventilation is inadequate, additional mechanical ventilation or other measures may be needed, especially in areas where the risk of transmission of TB is high.

Mechanical ventilation

Mechanical ventilation uses fans to drive the airflow through a building.

- Mechanical ventilation can be fully controlled and combined with air-conditioning and filtration systems as is normally done in some office buildings.
- Mechanical ventilation includes “mixed mode ventilation”, in which exhaust and/or supply fans are used in combination with natural ventilation to obtain adequate dilution when a sufficient ventilation rate cannot be achieved by natural ventilation alone.
- Mechanical ventilation with or without climate control may be appropriate where natural ventilation cannot be implemented effectively, or where such systems are inadequate given local conditions (e.g. building structure, climate, regulations, culture, cost and outdoor air quality).

Exhaust fans

The simplest form of mechanical ventilation is the use of exhaust fans, placed for instance in windows, to move air from inside a room to the outdoors.

- Exhaust fans may also be more acceptable to staff and patients than keeping windows consistently open.
- If exhaust fans are used, it is important to ensure that airflow is adequate, that air flows across the room (not in and out the same window or vent), and that exhaust fans and air intake (windows or vents) are not located so that short-circuiting may occur.

Challenges of achieving adequate ventilation and climate control

- Effective ventilation is often at odds with efforts to make indoor climate more comfortable. In practice, air cooling or heating with re-circulation of air is more energy efficient.
- The implication of installing a split air-conditioning and closing the doors and windows is, however, complete lack of air exchange.
- It is possible for rooms with air conditioning or heaters to have adequate ventilation. Careful attention must be given to ensuring adequate ventilation when installing climate control.

Minimum air-changes per hour

HCFs should maintain a minimum amount of ventilation during all climatic conditions. These recommendations are based on the minimum ventilation rate estimated to reduce the probability of infection in an enclosed room to less than 5% with an hour of exposure to an infectious source case.

Table 5.2 gives the minimum air-changes per hour (ACH) required for various healthcare settings.

Standards for natural ventilation

Where it is not possible to measure ACH, as is usually the case in rooms with

Table 5.2. Minimum air-changes per hour for various healthcare settings

Type of healthcare setting	Minimum air changes per hour	Minimum hourly averaged ventilation rates (litres/second/patient)
Registration areas	>6 ACH	> 40 litres/second/patient
Outpatient departments and waiting areas	>6 ACH	>40 litres/second/patient
Inpatient departments	>6 ACH	>40 litres/second/patient
High-risk settings and their waiting areas, ART centres, TB/chest departments (outpatient and inpatient bronchoscopy procedure room MDR-TB wards and clinics,) Airborne precaution rooms	>12 ACH	80–160 litres/second/ patient

natural ventilation, the following standards for ventilation ensure that air exchange is safely >12 ACH under all climactic conditions:

- Natural ventilation should be "controlled", with fixed, unrestricted openings that are insensitive to climactic conditions.
- Openings should constitute >20% of floor area.
- Openings should be on two sides, preferably opposite sides, for example, a 100 sq. feet room should have >10 sq. feet fixed, unrestricted openings on two sites, for a total of 20 sq. feet.

Considerations for hot climates

Climatic extremes may require some adjustments to ensure that minimum ventilation standards are achieved. In the case of hot climatic conditions, the following design considerations should be kept in mind.

- Air conditioners must be avoided, or used very cautiously in patient care areas. If air conditioners are used, it must be acknowledged that the need to maintain adequate ventilation for airborne infection control may to some degree necessarily compromise the comfort of the occupants and the efficiency of the air conditioner.
- Solar heat gain must be minimized through proper use of sunshades or external shading.
- Outdoor shaded waiting areas must be used to the greatest extent possible.
- Where augmentation of ventilation is required, the use of air supply fans may help improve thermal comfort, compared to exhaust fans.
- The use of evaporative coolers ("desert coolers") may be an effective solution to achieve both comfort and adequate ventilation, as these tend to have powerful fans. Proper maintenance, however, is essential. An online tool for estimating the total fan rating for a given room can be found at <http://www.csgnetwork.com/airexchangecalc.html>. This reference is provided for convenience, and is not an endorsement of the site.
- The installation of "whirlybirds" (also known as whirligigs or wind turbines) that do not use electricity and provide a roof exhaust system can greatly increase both ventilation and comfort.

Considerations for cold climates

In cold climates, high ventilation rates may adversely affect thermal comfort, and are difficult to achieve as windows may be closed to keep the building warm. Even if normal heating is introduced, high ventilation rates usually mean low energy efficiency. Therefore, ventilation and heating strategies must be planned carefully.

- The building design should seek to capture solar heat and minimize conduction loss through the wall. Proper insulation of walls and the use of double glazing on windows are desirable.
- Where augmentation of ventilation is required, the use of air exhaust fans may help maintain adequate ventilation, even where windows or doors are closed.
- Targeted radiant or direct near-body heating methods are more effective than common convective radiators. This includes modern electric coil heaters and heated blankets/ mattresses.

Directional control of air flow

- Directional control of air flow is recommended in specific high-risk settings where infectious patients with drug-resistant TB or other acute respiratory diseases of potential concern are likely to be managed – i.e. airborne precaution rooms, MDR-TB wards and clinics, and bronchoscopy suites.
- There should be a system in place for minimizing the chance of airflow from the room to other parts of the facility. In a room relying on natural ventilation that is situated away from other patient care areas, no additional changes would be required. However, it would be important to keep the doors to the corridor or other rooms closed, to prevent the escape of infectious aerosols to other parts of the facility.
- Assessment of the direction of air movement can be done easily using smoke tubes, strips of ribbon, or by observing the directionality of dense smoke from “dhoop” or incense stick.
- Directional control of airflow can be achieved in mixed mode ventilation by paying proper attention to adequate exhaust and supply ventilation.

Optimal arrangement of patients and staff in relation to the direction of air flow

- Healthcare staff should be mindful of the direction of airflow to ensure that they are closest to the clean air source, and that patients are closest to the exhaust. This involves arranging patients and staff so that contaminated air is not likely to cross directly into staff/patient spaces.
- The natural direction of air flow should be between patients and staff, and not across patients and staff. This is especially important for settings such as DOT centres, OPD examination rooms, and smear microscopy laboratories.

Seating arrangement in a naturally ventilated room is given in Fig. 5.1. The healthcare worker is marked with a red cross. Seating “B” is better than seating “A” as the potentially infected air from the patient with airborne disease does not cross the healthcare worker.

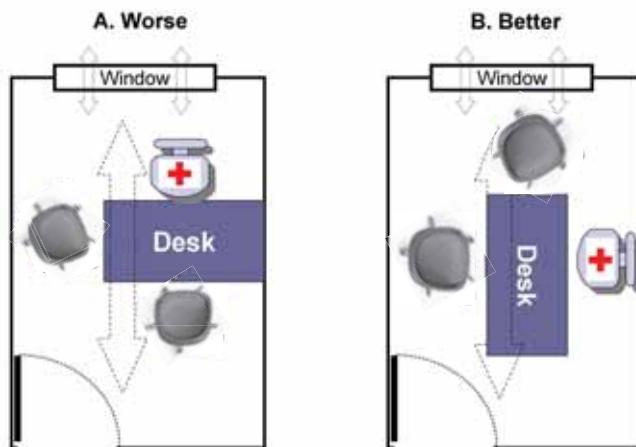


Fig. 5.1. Seating arrangement in a naturally ventilated room⁶³

A diagrammatical representation of a mechanically ventilated room with optimum directional airflow control is shown in Fig. 5.2. In “A” the supply of air is on one side and exhaust on the other; whereas in “B”, the supply is from the top and exhaust near the patients’ head and foot end.

Filtration (HEPA filters)

Filtration is another option to remove infectious particles from the air. Filtration may be considered where:

- sustainable resources for membrane replacement and maintenance are assured;
- natural ventilation is not possible; and
- risk of airborne transmission and morbidity are high such as bronchoscopy suites, laboratories and individual rooms for patients with TB.

Filtration devices perform poorly in high-dust conditions, as the effectiveness in terms of equivalent air exchange can diminish rapidly. Attention should be given to the equivalent air exchanges per hour that the filter requires. If filters are chosen, only true-HEPA membrane filters (rated to remove 99.97% of 1-micron particles) should be entertained.

Other filtration mechanisms, such as ionizers, have not been adequately studied.

The use of single rooms with HEPA filtration may reduce the risk of HAI by airborne fungi, in particular *Aspergillus* spp. This is particularly important where renovation, building or demolition are in progress in the hospital or nearby.

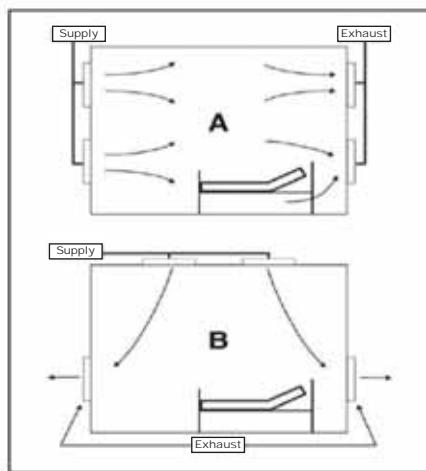


Fig. 5.2. Diagram of mechanical ventilated room with optimum directional airflow control⁶³

Heating ventilation and air-conditioning systems

In modern hospitals, heating, ventilation and air-conditioning (HVAC) systems control the concentration of airborne particulates in high-risk areas such as transplant units, operation theatres, intensive care units, and burn units to minimize the risk of infection by means of air pressure, flow control and air filtration (the physical removal of particulates from air). The three types of filtration used in central airconditioning are (i) coarse or pre-filters for large particles; (ii) micro-fine filters which filter up to 5 microns; and (iii) HEPA filters which keep out up to 0.3 microns with 99.97% efficiency.

There is evidence that there is a lower incidence of infection when immune-compromised and other high-acuity patients are housed in HEPA-filtered isolation rooms.

Laminar air flow^{64,65}

This is HEPA-filtered air blown in a unidirectional pattern with 100–400 ACH. LAF systems are thought to minimize contamination of the surgical field with airborne microbes and thus to contribute to reducing surgical site infections (SSIs). LAF systems should be available for prolonged procedures such as transplant and replacement surgery, neurosurgery, orthopaedic and implant surgery.

Airborne precaution room

Airborne precaution rooms can be naturally ventilated or mechanically ventilated. It is acknowledged that mechanical ventilation is expensive to instal and maintain

in precaution rooms, often does not deliver the recommended ventilation rate, and may fail to maintain negative pressure.

Recommended specifications and procedures for airborne precaution rooms are:

1. Room layout

- Post signage on the door.
- Ensure appropriate hand-washing facilities.
- Ensure appropriate room ventilation (>12 ACH).
- Ensure directional control of air flow, with air flow entering the room only when the door is open, and exhausted outside safely.
- In naturally ventilated airborne precaution rooms, the air flow should be directed to areas free of transit, or safely outside where it may be diluted.
- In mechanically ventilated airborne precaution rooms, to control the direction of air flow the pressure of the room should be maintained slightly less than the pressure of the entry area (i.e. “negative pressure”), so that air flows into the room when doors are open:
 - clean-to-dirty airflow;
 - a negative pressure differential of >2.5 Pa (0.01-inch water gauge);
 - an airflow differential >125-cfm (56 L/s) exhaust relative to supply;
 - sealing of the room, allowing approximately 0.5 square feet (0.046 sq. metre) leakage; and
 - an exhaust to the outside, or a HEPA-filter if room air is re-circulated.

2. Room setup

- Remove all non-essential furniture; the rest should be easy to clean, and should not conceal or retain dirt or moisture within or around it.
- Set up a trolley outside the door to hold PPE.
- Stock PPE supply and linen outside the precaution room/area (e.g. in the changing room).
- Stock the sink area with suitable supplies for handwashing, and with ABHR near the point-of-care and room door.
- Place appropriate waste bags in a bin. If possible, use a touch-free bin. Dirty bins should remain inside the precaution rooms.
- Place a puncture-proof container for sharps disposal inside the precaution room/area.
- Place an appropriate container with a lid outside the door for equipment that requires disinfection or sterilization.

3. Procedures

- Before being allowed into the airborne precaution areas, visitors should consult

the nurse in charge, who is also responsible for keeping a visitor record. A roster of all staff working in the airborne precaution areas should also be kept for possible outbreak investigation and contact tracing.

- Patient-care equipment that is required for use by other patients should be thoroughly cleaned and disinfected before use.
- Ensure scrupulous daily cleaning of the airborne precaution room/area.

Cleaning and sanitation

Need for cleaning and sanitation

Dry conditions favour the persistence of Gram-positive cocci (e.g. coagulase-negative *Staphylococcus* spp.) in dust and on surfaces, whereas moist, soiled environments favour the growth and persistence of Gram-negative bacilli. Fungal spores are present in dust and fungi can proliferate in moist, fibrous material.

Pathogenic organisms that survive in the environment can be a source of infection for patients admitted in the hospital. Therefore, it is important to clean the environment thoroughly on a regular basis. This will reduce the bacterial load, get rid of soil and make the environment unsuitable for growth of microorganisms.

Hospitals need to practise and maintain the highest standards of hygiene and an environment conducive to speedy patient recovery.

General principles of cleaning and sanitation⁶⁶

Regardless of the agent used for cleaning, the following protocol must be followed:

- Staff should be properly trained on the practices of cleaning and decontamination of hospital surfaces.
- Appropriate PPE should be worn and a log of all cleaning procedures must be maintained.
- Housekeeping surfaces can be divided into two groups – those with minimal hand-contact (e.g. floors and ceilings) and those with frequent hand-contact or “high touch surfaces” (e.g. doorknobs, bedrails, light switches, wall areas around the toilet in the patient’s room, and the edges of privacy curtains).
- All housekeeping surfaces (floors/table tops/counters) should be cleaned on a regular basis, when visibly soiled and when spills occur. Either hot water or a neutral detergent may be used or a detergent/disinfectant may be used.
- Housekeeping surfaces should be cleaned with a detergent/disinfectant solution on a daily basis or more frequently in specific high-risk areas (ICUs, transplant units, isolation rooms, burns wards, OTs, emergency rooms, or

when there are suspected spills of blood/body fluids) and in areas that have patients with known transmissible infectious diseases.

- All horizontal surfaces and all toilet areas including washbasins and commodes should be cleaned daily.
- Administrative and office areas with no patient contact require normal domestic cleaning.
- Fresh detergent/disinfectant solutions must be prepared every day according to manufacturers' instructions. These solutions must be replaced with fresh solutions frequently.
- Diluted disinfectant solutions may become contaminated with resistant pathogens. Therefore, after the day's use, the remaining solutions must be discarded and containers must be cleaned with detergent before being dried.
- High-touch surfaces must be cleaned and disinfected more frequently than minimal-touch surfaces.
- The methods of cleaning floors include wet mopping, and vacuum cleaning with filters attached. Avoid dry mopping with brooms, as this generates dust aerosols.
- Horizontal surfaces must be wet dusted with a cloth moistened with a hospital disinfectant (or detergent).
- Contamination of cleaning solutions and mops must be minimized. For wet mopping, a two-bucket method should be used. When a single bucket is used, the solutions should be changed more frequently. Used cleaning solutions must be discarded in the sluice. The buckets should be cleaned with detergent and kept inverted to assist drying.
- Mop heads must be changed after cleaning spills and at the beginning of the day.
- Mop heads and cleaning cloths must be decontaminated regularly by laundering (heat disinfection) with detergent and drying at 80 °C.
- Walls, blinds and window curtains must be cleaned when visibly soiled or contaminated.
- Disinfectant fogging is not recommended for routine patient care areas.
- Bacteriological testing of the environment is NOT RECOMMENDED as a routine unless seeking a potential source of an outbreak.

Blood and body substance spill management

Splashes of body fluids on walls and surfaces can be cleaned by using a high-level disinfectant.

- Use PPE (gloves, face masks and fluid-resistant gowns) for cleaning blood spills. Wear protective shoe covers/boots when cleaning large spills.

- For decontamination of small spills (<10 ml), if sodium hypochlorite solution is selected, use a 1:100 dilution (525–615 ppm of available chlorine) (Table 5.3). If spills involve larger amounts of blood, or involve a spill of microbiology cultures in the laboratory, a 1:10 dilution of hypochlorite solution for first application (before cleaning) reduces the risk of infection during cleaning. After the first application, remove the visible organic matter with absorbent material (e.g. disposable paper towels), discard into leak-proof, labelled bag/container and then dispose of as per waste management guidelines.

Cleaning agents and disinfectants for environmental use

A neutral detergent and warm water solution should be used for all routine and general cleaning. When a disinfectant is required for surface cleaning, e.g. after spillage or contamination with blood or body fluids, or in special areas such as the surgical unit, dialysis unit and ICU, the manufacturer's recommendations for use and occupational health and safety instructions should be followed. Table 5.4 lists the disinfectants used for the environment, their recommended use and precautions.

Table 5.3. Preparation of hypochlorite solution of 0.5%, 1% and 2%

Product	Chlorine available	0.5%	1%	2%
Sodium hypochlorite – liquid bleach	3.5%	1 part bleach to 6 parts water	1 part bleach to 2.5 parts water	1 part bleach to 0.7 parts water
Sodium hypochlorite – liquid	5%	1 part bleach to 9 parts water	1 part bleach to 4 parts water	1 part bleach to 1.5 parts water
NaDCC (sodium dichloro-isocyanurate) – powder	60%	8.5 grams to 1 litre water	17 grams to 1 litre water	34 grams to 1 litre water
NaDCC (1.5 g/tablet) – tablets	60%	6 tablets to 1 litre water	11 tablets to 1 litre water	23 tablets to 1 litre water
Chloramine – powder	25%	20 g to 1 litre water	40 g to 1 litre water	80 g to 1 litre water

Bleach solution becomes unstable rapidly, hence it needs to be freshly prepared daily or changed on becoming dirty/turbid. Chlorine bleach can be corrosive. Protect metal instruments by thoroughly rinsing them with water after soaking for 10 minutes.

Policy for cleaning, sanitation and disinfection

The healthcare facility should develop a policy for cleaning, sanitation and disinfection of environmental surfaces.

Table 5.4. Common cleaning agents and disinfectants for environmental cleaning

Disinfectants	Recommended use	Precautions
Sodium hypochlorite 1% in-use dilution; 5% solution to be diluted 1:5 in clean water	Disinfection of material contaminated with blood and body fluids	<ul style="list-style-type: none"> • Should be used in well-ventilated areas • Protective clothing required while handling and using undiluted • Do not mix with strong acids to avoid release of chlorine gas • Corrosive to metals
Bleaching powder 7 g/L with 70% available chlorine	Toilets/bathrooms – may be used in place of liquid bleach if this is unavailable	Same as above
Alcohol (70%) isopropyl, ethyl alcohol, methylated spirit	Smooth metal surfaces, table tops and other surfaces on which bleach cannot be used	<ul style="list-style-type: none"> • Flammable, toxic – to be used in well-ventilated area, avoid inhalation • Keep away from heat source, electrical equipment, flames, hot surfaces • Allow it to dry completely, and avoid diathermy burns
Detergent with enzyme	Cleaning endoscopes, surgical instruments before disinfection is essential	

Source: Practical guidelines for infection control in healthcare facilities

The key elements are:

- The interiors and external areas and premises of the hospital should be kept clean and odour free.
- Solid waste and garbage should be removed and disposed of hygienically.
- A hospital cleaning manual should be developed to provide detailed guidelines for procedures and practices.
- There should be a cleaning schedule for daily, weekly and terminal cleaning. The cleaning process, be it for a single room, or ward, must be coordinated with the nurse in-charge.

An example of a cleaning and sanitation policy including methods and procedures for cleaning various areas in the hospital is provided in Annex 5.2.

Safety of cleaning and sanitation staff

- Housekeeping staff should be enrolled in the hospital's occupational health programme and provided immunization against hepatitis B and tetanus.
- Appropriate and adequate PPE should be provided and staff trained in its use.
- Training should be provided in safe work practice, IPC policies and procedures relevant to their work and biomedical waste management.
- If commercial/outsourced housekeeping is used then contract housekeeping must comply with the IPC policies and guidelines.

Accidental exposure to blood or body substances

Inoculation injuries, such as needle-stick, other sharps injuries, bites, scratches and splash contamination of broken skin require immediate action:

- The area should be washed with soap and running water and bleeding should be encouraged. The wound should not be sucked.
- A waterproof dressing should be applied.

Splashes to intact skin: The affected area should be washed immediately with warm soapy water.

Splashes to the mouth: The mouth should be rinsed with large quantities of water.

Splashes to the eyes: Eyes should be irrigated immediately with water or, if available, with sterile saline.

Reporting

Inoculation injuries, splashes to mouth, eyes and mucous membranes should be

reported to the department manager and to the occupational health department or the emergency department for further advice, whichever is specified by the hospital policy.

For protection of the healthcare worker, see Chapter 8 and Annex 4.

Safe water and food

Provision of safe water

HCFs should have adequate and continuous supply of safe water. Safe water should be available for drinking, handwashing, food preparation, personal hygiene, medical activities, cleaning and laundry. The requirement of water for hospitals with a bed strength of less than 100 is 340 litres/bed/day, whereas for hospitals with bed strength over 100 beds, it is 400 litres/bed/day.

Water in healthcare facilities should be of drinking water quality and meet the national standards for drinking water. The institution is responsible for the quality of water once it enters the building. Drinking water should be safe for oral ingestion. Tap water may not be safe for drinking in our country and requires treatment to be safe for oral ingestion and to meet the standards for drinking water. Contaminated water from the water system can be a source of infection. Biofilms are slimy layers consisting of a community of microorganisms that form on surfaces immersed in water. Biofilms in storage tanks, tap water and showers have been linked to nosocomial outbreaks. Faecal contamination of water can also occur and unless adequate treatment is provided, contamination may be sufficient to cause infection through handwashing, food preparation, bathing, and during the general care of patients.

The criteria for drinking water are not adequate for the medical uses of water.⁶⁷ Medical uses of water require additional treatment. Some of the medical uses of water are: purified water for the preparation of injections which must be sterile, water required for haemodialysis which should be purified and free from contaminants and has its own standards. Bacterial and endotoxin limits for dialysis fluids are given in Chapter 6.

Reducing water-borne transmission

Waste water from healthcare facilities may lead to the contamination of the municipal water system, surface water or ground water of the community and therefore should be adequately treated.⁶⁸

Waste water from a hospital needs to be treated by an effluent treatment plant as

directed by the Biomedical Waste Management and Handling Rules 2016, 2018 (see Chapter 5 and Annex 8.4).

Water supply system

- It should be designed and maintained with proper temperature and adequate pressure.
- Stagnation and back flow should be minimized and dead-end pipes should be avoided.
- Growth of *Pseudomonas* spp. and other bacteria can be prevented if the water system maintains water at the right temperatures, i.e. cold water at a temperature below 20 °C, stored hot water above 60 °C, and circulated hot water with a minimum return temperature of 51 °C.
- Clean water pipes should not run alongside waste water pipes as this may lead to waste water being sucked into the clean water pipes through leaking cracks and joints.
- When the water system cannot supply water of the recommended standards for drinking, measures such as boiling, chlorine treatment, and filtration or reverse osmosis are recommended at the point of use.

Point-of-use fixtures

- Water fixtures such as sinks, faucets, aerators, showers, and toilets have been identified as potential reservoirs for pathogenic microorganisms.
- Regular cleaning, disinfection and preventive maintenance protocols should be followed, especially in areas housing immunocompromised patients.

Water storage tanks

Due to the lack of continuous running water, many hospitals have to use stored water. These storage tanks can be large overhead tanks or smaller tanks at the ward level. Overhead storage tanks should have the capacity to store 48 hours of water requirement.

Large overhead water tanks

Water storage tanks should be covered with appropriate sealed lids and need to be under lock and key. The tanks should be thoroughly cleaned at regular intervals.

Water storage tanks at ward level

- The cleaning of the potable water storage tank at the ward level should be done daily and the tank must be provided with a tap or stop cock.
- The tank should be kept securely covered at all times.

- Water provided for drinking must be adequately filtered or treated by reverse osmosis. Boiled and cooled water should be provided to immunocompromised patients. Water should be boiled in a covered container to 100 °C for 20 minutes, cooled, covered and then used. Boiled water standing for over 8 hours should not be used for drinking.
- Disposable plastic water bottles should not be used. Traditional stainless steel jugs and cup/glass should be provided and daily cleaning should be ensured.
- Water filters/RO systems should be regularly maintained. Their efficacy should be checked regularly and records maintained. Random sampling of water for microbiological analysis should be done periodically.
- Patients and their relatives should be educated about the importance of safe drinking water.

Procedure and schedule for water tank cleaning

- The tanks must be emptied completely by using pumps, followed by thoroughly cleaning water tanks from inside including all walls, floor, beams and ceiling and any other parts.
- Water must be bailed out manually or by pumping, draining out and removing all the residual water and silt.
- Cleaning should be done manually first and then mechanically by using stiff wire brushes and then removing all fungus/algae by using soda bicarbonate/bleaching powder of approved grade and quantity, followed by flushing thoroughly with water.
- All corners and joints must be heated with hot air to kill germs, and then rinsed thoroughly twice with clean water.
- The workers should wear clean gloves, masks and gum boots for safety.
- The work should be organized so as not to disturb the routine.
- Cleaning should be carried out over the weekend/holiday after office hours of the hospital and in consultation with the engineer in-charge.
- Refilling of tanks should be started only after due inspection is carried out by the engineer in-charge.
- All tools such as ladders, brushes, pump, hot air guns, buckets and drums required for this work should be as specified by the engineer in-charge.

Plumbing job guidelines

- The hospital water supply system must not be connected to any other piping system or fixtures that could allow contamination without the use of adequate air gaps or approved back flow preventers or vacuum breakers.
- When using implements to unstop faulty drains, rubber gloves should be worn.

- When cleaning out main sewer lines, or when exposed to gross contaminated waste, protective gear such as rubber boots and rubber gloves, goggles and mask must be worn. Equipment and machines must be used as per regulations for cleaning sewer lines.
- After exposure to sewer lines or gross contaminated waste, the exposed areas of the body should be cleaned with soap and water. Change uniform if necessary. Do not return to patient care areas before cleaning up.

Microbiological testing of water⁶⁹

Water used for drinking, handwashing, cleaning and disinfection should be tested as decided by the HICC. The suggested frequency is every three months and additionally if the source of water is changed, or after major repairs of the water supply system, or when a waterborne outbreak is suspected. Suggested sites of collection of water for testing are: hand wash/scrub sinks in the OT, ICUs, OPD/emergency, ward that caters to the maximum number of patients, RO/filtered water, drinking water sources. The samples should show absence of coliform organisms.

Disinfection of water sources

Water sources and tanks may be disinfected by adding chlorine in the form of bleaching powder, high strength calcium hypochlorite or liquid bleach. The quantity of the chemicals needed to disinfect water for drinking can be calculated, the dose being approximately 0.7 mg of applied chlorine per litre of water.

The testing of water sources for free chlorine is done to measure the potability of water. The presence of free chlorine should be at 0.2 ppm, which indicates that an adequate amount of chlorine was added to inactivate the contaminating bacteria and viruses and that the water would be free from contamination during storage.

Provision of safe food and kitchen hygiene

The quality and quantity of food are key factors for patient convalescence. Ensuring safe food is an important service delivery in healthcare.⁷⁰

The dietary department ensures that food prepared and served to patients, visitors and employees is received, stored, prepared and served in a manner that avoids contamination. The aim is to prevent food- and waterborne infections. The dietary department should have a manual in which all the procedures for preparation and handling of food are available.

The guidance document by the FSSAI (Food Safety and Standards Authority of India) on the food management system must be followed.⁷¹

Risk factors in hospital kitchens

These are mainly due to contamination of food, stale food, storing food at room temperature or inadequate refrigeration, unhygienic preparation of enteral or baby feeds, with food-handlers being carriers. Food contamination can be prevented by:

- reliable and good-quality supplies;
- adequate storage facilities;
- hygienic precautions;
- personal hygiene, hand hygiene;
- use of uniform including hair covering and gloves;
- screening of food handlers for infectious diseases (enteric, respiratory or skin infections).

Kitchen procedures

Pre-preparation

The pre-preparation area must be well segregated into dry and wet zones. All contact surfaces must be pre-sanitized. Vegetarian cutting boards must be sanitized with 50 ppm chlorine and non-vegetarian cutting boards with 100 ppm chlorine, with a minimum contact of 2–3 hours.

Storage facilities

- There must be adequate storage facilities for all items, including food ingredients, equipment, and non-food materials such as utensils, linen, single-service and single-use articles, packaging and chemical agents. During storage, food items must be protected from contamination such as water leakage, pest infestation or any other insanitary condition. Adequate off-the-floor shelves and racks must be used for storing food. Floors should not be used for storing food.
- The storage area must be cleanable and in a dry location to prevent deterioration. It should be protected from pests and should be away from locker rooms, toilets, sewer lines, stores of chemicals/pesticides.
- The storage facilities should be designed and constructed to avoid cross-contamination.
- Cold storage at 4 °C–8 °C and freezer at –18 °C should be provided for foods that need refrigeration and for frozen foods, with a separate refrigerator and freezer for vegetarian and non-vegetarian products.
- Separate storage sections should be provided for raw, processed, packaged, rejected, returned or recalled food items. Allergenic material or foods like groundnuts must be distinguishably marked.
- Cleaning agents should have prominent labels and stored separately.

Food temperature

Cold food items are refrigerated and maintained at 4 °C–8 °C or below.

Walk-in storage facilities are maintained at the following temperatures and the temperatures are checked daily and a log is maintained of the temperatures.

Foods prepared to be served cold are cooled from their preparation temperature to 4 °C or below. The cooling period should not exceed 4 hours. Hot foods are held at an internal temperature of 63 °C or above. Both hot and cold food items should be transported in food trolleys in such a manner that appropriate temperatures are maintained during the transportation of the food.

Food type	Temperature
Frozen food	-18 °C
Cooked food	Above 60 °C
Cold food	Below 5 °C
Dry stores	At room temperature

Special formula food

Infant formulas and other formulas prepared by the dietary department and ward pantry are subject to specific preparation and storage policies and procedures that may be found in the dietary department manual. These are microbiologically checked only when epidemics occur.

Food for immunocompromised patients

The food for this set of patients should be double cooked. Food should be cooked again in a pressure cooker just before serving.

Food distribution

- Food trays are placed in food trolleys which are brought to the ward from the kitchen. The trays are dispensed in the ward. Food should be handled in a hygienic manner throughout this process. Trays should be kept covered when food is served in the ward.
- Dietary workers should be taught to observe standard precautions to protect themselves and patients.

Cleaning of utensils

- The returned trays should be heat treated to render the items sanitized (wash temperature 65 °C–70 °C, rinse temperature 85 °C–95 °C).

- If a utensil is cleaned in a pantry at the ward level, a hot water connection should be provided for effective cleaning and disinfection.

Kitchen staff hygiene

Dietary personnel should be taught to protect food consumers from their body substances. Barriers (see uniform below) should be provided to dietary personnel, and hygienic practices should be taught and supervised as per the guidance in the catering section of the guideline of FSSAI.

Uniform

Uniforms must be changed daily and provision must be made to supply clean uniforms daily.

- Aprons
- Hair covering and caps
- Gloves
- Footwear: dedicated footwear is to be used in kitchens.

Screening for infectious diseases (enteric, respiratory or skin infection)

All food handlers must undergo medical examination by a registered medical practitioner and must be free from infectious and transmissible diseases.

Employees should report the following conditions to the supervisor for possible exclusion from food handling areas—jaundice, vomiting, diarrhoea, fever, sore throat with fever, visibly infected lesions, boils, cuts, sores and discharge from ears/eyes/nose, etc. (Personnel with open cuts, wounds or burns shall be required to cover them with suitably waterproof dressings before starting operation.)

Food handlers must maintain a high degree of personal hygiene.

Hair, nails, and moustache/beard must be properly trimmed and hair must be tied and gloves worn at all times.

Hand hygiene

Hands should be washed after handling non-food chemicals and incompatible food products (such as raw versus cooked food) or contaminated material.

Hand washing should be mandatory and repeated after using the toilet, eating or drinking, arranging or combing the hair, touching the face, nose or eyes, contact with unclean equipment and work surfaces and after handling raw food. Placement of liquid soap and single use towel in the toilets is mandatory.

Personnel should wash exposed portions of their arms and hands with soap and water before starting work.

Personal habits

Staff should keep short nails and not wear religious bands, wrist bands, rings, bracelets and nail polish on duty.

- Keep clothing free from obvious dirt and food spills.
- Use hair nets (hair restraints) while on duty.
- Use serving tools/utensils to handle food whenever possible.
- Do not consume food or drinks in the food preparation or serving areas.
- Do not use tobacco products in any form while engaged in the preparation or serving of food.

Environmental hygiene and sanitation

- The kitchen design should be appropriate. This includes areas for receiving raw material, storage of material, facility for storing perishable items, i.e. cold storage, facility for “first in first out” particularly for raw food such as onions and potatoes. Adequate supply of clean (potable) water should be ensured.
- Raw material cutting surfaces should be segregated because raw material such as spinach and vegetables with roots bring in soil and dirt.
- Food should be served as soon as possible after preparation.

Water

Uninterrupted potable water and hot water supply should be available in the kitchen.

Cleaning schedule

- All surfaces should be cleaned with detergent and hot water followed by drying, which is mandatory.
- Chopping boards should be cleaned and disinfected after cutting.
- The kitchen should be kept dry. A separate area should be provided for washing. Utensils and vessels should be washed in a sink.
- Cleaning activities should be recorded.
- Cleaning of areas where special meals are prepared should be done using separate and dedicated cleaning equipment.

Maintenance of refrigerators and cold storage

Regular temperature check and cleaning of refrigerators should be done according to a schedule, which should be recorded.

Disposal of waste from the kitchen

Food returned to the kitchen should be discarded. These and other dietary wastes should be kept in bins lined by black plastic bags outside the dietary department, which are removed regularly.

Raw kitchen material after cutting vegetables, fruits, etc. can be composted if suitable space is available.

Waste stores and dustbins must be kept appropriately clean, free of pests and in closed conditions, and should be disposed of as per local rules and regulations, including those for plastic and other non-environment-friendly materials.

Environment control

This includes maintenance of ventilation, lighting, plumbing, drainage system, floors, walls, ceilings, doors and windows, service lift cleaning schedule and maintenance.

Weekly thorough cleaning of the kitchen should be carried out and recorded.

Ventilation

Natural/mechanical ventilation systems including air filters and exhaust fans should be provided. They should prevent grease or condensation from collecting on the walls and ceiling, and must be easy to clean. Maintaining a good ventilation system in the kitchen is necessary. Regular cleaning of all vents/AC filters must be carried out in a systematic manner at least once a week; record to be maintained by the engineering department.

Hygienic transportation of food

- The conveyance must be clean, maintained and repaired so that there is no food contamination.
- Adequate temperature must be maintained for all types of foods and must be protected from pests, foreign matter and environmental pollution.
- The conveyance must be used only to carry food and for no other purpose.

Outbreaks

Bacterial food poisoning (acute gastroenteritis) is an infection or intoxication manifested by abdominal pain and diarrhoea, with or without vomiting or fever. The onset of symptoms may range from less than one hour to more than 48 hours after eating contaminated food. Usually, large numbers of organisms actively growing in food are required to initiate symptoms of infection or intoxication. Water, milk, and solid foods are all vehicles for transmission.

When a foodborne illness is suspected, the HICC is notified. The Microbiology department will obtain specimens from symptomatic individuals and from suspected food. The HICC will be responsible for obtaining significant histories and conducting the investigation of a suspected foodborne illness.

Biomedical waste

The modern hospital is a complex multidisciplinary system, which consumes several types of items for the delivery of patient care. All these products consumed in the hospital have some unusable leftovers, which are called healthcare/clinical waste as they are generated as a result of some clinical activity. Biomedical waste is a broader term applied to waste generated in the diagnosis, treatment or immunization of humans and animals, in research or in the production and testing of biological products.⁷² It also includes the waste coming out of medical treatment given at home or in health camps.

Infectious waste

Infectious waste includes all healthcare/clinical waste that has the potential to transmit viral, bacterial, fungal or parasitic disease. It includes both human and animal waste, waste generated in laboratories and veterinary practice. Hazardous waste is any waste with a potential to pose a threat to human health and life. Infectious waste is a part of hazardous waste.

Any waste contaminated with blood, body fluids, excretions and secretions is potentially infectious. One of the most hazardous waste is contaminated sharps waste, which is a part of infectious waste and can also cause injury. The most common documented transmission of infection from waste to HCWs is through contaminated needles. Laboratory waste is a major potential reservoir of pathogenic microorganisms and requires appropriate handling.

Effect on human health and environment

Along with the effect on hospital personnel and patients within the hospital, the impact on human health and environment outside the hospital is also important. Infectious waste can transmit numerous diseases in the community and also to those who handle waste. Besides, the increasing use of disposables in healthcare is also posing an additional burden on the waste management facility. It is extremely important that the unscrupulous reuse of these disposable items is prevented.

Health hazards associated with poor healthcare waste management are:

- Injuries from sharps to all categories of hospital staff and waste handlers;
- HAIs in patients because of poor IPC and poor waste management;
- Risks of infections outside hospitals for waste handlers, scavengers, and eventually the general public, changes in microbial ecology, spread of antimicrobial resistance; and
- Risks associated with handling of hazardous chemicals and drugs at all levels.

National rules for biomedical waste management

The Ministry of Environment, Forest and Climate Change published the Biomedical Waste Management Rules on 28 March 2016. These rules superseded the Biomedical Waste (Management and Handling) Rules, 1998. The 2016 Rules have been amended in 2018 and 2019.

- These Rules apply to all persons who generate, collect, receive, store, transport, treat, dispose, or handle biomedical waste in any form, including hospitals, nursing homes, clinics, dispensaries, veterinary institutions, animal houses, pathological laboratories, blood banks, AYUSH hospitals, clinical establishments, research or educational institutions, health camps, medical or surgical camps, vaccination camps, blood donation camps, first-aid rooms of schools, forensic laboratories and research laboratories.
- Safe and proper identification, handling, storage, and disposal of biomedical waste from laboratories and related facilities is the responsibility of every occupier. "Occupier" means a person having administrative control over the institution and the premises generating biomedical waste, which includes a hospital, nursing home, clinic, dispensary, veterinary institution, animal house, pathological laboratory, blood bank, HCF and clinical establishment, irrespective of their system of medicine and by whatever name they are called. Duties of the Occupier/HCF are given in Annex 8.1.

Box 5.1. Categories of waste*

- **Yellow:** for human anatomical waste, animal anatomical waste, soiled waste, expired or discarded medicines, chemical waste, chemical liquid waste, discarded contaminated beddings and microbiology, biotechnology and other clinical waste;
- **Red:** for contaminated plastic waste;
- **White sharps bin:** for metallic sharps; and
- **Blue sharps bin:** for glass sharps.

*As per the categories mentioned in Schedule I (see Annex 8.2)

Management of biomedical waste

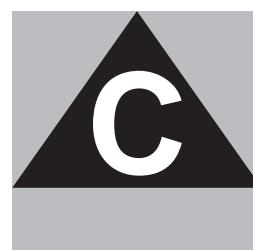
Waste segregation at point of generation

- HCF/laboratory waste requires management at every step from generation, segregation, collection, transportation, storage, and treatment to final disposal.
- Of the waste generated in healthcare settings, approximately 10% to 25% is hazardous but if not segregated properly, the entire waste becomes infectious thereby escalating the overall cost of waste management. The most practical approach to the management of biomedical waste is to identify and segregate infectious waste, which would in turn drastically reduce the cost of waste disposal in healthcare settings.
- Biomedical waste should be segregated into containers or bags at the point of generation in accordance with Annex 8.2. This includes placing different types of waste in different colour-coded bags and containers at the site of generation.
- Proper segregation should identify waste according to type of waste and type of disposal/disinfection (Annex 8.2).
- Colour-coded bags as per national norms (Annex 8.2) need to be placed in appropriate containers with the appropriate label/ logo. For example, the use of a biohazard symbol for infectious waste (Fig. 5.3).
- Puncture-proof containers made of plastic or metal with a biohazard symbol, in blood collection areas, injection trolleys, nursing stations and OTs should be made available for collecting metallic wastes.
- Syringes should be either mutilated or needles should be cut and/or stored in tamper-proof, leak-proof and puncture-proof containers for sharps storage.
- Ensure segregation of liquid chemical waste at source and ensure pre-treatment or neutralization before mixing with other effluent generated from HCFs.

BIOHAZARD SYMBOL



CYTOTOXIC HAZARD SYMBOL



HANDLE WITH CARE

Note: The label shall be non-washable and prominently visible.

Fig. 5.3. Label for biomedical waste containers or bags

Collection bags

Solid waste is collected in leak-resistant heavy-duty bags. Coloured bags made of non-chlorinated plastic with the biohazard sign and labels mentioning the date and details of waste are to be used. The bags are tied tightly after they are three-fourths full.

Pre-treatment, packing, storage and transport

Laboratory waste, microbiological waste, blood samples and blood bags must be pre-treated through disinfection or sterilization on site in the manner prescribed by the WHO guidelines on safe management of wastes from healthcare activities and then sent to a common biomedical waste treatment facility for final disposal. Standards for autoclaving are as given in Schedule II of the Biomedical Waste Management Rules 2016 (Annex 8.4). The bags or containers used for waste segregation shall be labelled as per Schedule IV of the Rules (Figs 5.3 and 5.4).

Provision must be made within the premises of an HCF for a safe, ventilated and secured location for storage of segregated biomedical waste in coloured bags or containers, inaccessible to scavengers and protected against insects, birds, animals and rain, to ensure that there is no secondary handling, pilferage of recyclables, or inadvertent scattering or spillage by animals. The biomedical waste from such places or premises should be directly transported to the authorized common biomedical waste treatment facility for the appropriate treatment and disposal.

Transport of biomedical waste to a common biomedical waste treatment facility

Waste category Number	DayMonth Year
Waste quantity.....	Date of generation
Sender's Name and Address	Receiver's Name and Address
Phone Number	Phone Number
Fax Number	Fax Number
Contact Person	Contact Person
In case of emergency please contact	
Name and Address:	
Phone Number:	

Fig. 5.4. Label for transporting biomedical waste bags or containers
(Part B Schedule IV of Biomedical Waste Management Rules, 2016)

will be done only in vehicles having an appropriate label as provided in Part A of Schedule IV of the Biomedical Waste Management Rules 2016 (Fig. 5.3), along with the necessary information as specified in part B of Schedule IV of the Biomedical Waste Management Rules 2016 (Fig. 5.4). The label shall be non-washable and prominently visible.

The vehicles used for transportation must comply with conditions, if any, stipulated by the State Pollution Control Board or Pollution Control Committee in addition to the requirement contained in the Motor Vehicles Act, 1988, if any, or the rules for transportation of such infectious waste.

Untreated human anatomical waste, animal waste, soiled waste and biotechnology waste shall not be stored beyond a period of 48 hours.

Treatment and disposal

- The HCF shall hand over segregated waste as per Schedule I (Annex 8.2) to the common biomedical waste treatment facility for treatment, processing and final disposal: provided that the laboratory and highly infectious biomedical waste generated shall be pre-treated by equipment such as an autoclave or a microwave.
- The HCF shall treat and dispose of the biomedical waste in accordance with Schedule I (Annex 8.2), and in compliance with the standards provided in Schedule II of the Biomedical Waste Management Rules 2016 (Annex 8.4).
- On-site biomedical waste treatment and disposal facilities are not to be established unless a common biomedical waste treatment facility is not available within a distance of 75 km.
- The duties of the common biomedical waste treatment facilities are given in Annex 8.3.
- In cases where service of a common biomedical waste treatment facility is not available, the HCF shall set up requisite biomedical waste treatment equipment such as an incinerator, autoclave or microwave, shredder before commencement of its operation, as per the authorization given by the prescribed authority.
- Every operator of the common biomedical waste treatment facility shall set up requisite biomedical waste treatment equipment such as an incinerator, autoclave or microwave, shredder and effluent treatment plant as a part of treatment before commencement of its operation. The standards for treatment and disposal of biomedical wastes in Schedule III of Biomedical Waste Management Rules 2016 must be complied with.

- Every HCF shall phase out the use of chlorinated plastic bags within two years from the date of publication of the Biomedical Waste Management Rules 2016. Bags used for storing and transporting biomedical waste shall be in compliance with the Bureau of Indian Standards. Till the Standards are published, the carry bags shall be as per the Plastic Waste Management Rules, 2016.
- The handling and disposal of all the mercury waste and lead waste is to be done in accordance with respective rules and regulations.

Biomedical waste handlers

- Immunize all HCWs and others, involved in handling of biomedical waste for protection against diseases including hepatitis B and tetanus, which are likely to be transmitted by handling of biomedical waste, in a manner as prescribed in the National Immunization Policy or the guidelines of the Ministry of Health and Family Welfare issued from time to time.
- Ensure occupational safety of all HCWs and others involved in handling of biomedical waste by providing appropriate and adequate PPE.
- Conduct health check-up at the time of induction and at least once in a year for all HCWs and others involved in handling of biomedical waste and maintain the records for the same.

Annual report

- Every HCF has to submit an annual report to the prescribed authority in Form-IV (Annex 8.5), every year on or before the 30 June. The prescribed authority is the state pollution control board for states and pollution control committees for Union Territories. For establishments under the Ministry of Defence, the prescribing authority is the Director General, Armed Forces Medical Services.

Maintenance of records

- Maintain and update on a day-to-day basis the register for biomedical waste management and display on the website the monthly record of the biomedical waste generated in terms of category and colour coding.
- Records related to the generation, collection, reception, storage, transportation, treatment, disposal or any other form of handling of biomedical waste must be maintained for a period of 5 years.
- All records must be available for inspection and verification by the prescribed authority or the Ministry of Environment, Forest and Climate Change at any time.

- Maintain all records for operation of incineration, autoclaving, etc. for a period of 5 years.

Reporting of accidents

- Any major accident at any institution or facility or any other site while handling biomedical waste must be intimated immediately to the prescribed authority and a report forwarded within 24 hours in writing regarding the remedial steps taken in Form I of the Biomedical Waste Management Rules 2016.
- Information regarding all other accidents and remedial steps taken shall be provided in the annual report.

Training

- All workers involved in handling of biomedical waste must be provided training at the time of induction and at least once a year thereafter.
- Records of the training programmes conducted, number of personnel trained and number of personnel who have not undergone any training must be maintained.

6. Infection prevention and control in special units or situations

A. IPC in surgical units

Aseptic protocols

Personnel

Hand/forearm antisepsis for surgical team members is of crucial importance.

- Nails should be kept short and all jewellery, artificial nails or nail polish should be removed before surgical hand preparation.
- Hands should be washed and debris should be removed from underneath fingernails using a nail cleaner (not brushes), preferably under running water. Sinks should be designed to reduce the risk of splashes.
- Surgical hand antisepsis should be performed using either a suitable antimicrobial soap or ABHR, before donning sterile gloves.
- A preoperative surgical hand scrub should be done for at least 5 minutes using an appropriate antiseptic scrub. Hands and forearms should be cleaned up to the elbows.
- After performing the surgical hand scrub, hands should be kept up and away from the body (elbows in flexed position) so that water runs from the tips of the fingers toward the elbows and not vice versa.
- If running water is not available, clean stored water can be used. Water should be stored in a bucket with a tap at one side to dispense water. If such a bucket is not available, clean water can be poured on the hands with the help of a container with a long handle. Another person should pour the water.
- If the quality of water is not assured in the OT, surgical hand antisepsis using ABHR is recommended. A sufficient amount of ABHR should be applied to the dry hands and forearms for the length of time recommended by the manufacturer, typically 1.5 minutes, and hands and forearms allowed to dry before donning sterile gloves. (Steps for performing the surgical hand scrub are given in Annex 9.1.)

Scrubs

Microorganisms are constantly shed from the hair and skin of persons and also from their clothes. Microorganisms are also expelled through respiratory secretions while breathing, talking, coughing and laughing.

“Scrubs” refers to the sanitary clothing worn by the OT staff, usually comprising a short-sleeve, v-neck shirt and loose-fitting, drawstring pants. The design of scrubs minimizes places where contaminants can hide, and they are easy to launder. They should be changed after a likely contamination and should always be cleaned in a healthcare laundering facility.

Surgical attire

The surgical attire includes gloves, gowns, caps, mask, eye protection, waterproof aprons and footwear. It protects the patient from the risk of infection from the hair, skin, clothes and respiratory secretions of the surgical team. The surgical attire also protects the surgical team from the risk of exposure to blood and tissues of the patient during operation. (Steps for wearing the surgical attire are given in Annex 9.1.)

The sterile field

It is important to maintain a sterile field to prevent contamination of the surgical incision.

- A sterile field is the area prepared around the surgical procedure site and where the sterile instruments and other items needed during the operation are placed.
- It is created by placing sterile towels or sterile drapes on the prepared procedure site on the patient and includes a stand nearby.
- Only sterile objects and persons in surgical attire (scrubbed team) are allowed within this field.
- Areas above the chest and below the waist of the scrubbed team are considered non-sterile. Items outside and below the draped area are considered non-sterile.
- The field is considered non-sterile if a non-sterile object or non-scrubbed person comes within the sterile field.

Cleaning and disinfection

A clean operating environment is essential to prevent SSI. The OT is cleaned and

Box 6.1. Maintenance of the sterile field

- Place only sterile items within the sterile field.
- Open, transfer and dispense items without contaminating them.
- The outer cover of sterile items is considered unsterile and should not be placed within the sterile field.
- Scrubbed persons should not touch non-sterile objects.
- Non-sterile items or personnel should not enter the sterile field.
- Never touch a sterile item with bare hands.
- If a sterile barrier has been made wet, is cut or torn, it is considered non-sterile.
- If there is a doubt whether the sterile field has been breached, consider it non-sterile.

disinfected to prevent microbial contamination. Exogenous sources of infection in the OT are: people, anaesthesia equipment, surfaces such as walls floors and furniture, air and dust, instrument supplies and medications.

There should be no dust in the OT; dust settling on the sterile field can carry microorganisms particularly in operations of long duration. Dust may be acquired from the outside environment due to defective filtration of air. Lint-containing textiles can be a source of dust as also floor mops. Dust particles can be reduced by good laundry practices to reduce the formation of lint and by the use of wet vacuum on the floor.

General principles

- Surfaces must be routinely cleaned first with detergent to remove any foreign and organic matter. Disinfection should follow cleaning. Do not apply disinfectant without cleaning as organic matter such as pus, blood urine, amniotic fluid, etc. inhibits the action of the disinfectant by protecting microorganisms. A detergent disinfectant combination solution if available can be used for convenience.
- Spills must be cleaned immediately. Apply a higher concentration of disinfectant to the spill, then clean with detergent.
- Disposable or freshly laundered washable cloths or mops should be used with freshly prepared solution for each task.
- OTs must be cleaned daily. This includes furniture, lights, equipment, windowsills, ledges, scrub rooms and sinks. Thorough cleaning of the entire OT should be done once a week.
- Wet vacuuming is the preferred method to clean the floors, wet mopping can

be done if wet vacuum is not available.

- Collections of water should be dried immediately. Leaking faucets and sinks should be fixed as wet areas encourage microbial growth and can be a source of infection.

(Cleaning procedures for OTs are given in Annex 9.2.)

Infrastructure of OTs

Location

To ensure a clean and uncontaminated environment, the OT should be located away from patient care areas and patient traffic. For this reason, the OT is located at a higher level, preferably on the top floor.

Components of the OT

The OT is a multifunctional area. In this area patients are received and prepared for surgery, the operation team prepares for surgery and the actual surgical procedures

Box 6.2. Zones

Concept of zoning

The features of the different zones in order of their cleanliness are:

- Zone 3 is the cleanest or ultra-clean zone. It is also called the aseptic zone and includes the OT and areas where the operation team and patient are prepared for surgery. The areas for packaging and sterilizing surgical instruments are also included in this zone. The different areas in this zone are physically separated from each other. Within this zone, the cleanest is the OT where the patient's tissues are exposed during surgery.
- Zone 2 is the restricted zone where entry is restricted. It is the transitional area between the outer zone and the aseptic zone. Persons entering this zone have to change to protective clothing and footwear to prevent contamination of the surroundings.
- Zone 1 is also called the outer zone and has a similar level of cleanliness as other patient-care areas in the hospital. It is the zone where patients are received and administrative functions are carried out. Toilets are located in this zone.
- Zone 4 or disposal zone is a relatively dirty zone. Staff working in this area need to wear special protective wear for their protection. There should be no movement of staff or equipment from this zone to cleaner zones of the OT. This zone is connected by a separate corridor (also called "dirty corridor") leading out of the OT.

are carried out. In many hospitals in the developing world, which do not have a CSSD, the OT may also include equipment cleaning, processing and sterilization areas. In addition, there are areas for administrative functions, sluicing and waste disposal. The OT areas are distributed into zones depending upon the level of sterility and cleanliness required.

Surgical antimicrobial prophylaxis

- Surgical antimicrobial prophylaxis (SAP) should be administered before the surgical incision when indicated (depending on the type of operation). This should be based on the hospital antibiotic policy.
- The initial dose of prophylactic antimicrobial agent should be administered by the intravenous route, timed such that a bactericidal concentration of the drug is established in the serum and tissues when the incision is made.
- Administration of SAP should be within 120 minutes of incision, while considering the half-life of the antibiotic.
- Clinicians should consider the half-life and protein binding as the most important pharmacokinetic parameters of any single SAP agent in order to ensure adequate serum and tissue concentration at the time of incision and during the entire surgical procedure.
- SAP should not be prolonged after completion of the operation and is not recommended in the presence of a wound drain for the purpose of preventing SSI.

To reduce the stay in hospital, patients are discharged before the incision has healed. The patient should be educated on how to take care of the incision site, personal hygiene, signs and symptoms of infection and whom to contact if infection occurs (see Chapter 7 for details of SSI).

B. IPC in ICUs

Intensive care units (ICUs) house patients that are particularly vulnerable and at five- to ten-times higher risk of HAI. With defences compromised due to various invasive devices such as peripheral and central lines, urinary catheters and mechanical ventilators, they are particularly prone to device-related infections. Intrinsic factors such as immunosuppression and comorbidities compound their vulnerabilities. Patients in the ICU are also exposed to broad-spectrum antibiotics and are susceptible to multidrug-resistant organisms such as *Acinetobacter* spp. and *Pseudomonas* spp. It is estimated that:⁷³

- In high-income countries, approximately 30% of patients in ICU are affected by at least one HAI.
- In LMICs the frequency of ICU-acquired infection is at least 2–3-fold higher than that in high-income countries; device-associated infection densities are up to 13 times higher than those in the USA.
- Similarly, newborns admitted in NICUs are at higher risk of acquiring HAI in developing countries, with infection rates 3 to 20 times higher than those in high-income countries.

Patients at risk of HAI

Patient, therapy and environment-related risk factors for the development of HAI are:⁷⁴

- Age >70 years
- Shock, major trauma, acute renal failure, coma
- Prior antibiotics
- Mechanical ventilation
- Indwelling catheters
- Immunocompromised patients on steroids or chemotherapy
- Prolonged ICU stay (>3 days)

IPC practices

Standard precautions should be applied for all patients in the ICU. In addition, transmission-based precautions should be applied to standard precautions to prevent infections where the route of transmission is known (see also Chapter 4).

Skin preparation and use of antiseptic agents

- Gross contamination at the site of incision should be removed before antiseptic skin preparation.
- Antiseptic skin preparation should be applied in concentric circles moving away from the proposed incision site to the periphery; allowing sufficient prepared area to be included.

ICU footwear

- Special well-fitting footwear with impervious soles should be worn in the ICU. Shoes should be preferred over slippers.

- Footwear should be regularly cleaned to remove splashes of blood and body fluids.
- ICU footwear must not be taken out of the ICU to other areas of the hospital.

Bundle approach to prevent device-associated infections

Since device-associated infections form a major burden of HAIs, a bundled care approach has been proven to achieve high levels of compliance with better outcomes.

What is a care bundle?

A care bundle identifies a set of key interventions deriving from evidence-based guidelines that, when implemented, are expected to improve health outcomes of patients. The aim of care bundles is to improve health outcomes by facilitating and promoting changes in patient care and encouraging compliance to guidelines.^{75–77}

Implementation of care bundles creates an important opportunity for delivering evidence-based and safe healthcare to patients using a multimodal or multidisciplinary approach. Training of staff is one of the most important components of a care bundle for prevention of HAI.

Care bundles for prevention of device-associated infections are:

- Ventilator-associated pneumonia (VAP) bundle
- Central line-associated bloodstream infection bundle
- Catheter-associated urinary tract infection bundle

Ventilator-associated pneumonia

Pneumonia is the second most common HAI reported in the world and is associated with substantial morbidity and mortality. Most patients with healthcare-associated pneumonia are those at the extremes of age, with severe underlying disease, immunosuppression, depressed sensorium and cardiopulmonary disease, and those who have had thoraco-abdominal surgery. Most bacterial healthcare-associated pneumonia occurs by aspiration of bacteria colonizing the oropharynx or upper gastrointestinal tract of the patient. Intubation and mechanical ventilation greatly increase the risk of bacterial pneumonia because they alter first-line patient defences. Pneumonia due to infective causes occurring in a patient on mechanical ventilation is termed ventilator-associated pneumonia or VAP. (See Chapter 7 for the current definition of VAP for surveillance.)

Prevention of VAP

Preventive measures for VAP include decreasing aspiration by the patient, preventing cross-contamination or colonization via hands of personnel, the correct use and appropriate disinfection or sterilization of respiratory therapy devices and staff education.

Strategies to prevent VAP are:⁷⁸

1. Maintenance of in-use respiratory therapy equipment
 - Fluids, nebulized or used in a humidifier should be sterile and dispensed aseptically.
 - Fluid reservoirs should be filled immediately before use. Fluid should not be added to replenish partially filled reservoirs. Residual fluid should be discarded and the reservoir filled with fresh fluid.
 - Water that has condensed in tubing should be discarded and not allowed to drain back into the reservoir.
 - Disposable supplies such as nasal prongs, tubing, masks, ventilator and breathing circuits are for single patient use only.
 - When a respiratory therapy machine is used to treat multiple patients, the breathing circuit must be changed between patients.
 - Maintain ventilator circuits
 - o Change the ventilator circuit only if visibly soiled or malfunctioning.
 - o Changing the ventilator circuit as needed rather than on a fixed schedule has no impact on VAP rates or patient outcomes but decreases costs.
2. Processing reusable equipment
 - All equipment to be sterilized or disinfected should be thoroughly cleaned first to remove organic material such as blood, secretions or other residue/soil.
 - Respiratory therapy equipment that touches mucous membranes or is a non-disposable part of a breathing circuit should receive high-level disinfection or be sterilized.
 - Coolant chambers for ultrasonic nebulizers are difficult to disinfect adequately and should have at least 30 minutes contact with a high-level disinfectant or be gas-sterilized (ethylene oxide). This is not necessary if a disposable chamber is used.
 - Hand-powered resuscitation bags that have been used for a patient should receive high-level disinfection or be sterilized (unless disposable).
3. Suctioning of the respiratory tract

- Frequent suctioning causes excessive trauma and risk of cross-contamination. Suctioning should be done only when needed to reduce excessive secretions.
- Suctioning should be performed using gloves on both hands and protective eyewear and mask.
- A sterile catheter should be used for each series of suctioning (defined as a single suctioning or repeated suctioning done with only brief periods intervening to clear or flush the catheter).
- Catheter should be flushed with sterile fluid in case flushing is required. Fluid that has been used for one series of suctioning should be discarded.
- Suction connecting tubing and suction canisters should be changed between patients, and daily for ongoing patients.
- Unless disposable, suction canisters should be thoroughly cleaned to remove organic material, then receive high-level disinfection or be sterilized.

Bundle of care for prevention of VAP⁷⁹

- Elevation of the head of the bed between 30 and 45 degrees
- Peptic ulcer disease prophylaxis
- Deep venous thrombosis (DVT) prophylaxis unless contraindicated
- Daily mouth care with chlorhexidine

Catheter-related bloodstream infection and CLABSI

Intravascular catheters are an indispensable part of modern healthcare, but their use puts patients at risk of local and systemic infections: local site infection, bloodstream infection (BSI), septic thrombophlebitis, endocarditis, and other metastatic infections.⁸⁰

Central line-associated bloodstream infection (CLABSI) may be caused by cutaneous microorganisms that contaminate the catheter during insertion or migrate along the catheter track or by microorganisms from the hands of HCWs during interventions. The most frequently implicated organisms are: coagulase-negative Staphylococci, particularly *Staph. epidermidis*. Other organisms are *Staph. aureus*, *Candida* spp., Enterococci and Gram-negative organisms. It is essential that the best evidence-based practices be followed for prevention of catheter-related or associated BSIs.⁸¹

Routes for contamination of catheters

There are four recognized routes for contamination of catheters:

- Migration of skin organisms at the insertion site into the cutaneous catheter tract and along the surface of the catheter with colonization of the catheter tip (most common route of infection for short-term catheters)
- Direct contamination of the catheter or catheter hub by contact with hands or contaminated fluids or devices
- Through the bloodstream from another focus of infection
- Contaminated infusate

Types of vascular catheters

Table 6.1 gives details of various types of catheters used for venous and arterial access.

Selection of catheter type

Central venous catheters may be made from different materials, single or multi-lumen, medically impregnated, e.g. antimicrobial, antiseptic or heparin bonded, cuffed and designed to be tunnelled or having totally implantable ports.

- Polytetrafluoroethylene or polyurethane catheters have been associated with fewer infectious complications than catheters made of polyvinyl chloride or polyethylene but there is no evidence that demonstrates conclusively that CLABSI rates vary with different materials.
- Generally polyurethane is considered suitable for short-term use, and silicone for long-term use.

Prevention of catheter-related infections

Strategies to prevent CLABSI are:

Education, training and staffing

- Educate HCWs regarding the indications for intravascular catheter use, proper procedures for the insertion and maintenance of intravascular catheters, and appropriate infection control measures to prevent intravascular catheter-related infections.
- Periodically assess knowledge of and adherence to guidelines for all personnel involved in the insertion and maintenance of intravascular catheters.
- Designate only trained personnel who demonstrate competence in the insertion and maintenance of peripheral and central intravascular catheters.
- Ensure appropriate nursing staff levels in ICUs.

Selecting the best insertion site: peripheral catheters and midline catheters

- Use an upper extremity instead of a lower-extremity site for catheter insertion.

Table 6.1. Catheters used for venous and arterial access

Catheter type	Entry site	Length	Comments
Peripheral venous catheters	Usually inserted in veins of forearm or hand	<7.5 cm	Phlebitis with prolonged use; rarely associated with bloodstream infection (BSI)
Peripheral arterial catheters	Usually inserted in radial artery; can be placed in femoral, axillary, brachial, posterior tibial arteries	<7.5 cm	Low infection risk; rarely associated with BSI
Midline catheters	Inserted via the antecubital fossa into the proximal basilic or cephalic veins; does not enter central veins, peripheral catheters	7.5–20 cm	Anaphylactoid reactions have been reported with catheters made of elastomeric hydrogel; lower rates of phlebitis than short peripheral catheters
Non-tunelled central venous catheters (CVCs)	Percutaneously inserted into central veins (subclavian, internal jugular or femoral)	≥8 cm depending on patient size	Account for majority of CLABSI
Pulmonary artery catheters	Inserted through an introducer in a central vein (subclavian, internal jugular or femoral)	≥30 cm depending on patient size	Usually heparin bonded; similar rates of BSI as CVCs; subclavian site preferred to reduce risk of infection
Peripherally inserted central venous catheters (PICC)	Inserted into basilic, cephalic, or brachial veins and enter the superior vena cava	≥20 cm depending on patient size	Lower rate of infection than non-tunelled CVCs
Tunelled CVCs	Implanted into subclavian, internal jugular or femoral veins	≥8 cm depending on patient size	Cuff inhibits migration of organisms into catheter tract; lower rate of infection than non-tunelled CVC
Totally implantable	Tunelled beneath skin and have subcutaneous port accessed with a needle; implanted in subclavian or internal jugular vein	≥8 cm depending on patient size	Lowest risk for CLABSI; improved patient self-image; no need for local catheter-site care; surgery required for catheter removal

Table 6.1. Catheters used for venous and arterial access (*continued*)

Catheter type	Entry site	Length	Comments
Umbilical catheters	Inserted into either umbilical vein or umbilical artery	≤6 cm depending on patient size	Risk for CRBSI similar with catheters placed in umbilical vein versus artery

Source: CDC Guidelines for the prevention of intravascular catheter-related infections

- Replace a catheter inserted in a lower-extremity site to an upper-extremity site as soon as possible.
- In paediatric patients, the upper or lower extremities or the scalp (in neonates or young infants) can be used as the catheter insertion site.

Aseptic technique during catheter (CVC/umbilical) insertion

- Aseptic technique during CVC placement significantly reduces the risk of infection.
- Strict adherence to hand decontamination and aseptic technique shall be practised.
- Maximal sterile barrier precautions shall be used, regardless of whether the placement takes place in the OT or ward. This should include the use of a sterile gown, gloves, cap, mask and a sterile full body drape for insertion of CVCs or PICCs.
- Use sterile sleeve to protect pulmonary catheters during insertion.

Skin preparation

- Prepare clean skin with an antiseptic (70% alcohol, tincture of iodine, an iodophor or chlorhexidine gluconate) before insertion of a peripheral venous catheter.
- Prepare clean skin with a >0.5% chlorhexidine preparation with alcohol before insertion of a central venous catheter or peripheral arterial catheter and during dressing changes. If there is a contraindication to chlorhexidine, use tincture of iodine, an iodophor or 70% alcohol.
- Antiseptics should be allowed to dry according to the manufacturer's recommendation before placing the catheter.

Antibiotic prophylaxis

- Systemic antimicrobials should not be routinely administered before insertion or during use of a central venous catheter to prevent catheter colonization or CLABSI.

Care of pressure monitoring systems

- Keep all components of the pressure monitoring system (including calibration devices and flush solution) sterile.
- Minimize the number of manipulations of and entries into the pressure monitoring system. Use a closed-flush system (i.e. continuous flush), rather than an open system (i.e. one that requires a syringe and stopcock) to maintain the patency of pressure monitoring catheters.
- When the pressure monitoring system is accessed through a diaphragm rather than a stopcock, wipe the diaphragm with an appropriate antiseptic before accessing the system.
- Do not administer dextrose-containing solutions or parenteral nutrition fluids through the pressure monitoring circuit.

Types of gloves

Table 6.2 gives the types of gloves that should be used for procedures and for catheter care.

Bundle of care for prevention of CLABSI

Insertion bundle

- Maximal sterile barrier precautions (surgical mask, sterile gloves, cap, sterile gown, and large sterile drape).
- Skin cleaning with alcohol-based chlorhexidine (rather than iodine).
- Avoidance of the femoral vein for central venous access in adult patients; use of subclavian rather than jugular veins.
- Dedicated staff for central line insertion and competency training/assessment.
- Standardized insertion packs.
- Availability of insertion guidelines (including indications for central line use) and use of checklists with trained observers.
- Use of ultrasound guidance for insertion of internal jugular lines.

Maintenance bundle

- Daily review of central line necessity
- Prompt removal of unnecessary lines
- Disinfection before manipulation of the line
- Daily chlorhexidine washes (in ICU, patients >2 months)
- Disinfect catheter hubs, ports, connectors, etc. before using the catheter
- Change dressings and disinfect site with alcohol-based chlorhexidine every 5–7 days (change earlier if soiled)

Table 6.2. Characteristics of gloves

Clean gloves	Peripheral intravascular catheter (if access site not touched after application of skin antisepsis)
Sterile gloves	Arterial catheter Central catheter Midline catheter
Sterile gloves	Guide-wire exchange
Clean or sterile gloves	Changing dressing on intravascular catheter

- Replace administration sets within 96 hours (immediately if used for blood products or lipids)
- Ensure appropriate nurse-to-patient ratio in ICU (1:2 or 1:1)

Catheter-associated urinary tract infection

Catheter-associated urinary tract infection (CAUTI) is usually defined as a UTI (significant bacteriuria plus symptoms and/or signs attributable to the urinary tract with no other identifiable source) in a patient with current urinary tract catheterization or who has been catheterized in the past 48 hours.

Guidelines from the Infectious Diseases Society of America (IDSA) define CAUTI “in patients with indwelling urethral, indwelling suprapubic, or intermittent catheterization...by the presence of symptoms or signs compatible with UTI with no other identified source of infection along with $\geq 10^3$ colony-forming units (cfu)/ml of ≥ 1 bacterial species in a single catheter urine specimen or in a midstream voided urine specimen from a patient whose urethral, suprapubic, or condom catheter has been removed within the previous 48 hours.”⁸² (See also Chapter 7 on surveillance.)

Risk factors for CAUTI

Table 6.3 gives the risk factors for symptomatic UTI and asymptomatic bacteriuria.⁸³

Strategies for prevention of CAUTI

*Catheter indications*⁸⁴

- Urinary catheters shall be inserted only when necessary and left in place for as long as necessary. They should not be used solely for the convenience of patient-care personnel.

Table 6.3. Risk factors for symptomatic UTI and asymptomatic bacteriuria

Symptomatic UTI	Bacteriuria
Prolonged catheterization Female gender Older age Impaired immunity	Disconnection of drainage system Lower professional training of inserter Placement of catheter outside of OT Incontinence Diabetes Meatal colonization Renal dysfunction Orthopaedic/neurology services

- Avoid use of urinary catheters for the management of urinary incontinence.
- Use urinary catheters in operative patients only when necessary rather than routinely.
- For operative patients who have an indication for an indwelling catheter, remove the catheter as soon as possible postoperatively, preferably within 24 hours, unless there are appropriate indications for continued use.

Catheter insertion

- Thoroughly wash hands or use ABHR before inserting the catheter.
- Catheters should be inserted using aseptic technique and sterile gloves and equipment.
- Sterile gloves, drapes, sponges, an appropriate antiseptic solution for periurethral cleansing, and a single-use packet of lubricant jelly should be used for insertion. The patient should be appropriately draped and sterile personal protective equipment shall be worn by the HCW inserting the catheter.
- Indwelling catheters should be properly secured after insertion to prevent movement and urethral traction.

Urinary catheter maintenance

- Maintain a closed drainage system.
- If breaks in aseptic technique, disconnection or leakage occur, the catheter and the collecting system should be replaced using an aseptic technique.
- Keep the catheter and collecting tube free from kinking. The collecting bag should be kept below the level of bladder at all times. The collecting bag should be emptied regularly using a separate, clean, collecting container for each patient. Never place the drainage bag in a place that can contaminate it, e.g. the floor.

- Indwelling catheters or drainage bags should not be changed at routine/fixed intervals.
- Unless clinical conditions exist (e.g. in patients with bacteriuria on catheter removal post-urological surgery), systemic antimicrobials should not be administered to prevent CAUTI.
- The periurethral area should not be cleaned with antiseptics to prevent CAUTI. Routine hygiene (e.g. cleansing of meatal surface during daily bathing or showering) is appropriate.
- Irrigation should be avoided unless obstruction is anticipated (e.g. as might occur with bleeding after prostatic or bladder surgery); closed continuous irrigation may be used to prevent obstruction.
- Intermittent irrigation should only be used to relieve obstruction due to clots, mucus or other causes. A large-volume sterile syringe and sterile irrigate should be used and then discarded. Aseptic technique shall be used. The catheter–tubing junction should be disinfected before disconnection.
- If the catheter becomes obstructed, it should be changed if it is likely that the catheter is contributing to the obstruction (e.g. formation of concretions).
- Small volumes of fresh urine for examination can be obtained from the sampling port. The port should be disinfected and urine aspirated with a sterile needle and syringe or other collection device (e.g. vacutainer).
- Larger volumes of urine for special analyses (not culture) should be obtained aseptically from the drainage bag.

Other issues⁸⁵

- Change the drainage bag when inserting a new catheter. Also, change the drainage bag when it becomes stained, clouded by sediment or is leaking.
- Encourage fluids within the limits the patient can medically tolerate. Flush the urinary system from the inside out, the so-called "natural flush". Normal fluid intake should be around 2000 ml daily.
- Avoid clamping before catheter removal.

Bundle of care for prevention of CAUTI

CAUTI insertion bundle

- Verification of need prior to insertion
 - Urinary retention/obstruction
 - Severely ill/immobility
 - Lack bladder control
 - Patient request/end of life

- Perioperative – selected surgical procedure
- Assisting with pressure ulcer healing for incontinent patients
- Insert urinary catheter using aseptic technique
 - Hand hygiene
 - Catheter insertion kit with sterile gloves, drape, cleaning supplies
 - Sterile lubricant
 - Sterile urinary catheter attached to a drainage bag
- Maintain urinary catheter based on recommended guidelines
 - Secure catheter to prevent irritation of the urethra
 - Maintain an unobstructed flow
 - Maintain the drainage bag below the level of the bladder and off the floor
 - Perform hand hygiene before and after each patient contact
 - Provide individual labelled collection container at the bedside
 - Review urinary catheter necessity daily, remove catheter promptly when not needed

CAUTI maintenance bundle

- Daily documented assessment of need
- Catheter secured – device to secure catheter in place
- Hand hygiene performed for patient contact
- Daily meatal hygiene performed with soap and water
- Drainage bag emptied using a clean container
- Unobstructed flow maintained

C. IPC in maternal and neonatal units

Maternal and neonatal infections

Maternal “peripartum infection” includes:

- Intrapartum (intra-amniotic infection occurring before birth) and
- Postpartum (or puerperal) bacterial infections related to childbirth

The clinical presentations of maternal infections are:

Endometritis: Infection of the endometrium (lining of the uterus) and may extend to the myometrium (smooth muscle of the uterus). Presents as fever, pain in abdomen, uterine tenderness, foul-smelling vaginal discharge and signs of peritonitis in women who have had caesarean section. Caesarean section is the most important factor contributing to postpartum endometritis.

SSI: Infection of the surgical site after caesarean section. May be superficial, deep or organ-space. Postpartum SSI, wound infection and endometritis are major causes of prolonged hospital stay and pose a burden to the healthcare system.

Septic pelvic thrombophlebitis: Thrombosis of the deep pelvic veins due to inflammation and blood clots. It can occur after prolonged labour, premature rupture of membranes and difficult labour.

Infected episiotomy: This is an infection in the surgical cut which is made in the perineum to facilitate delivery.

Healthcare-associated UTIs: Usually occur after caesarean delivery

Intra-amniotic infection syndrome also referred to as amnionitis or chorioamnionitis. This is an acute infection of the uterus and its contents (foetus, placenta and amniotic fluid) during pregnancy. It occurs after prolonged rupture of the membranes and due to organisms present in the cervix and vagina.

Prevention of newborn and maternal infections during deliveries

Prevention of maternal and neonatal infections during vaginal delivery

Vaginal deliveries do not require sterile conditions of the OT but cleanliness is of utmost importance. Particular attention should be given to having clean hands, clean perineal area and clean umbilicus.

Factors that increase risk of infection during vaginal delivery

- Prolonged rupture of membranes (>24 hours)
- Trauma to the birth canal: lacerations of the vagina or perineum or urethral tear
- Retained placenta, necessitating manual removal of placenta or placental fragments
- Episiotomy
- Mid-forceps delivery
- Multiple vaginal examinations (particularly by medical and nursing students)

Prevention of infection during vaginal examination

- Digital vaginal examination at intervals of four hours is recommended for routine assessment of the active first stage of labour in low-risk women.

- A clean pair of gloves should be used for each examination. Sterile gloves are not necessary.
- The tip of the examining finger should not enter the cervical os unless the decision has been made to induce labour.
- Student training should be limited to cases that are in active labour.

Prevention of infection before delivery

- Use clean examination gloves, wash the perineal area (vulva, perineum and anal region) with soap and clean water.
- Use downward and backward motion while cleaning so that faecal organisms are not introduced into the vagina.
- The anal area should be cleaned last and the wash towel discarded in a yellow-coded container. Disinfect gloved hands by immersing in 0.5% chlorine solution, wash gloved hands and remove gloves by inverting and discard in the yellow-coded container.
- Perineal/pubic hair should not be shaved, hair clipper should be used if required. Routine shaving is not recommended by WHO. Shaving has been shown to increase the risk of infection after delivery.⁸⁶

Prevention of infection during delivery

- Hand hygiene by ABHR or washing with antiseptic soap and water meticulously up to the elbows and adhering to the seven steps of hand hygiene
- PPE: High exposure to blood and body fluid as splashes of blood and blood-tinged amniotic fluid is expected
 - Gloves
 - Sterile surgical gloves
 - To provide protection up to the elbow, normal length gloves can be augmented by sterile surgical sleeves that come up to the elbow (these sleeves can be made by cutting off the fingers of a pair of sterile gloves with a sterile scissors). The sterile sleeve can be worn on each forearm before wearing the sterile surgical glove. Clean examination gloves for washing the perineum.
 - Sterile water-resistant gown, rubber/plastic apron
 - Mask with eye shield
 - Boots
- Instruments used during delivery (scissors, cord clamp, needle holder, forceps, tissue forceps, urinary catheter, sutures, etc. should be sterile or high level disinfected)
- The HCW receiving the baby should clean their hands by performing hand

hygiene and wear clean examination gloves. Baby should be received on a clean towel.

- If resuscitation of the baby is required it should be done by mechanical suction. If mouth suction is done a trap should be placed in the line.
- If manual removal of the placenta is required, a fresh pair of sterile gloves should be worn augmented by a sterile sleeve up to the elbow to avoid contaminating the forearm with blood.

Prevention of infection after delivery

- Before removing gloves, put the placenta in a clean basin and place all blood-stained waste in the appropriate yellow-colour coded container with lid.
- Place suture needles after use in a puncture-proof sharps container.
- Before disposal of a syringe and needle, flush out the syringe with 0.5% chlorine solution and then place in puncture-proof sharps container.
- Immerse both gloved hands in 0.5% chlorine solution, rinse with water, remove gloves by inverting. Wash hands with soap and water after removing gloves.

Prevention of infection during caesarean section

Caesarean section should be performed using all the precautions and procedures as for surgical procedure described in Chapter 6. The WHO surgical checklist to prevent surgical complications should be applied.

Similar to the implementation of surgical bundles to prevent SSI in non-obstetric patients, creating patient care bundles comprising evidence-based elements in patients who undergo caesarean section may decrease the incidence of SSI. Each hospital has the opportunity to create its own caesarean section surgical bundle to reduce SSI.

Procedures to prevent infection in patients undergoing caesarean section include:

- The abdomen should not be shaved prior to surgery. If required, hair clipper should be used instead.
- The surgeon and assistant should wear a face shield or mask and goggles, a plastic or rubber apron over the scrub-suit since splashing with blood and blood-tinged amniotic fluid is expected.
- If there has been prolonged rupture of membranes or the caesarean section is non-elective, then a single shot of first-generation cephalosporin or penicillin is given intravenously, preferably just before incision rather than after the cord is clamped. WHO recommendations regarding antibiotic prophylaxis are given in Table 6.4.

- The HCW receiving the infant should clean their hands by the hand hygiene procedure as detailed in Chapter 4 and wear clean examination gloves before handling the baby.
- The baby should be placed on a clean towel.
- Surgical gloves should be changed before manually removing the placenta, elbow length sterile surgical gloves should be worn or use a sterile sleeve with the normal sterile surgical glove as described above.
- If there is prolonged rupture of membranes or chorio-amnionitis is present:
 - Avoid spillage of amniotic fluid into the abdominal cavity.
 - Place sterile moistened pads in the paracolic gutters to absorb as much of the amniotic fluid as possible.
 - If large amounts of amniotic fluid spill into the abdominal cavity, lavage the cavity with sterile isotonic saline solution.
 - Avoid exploring the uterine cavity unless absolutely necessary and only after closing the uterine incision.
- In elective caesarean section, if the cervix is closed and membranes were not ruptured then dilate the cervix through the vagina to allow the outflow of blood and fluid from within the uterus after delivering the baby and removing the placenta. Dilate the cervix with a gloved finger only once. When dilatation is completed, change the gloves and wear a new pair of sterile surgical gloves.⁸⁷

Postpartum care of the mother

- Gloves should be worn when handling perineal pads, touching vaginal discharge or touching the episiotomy.
- Check whether the mother is voiding urine without difficulty.
- The mother should be taught to wash the perineal area with boiled water after changing the pad or passing stool.
- If the mother is breastfeeding, she should be taught how to care for her breasts and nipples to avoid mastitis.
- If delivery was by caesarean section, care should be taken to avoid pulmonary problems during the postoperative period.
- The patient should be encouraged to move about frequently in bed and walk within 12 hours.
- If an indwelling urinary catheter is inserted, precautions to prevent urinary infection should be followed. Remove the catheter as soon as possible.

Postnatal care of the neonate

- Gloves and plastic/rubber apron should be worn while handling the neonate

Table 6.4. Summary of WHO recommendations for prevention and treatment of maternal peripartum infections⁸⁸

Context	Recommendation
Prevention of peripartum infections	<ol style="list-style-type: none"> 1. Routine perineal/public shaving prior to giving vaginal birth is not recommended. 2. Digital vaginal examination at intervals of four hours is recommended for routine assessment of active first stage of labour in low-risk women. 3. Routine vaginal cleansing with chlorhexidine during labour for the purpose of preventing infectious morbidity is not recommended. 4. Routine vaginal cleansing with chlorhexidine during labour in women with group B <i>Streptococcus</i> (GBS) colonization is not recommended for prevention of early neonatal GBS infection. 5. Intrapartum antibiotic administration to women with GBS colonization is recommended for prevention of early neonatal GBS infection. 6. Routine antibiotic prophylaxis during the second or third trimester for all women with the aim of reducing infectious morbidity is not recommended. 7. Routine antibiotic administration is not recommended for women in preterm labour with intact amniotic membranes. 8. Antibiotic administration is recommended for women with preterm pre-labour rupture of membranes. 9. Routine antibiotic administration is not recommended for women with pre-labour rupture of membranes at (or near) term. 10. Routine antibiotic administration is not recommended for women with meconium-stained amniotic fluid. 11. Routine antibiotic prophylaxis is recommended for women undergoing manual removal of the placenta. 12. Routine antibiotic prophylaxis is not recommended for women undergoing operative vaginal birth (caesarean section). 13. Routine antibiotic prophylaxis is recommended for women with a third- or fourth-degree perineal tear. 14. Routine antibiotic prophylaxis is not recommended for women with episiotomy.

Context	Recommendation
Prevention of peripartum infections	15. Routine antibiotic prophylaxis is not recommended for women with uncomplicated vaginal birth.
	16. Vaginal cleansing with povidone-iodine immediately before caesarean section is recommended.
	17. The choice of an antiseptic agent (povidone-iodine or chlorhexidine) and its method of application for skin preparation prior to caesarean section should be based primarily on the clinician's experience with that particular antiseptic agent and method of application, its cost and local availability.
	18. Routine antibiotic prophylaxis is recommended for women undergoing elective or emergency caesarean section. <ul style="list-style-type: none"> • For caesarean section, prophylactic antibiotics should be given prior to skin incision, rather than intra-operatively after umbilical cord clamping. • For antibiotic prophylaxis for caesarean section, a single dose of first-generation cephalosporin or penicillin should be used in preference to other classes of antibiotics.
Treatment of peripartum infection	19. A simple regimen such as ampicillin and once-daily gentamicin is recommended as first-line antibiotics for the treatment of chorioamnionitis.
	20. A combination of clindamycin and gentamicin is recommended as first-line antibiotics for the treatment of postpartum endometritis.

until blood, meconium or amniotic fluid has been removed from the neonate's skin.

- The removal of blood and body fluids from the neonate's skin should be done carefully using cotton swabs/soft cotton soaked in boiled warm water, followed by drying the skin to avoid infection.
- Hand hygiene (handwashing or ABHR) should be performed before handling the neonate.
- Bathing or washing the neonate should be done once the temperature of the neonate has stabilized (usually by 6 hours of birth). The perineal area and buttocks should be kept clean, by washing with a soft cloth, cotton swabs soaked in warm water after every diaper change using fresh swabs and a separate bowl for each wash occasion. Perform hand hygiene before and after diaper change.

- Cord care:
 - Perform hand hygiene before and after cord care
 - Keep the cord stump clean and dry
 - Do not cover the cord stump with dressing or bandage
 - Educate the mother on examining the stump for redness or presence of pus/ blood and to report to the clinic as soon as possible if this happens

Prevention of infection during procedures in the neonatal unit

Preparation of intravenous fluids

- Intravenous (IV) administration of fluids and drugs are a potent source of infection for the vulnerable neonate. Outbreaks of sepsis have often implicated IV fluids as either the source or vehicles of transmission between neonates. Strict attention to aseptic technique is essential in the preparation and administration of IV fluids.
- As far as possible procure base solutions such as IV glucose, saline solutions in paediatric packings/small amounts rather than adult packaging and transfer into smaller aliquots. Avoid procurement of multi-dose vials as far as possible; single use ampoules/vials are preferred.
- Have a designated area to prepare IV infusions. Clean the area with a disinfectant before a procedure.
- Gather the necessary materials (IV fluids, drugs, syringes, needles, swabs, 70% alcohol, etc.).
- Examine the IV fluid containers, ampoules and vials for expiry date, cracks, leaks, cloudy consistency, flakes, etc.
- Perform hand hygiene either by handwashing using medicated soap followed by drying with a single-use towel, or ABHR (it is important that hands are dry before starting the procedure).
- Disinfect the port of IV bottles/bags with 70% alcohol immediately before removing/adding fluids.
- Wear sterile gloves.
- Use sterile needle/syringe for each IV fluid bottle and ampoule/ vial using the no-touch technique during mixing of IV fluids and medications.
- Never enter IV fluids and bottles with a needle, except through a designated port.
- Label the prepared bottle with the patient's name, registration number, date and time of preparation.
- If it needs to be stored in the fridge, do not refrigerate for more than 24 hours. Discard after 24 hours in the fridge and after 8 hours at room temperature.

- The improper use of multi-dose vials can be a cause and source of infection in the neonate. (Recommendations for the use of multi-dose vials are given in Chapter 4.)
- Strict aseptic technique should be followed during administration of IV fluids, and a closed system maintained at all times.

IV therapy and umbilical catheter care

Umbilical vessel catheters are frequently used in the initial management of the sick neonate. There is increased potential of bacterial colonization as this site is non-sterile and there is the presence of devitalized cord tissue. Umbilical catheters should be replaced by percutaneous peripheral or central venous catheters in neonates requiring long-term access.

- Umbilical catheters should be inserted using sterile techniques.
- Umbilical catheters should only be replaced if the catheter site is infected or the catheter malfunctions.
- Do not replace the umbilical catheter if there are signs of CRBSI or thrombosis. In addition, for the umbilical artery catheter, do not replace if there are signs of vascular insufficiency.
- Clean the umbilical site before insertion with an appropriate disinfectant avoiding tincture of iodine due to its potential effect on the neonatal thyroid. Povidone-iodine can be used.
- Do not use topical antibiotic or creams due to the potential for fungal infection and AMR.
- Low-dose heparin can be added to the fluid infused through the umbilical arterial catheter.
- Umbilical arterial catheters should be removed as soon as possible and not left in place for more than 5 days. Remove the catheter if there are signs of vascular insufficiency in the lower limbs.
- Umbilical venous catheters should be removed as soon as possible and left in place for not more than 14 days.

D. IPC in outpatient and emergency care

Outpatient department

Registration desk

The first point of contact for an ill patient seeking hospital care is the registration desk

of the outpatient department (OPD). Recognition of transmissible illness and moving the infectious patients to the appropriate examination room as quickly as possible is important. Frontline staff at the registration desk should be trained to recognize patients showing signs and symptoms of transmissible diseases. Visual alerts and posters indicating the signs and symptoms of transmissible diseases should be displayed at the entrance. A short (3–5 questions)and simple questionnaire can be given to patients at registration to facilitate rapid identification and isolation if required. This is particularly important in epidemic/pandemic situations.

Pandemic preparedness

Time and again emerging and re-emerging diseases have caused epidemic and pandemic situations. The major international outbreaks in the last decade have been: Swine flu in 2009, MERS in 2012, Ebola in 2014 and Zika in 2016 and Nipah in India (2018). In outbreaks of public health importance, the first point of contact in an HCF is the OPD or the emergency department. Staff at the frontline must be prepared to identify and transfer cases safely without disease transmission. Preparation for all diseases should include screening and isolating potentially infectious persons, PPE use, cleaning and disinfection and drill exercises.

- Individuals who meet criteria for highly communicable diseases requiring isolation such as novel influenza or other emerging infections must be placed in a private examination room as soon as possible.
- PPE kits should be available. Staff should be trained on the correct steps and techniques of wearing and removing PPE. PPE assessment includes competency validation to ensure that participants are using PPE correctly.
- To maintain the level of competency and awareness, staff should participate in drills. PPE skill maintenance can be included in annual competency training.

IPC in emergency care

The emergency department is a busy place subject to rapid patient turnover and overcrowding; half of all admissions to the hospital are from the emergency. The emergency department, such as the OPD, is also the frontline in the response to public health emergencies and disasters. Patients admitted through the emergency are sicker than those who report to the OPD.

Infection prevention is a major challenge in the emergency department due to the following:⁸⁹

- High-volume of patients, many needing rapid intervention
- Patients present with undifferentiated illnesses of various types and the condition ranges from the otherwise healthy to the critically ill.

- Acutely ill and injured patients undergoing evaluation and treatment in the emergency department have the potential to spread communicable infectious diseases to HCWs and other patients.
- Risk recognition and decision-making are often based on limited and changing data.
- Patients await diagnosis, intervention and decisions about further management or discharge in close proximity to one another.

IPC in emergency care has two aspects:

- Preventing the transmission of infectious diseases from ill patients to HCWs and to other patients, and
- Reducing the risk of infection associated with receiving emergency care.

The basics of standard precautions including hand hygiene PPE, etc. should be strictly adhered to.

E. IPC in dialysis units

Infection is the most common cause of hospitalization and the second most common cause of mortality among haemodialysis (HD) patients, after cardiovascular disease. HD patients are exposed to different types of infection, which include BSI and localized infections of vascular access, blood-borne infections (HBV, HCV and/or HIV) and airborne infections such as tuberculosis.^{90–92}

Outbreaks of HCV infections in HD facilities, which occur frequently, have often been due to poor infection control practices. Sources of infection could be contaminated water, equipment and environmental surfaces in the treatment area and patients with infections who pose a risk to other nearby patients.

IPC programme in the dialysis unit

Patients undergoing haemodialysis are at increased risk of HAIs. Therefore, the IPC programme is essential for HD units. It includes multiple interventions which are designed to reduce the risk of infection.

A doctor or a senior nurse working in the unit should be given responsibilities of IPC activities. The role of this link person includes

- Monitoring of IPC practices
- training of new staff and ongoing training of all staff

- Periodic surveillance to assess risk
- Implementation of preventive bundles

It is important that this link person communicates and networks with the facility IPC team and all members of the HD team, including nurses, technicians, physicians, housekeeping staff, and the patient/family. It is important that all members of the HD team understand their role and are held accountable for compliance with IPC practices.⁹³

Measures to reduce the risk of infection in HD patients

In the haemodialysis setting, contact transmission plays a major role in transmission of blood-borne pathogens. Transmission occurs via hands of HCWs, contaminated with infected blood directly or indirectly from contaminated surfaces and equipment.⁹³

- Standard precautions are to be used routinely on all patients and include use of gloves, disposable plastic aprons or gown, mask (whenever needed), to prevent contact of HCWs with blood, secretions, excretions or contaminated items.
- Respiratory etiquette should be observed routinely.
- A patient identified with an airborne illness should be masked immediately and separated from other patients in a single room that is preferably under negative pressure.
- Details of standard and transmission-based precautions are given in Chapter 4. Patients and staff should be vaccinated as per the recommendations of the national immunization programme.
- The patient and nurse must wear a mask when a catheter (not fistula or graft) is connected or disconnected from the blood lines during dialysis.

Specific measures for IPC in dialysis units are given in Annex 5.3.

IPC for patients with blood-borne infections

Besides standard precautions, the following points should be kept in mind.

- HBsAg-positive patients should undergo dialysis in a separate room using separate machines, equipment, instruments and supplies.
- Dialysers are discarded in biomedical waste after treatment and cannot be reprocessed or reused.
- Staff caring for HBV patients should be HBV-immune, and cannot care for HBV-positive and -negative patients at the same time.

Care of patients with HCV and HIV requires strict adherence to environmental IPC practices including equipment disinfection.

Dialysis water

The patient is exposed to more than 100 litres of water during each session of dialysis. Therefore, water must be purified and filtered. Contaminants must be removed by deionization and reverse osmosis.

Perform bacterial culture and endotoxin assay on the dialysate and reverse osmosis water at least monthly and during outbreaks using standard quantitative methods, as per available guidelines. Dialysate should be tested at the end of the treatment day.

Reprocessing and reuse of dialyser sets

- Reprocessing is performed outside of the dialysis treatment area in a dedicated room. It is the act of cleaning, testing and filling the dialyser with disinfectant solution.
- Reuse is performed in the treatment area. It refers to verification of disinfection, rinsing and testing to ensure the complete removal of all disinfectants, and “reusing” the reprocessed dialyser for the designated (same) patient. Reuse and reprocessing must follow all applicable standards.

F. IPC in immunocompromised patients

Emergence of new clinical syndromes and infections due to organisms with antimicrobial resistance have altered the pattern of opportunistic infections. The range of organisms that can cause infection is very broad and the infection can progress rapidly.

The recognition of infection in immunocompromised patients particularly transplant recipients is a challenge as the signs and symptoms of infection are suppressed and may even be absent. Moreover, fever may be caused by non-infectious conditions such as graft rejection, reaction to drugs which makes the diagnosis of infection difficult.

Transplant recipients are at increased risk of HAIs, which can occur due to inadequate engineering controls, improper systems or procedures, breaks in established procedures, lack of monitoring for known contaminants, or inadequately trained and educated staff. In addition to other HAIs, intra-abdominal infection may

occur among liver, small bowel, or other visceral transplant recipients.

Given the high risk of infection in transplant patients, meticulous adherence to IPC practices is an essential requirement for the transplant unit. The unit should have knowledgeable, well-trained staff that understands the implications of deviating from established infection control procedures.

G. IPC practices in HCFs during epidemics/ pandemics

Hospitals and other HCFs play a critical role in national and local responses to emergencies, such as communicable disease epidemics. Primarily, there is a sudden surge of sick persons seeking care resulting in a serious challenge to HCFs in maintaining their services to the community and for the staff. Diagnosis and management of patients may also be challenging as the epidemic may be due to a new/emerging or re-emerging disease. The focus of this guidance is on IPC and preparedness during these epidemics.

Challenges during epidemics

- **Amplification of the epidemic.** If the HCF has not put in place adequate measures to prevent and control infection, it may amplify an epidemic by spreading the infection to patients, staff and visitors. On leaving the hospital these infected individuals may boost transmission in the community.
- **Overwhelming demand for healthcare resources.** Human and material resources, including hospital space and medicines, may not be adequate to meet the demand, particularly in the case of an epidemic lasting several weeks or months.
- **The health facility has to alter its priorities** and adapt its work routines to mount a coordinated, systemic response to a rapidly evolving, potentially complex situation.
- **Limited time to form links or strengthen partnerships.** Managing an epidemic or other emergency call for linkages between the hospital and local health authorities, service providers and other stakeholders in the health sector and the community. Thus, well in advance of the actual emergency, existing partnerships should be reviewed and, if necessary, new partnerships should be made.

Preparing HCFs for an epidemic⁹⁴

- **Identify the hospital's role** in the overall national and local community response. Some hospitals may be designated by the health authorities to receive only suspected or confirmed cases of an epidemic disease.
- **Implement IPC measures.** Appropriate measures should be taken to prevent the spread of infection to hospital staff, patients and visitors. The HICC and the hospital management should review and, if required, revise the hospital's IPC protocols. Additional prevention and control measures may be required to cope with the specific nature of an epidemic (see Annex 2).

An effective infection control programme and the ability of an HCF to implement appropriate IPC measures in normal, routine circumstances will strengthen the HCF's capacity to put them into practice during an epidemic situation.

- **Train hospital staff.** All staff members, irrespective of their individual routine duties, need training in implementing procedures and protocols described in the Hospital Emergency Response Plan. They must also participate in regular drills and exercises needed to maintain a state of readiness for fulfilling their role in the emergency.
- **Develop a hospital emergency response plan.**
 - Set up a Hospital Emergency Coordination Centre for holding meetings and managing the emergency response (including information and communication).
 - Develop an SOP for emergencies.
 - Develop protocols for patient triage (including the designation of triage areas) and for patient traffic flow within and in the vicinity of the hospital.
 - Define measures to ensure the safety of hospital staff.
 - Maintain continuity of essential services and routine procedures.
 - Develop the capacity needed to cope with information and communication activities, human resource issues and logistics.
- **Establish an epidemic response group and action plan.**
 - Develop an epidemic action plan adapted to the specific nature of the epidemic.
 - Implement measures to ensure that the hospital has the capacity to meet a sudden increase ("surge") in the demand for specific services, equipment or supplies created by the emergency/epidemic.
 - Define the roles and responsibilities of the key departments and individuals involved in the response.

- o Define the nature and magnitude of the epidemic and its likely impact on the health system.
- o Identify the number and competencies of staff present or available for recall, with emphasis on requirements for infection control and treatment of cases.
- o Organize frontline services (e.g. emergency department) for triage of patients.
- o Identify patient referral pathways within the hospital: reception → triage → emergency → ward/ICU/isolation.
- o Establish a mechanism of referral to other HCFs.
- o Establish a mechanism of communication with and reporting to public health authorities.

Annex 11 gives an outline of an Epidemic Action Plan for high-risk pathogenesis.

IPC practices

- Establish screening/surveillance for the early detection and investigation of cases.
- Job action sheets: Prepare these for all staff members describing their roles and tasks for IPC in the epidemic situation.
- Training: Ensure that staff receive training in IPC to enhance their ability to fulfil their roles in implementing the hospital's emergency response.
- Define infection control precautions for triage, flow and placement of patients, early reporting and treatment, specimen collection and transport.
- Identify the requirement of minimum supplies and infrastructure to implement IPC measures.

Response

- Ensure that mechanisms are in place to receive and respond to operational directions from the epidemic response group.
- Assess IPC staffing needs for the emergency (at least, a doctor and a nurse) and work with administration to secure additional staff as required.
- Once an epidemic has started, establish active surveillance of cases (among both incoming patients and patients already admitted). Check case definition on a daily basis from the public health authority.
- Monitor the number of cases and clinical outcome on a daily basis.
- Ensure that the IPC policies are consistent with locally available resources.
- Reinforce standard IPC precautions and establish additional precautions if required by the specific nature of the epidemic.
- Establish patient flow based on transmission risks and patient clinical status.

Defer or limit procedures that could facilitate spread of the infection.

- Identify mechanisms of patient referral, sample transport – ambulance, sample packaging, reference laboratories.
- Ensure adequate protection of the hospital staff against infection and monitor staff health status continuously. Undertake staff vaccination and prophylaxis, training in IPC.
- Monitor IPC practices and modify policies as necessary.
- Ensure communication of messages aimed at reinforcing IPC efforts among hospital staff, patients and visitors, and the community.
- Report and communicate with local public health authorities.

For IPC guidance on specific pandemic diseases refer to WHO documents (influenza, Ebola).^{95,96}

Recovery tasks

- Assess the HCF's performance in implementing IPC plans during the emergency and update these plans on the basis of lessons learnt.
- Implement measures to address the welfare needs of IPC staff such as leave and psychosocial support.
- Replenish stocks of PPE and pharmaceutical products to enable the hospital to maintain or restore routine IPC services.

Communication

Information issued by the hospital regarding risk reduction should be consistent with the information provided by health authorities. Develop a risk communication policy for:

- **Communication within the hospital.** Information about the epidemic and the risks should be communicated to all staff as soon as an alert of an impending emergency has been declared.
- **Communication with media and general public.** Information for the media and the general public should be communicated through a single source.
- **Coordination of communication activities.** Communications activities undertaken in response to an emergency should be coordinated through the hospital's epidemic response group and senior hospital staff.

H. IPC in the clinical laboratory

The clinical laboratory is a workplace where many potential pathogens are

encountered on a daily basis. However, the laboratory can be a safe place to work if possible risks are identified and safety and infection control protocols are followed. Laboratory workers can minimize the risks associated with work involving these infectious agents through the application of appropriate biosafety and containment principles and practices.

While safe practices in the laboratory are primarily intended to prevent morbidity due to infections in laboratory workers, laboratory-associated infections may impact public health, leading to secondary cases in the community. For example, household transmission of pathogens (e.g. influenza A) is well documented. Therefore, prevention of laboratory-associated infections has an individual as well as public health impact.

General laboratory safety practices

Good personal habits, housekeeping practices and laboratory techniques can all help ensure that the laboratory is a safe place to work.

Laboratory design and facilities

In designing a laboratory, special attention should be paid to conditions that are known to pose safety problems. Overcrowding and too much equipment must be avoided. Infestation with rodents and arthropods must be prevented.

Design features for biosafety

- There should be a designated area for collecting blood and other clinical samples, physically separated from the patient waiting room and specimen processing area.
- Handwashing basins, with running water if possible, should be provided in each laboratory room, preferably near the exit door.
- Ample space must be provided for the safe conduct of laboratory work and for cleaning and maintenance.
- Walls, ceilings and floors should be coved and slip-resistant, which allow easy cleaning, impermeable to liquids and resistant to the chemicals and disinfectants normally used in the laboratory.
- Floors should be slip-resistant.
 - Bench tops should be impervious to water and resistant to disinfectants, acids, alkalis, organic solvents and moderate heat.
- Illumination should be adequate for all activities. Undesirable reflections and glare should be avoided.

- Laboratory furniture should be sturdy. Open spaces between and under benches, cabinets and equipment should be accessible for cleaning.
- Storage space must be adequate to hold supplies for immediate use and thus prevent clutter on bench tops and in aisles. Additional long-term storage space, conveniently located outside the laboratory working areas, should also be provided.
- Space and facilities should be provided for safe handling and storage of solvents, radioactive materials, and compressed and liquefied gases.
- Facilities for storing outer garments and personal items should be provided outside the laboratory working area.
- Facilities for eating and drinking and for rest should be provided outside the laboratory working area.
- Doors should have vision panels, appropriate fire ratings, and preferably be self-closing.
- At biosafety level 2, an autoclave or other means of decontamination should be available in appropriate proximity to the laboratory.
- Safety systems should cover fire, electrical emergencies, and emergency shower and eyewash facilities.
- First-aid areas or rooms suitably equipped and readily accessible should be available.

Laboratory dress code

- Laboratory coats should be fully buttoned, and must be worn by all laboratory staff at all times in the laboratory. These coats should be left in the laboratory when going out for lunch or breaks and when leaving the laboratory.
- Laboratory coats should be decontaminated and laundered regularly (never taken home for laundering).
- Comfortable, water repellent closed shoes with non-skid soles should be worn and must enclose the entire foot.
- Long, dangling jewellery is not permitted in the laboratory.
- Long hair and beards must be tied back to avoid contamination and interference with laboratory work.
- A spare, clean laboratory coat must be available in case of a spill or an emergency.

Good personal habits

- Wear proper attire and protective clothing as described above.
- Wash hands after entering and before leaving the laboratory.

- Never eat, smoke, drink, chew gum, apply cosmetics, or adjust contact lenses while in the laboratory.
- Mouth pipetting is prohibited, instead use pipetting bulbs.
- Keep hands away from the mouth, nose, and eyes to prevent self-inoculation with infectious agents.
- Do not put objects in the mouth (such as pens, pencils or pipettes).
- Wear gloves when working with biological specimens. Change gloves when contaminated.
- In preparing specimens, prevent aerosols and the resultant possible spread of infectious agents by
 - o capping all tubes to be centrifuged prior to centrifugation;
 - o never open the lids of centrifuges until the centrifuge has come to a complete stop; and
 - o only open specimen tubes by gently twisting the stoppers and lifting them (sometimes holding a lint-free tissue over the stopper may prevent aerosolization).
- Keep the test request forms, registers and other paper work separate from specimen containers since the outer surface of specimen containers may be contaminated.
- Wipe the outer surface of containers with a suitable disinfectant before handling.
- Keep the smear preparation area separate from other laboratory activities.
- Open containers carefully to minimize production of aerosols.
- Keep the container open only long enough to remove a portion for direct smear preparation if not processing for culture.

Risk assessment

Risk assessment of all activities being performed in the laboratory is mandatory to be able to manage and reduce the risks to those working in the laboratory. Risk must be assessed taking into account the adequacy of any existing controls and whether or not the risk is acceptable. Risk assessment involves systematically reviewing the work to see:

- which biological agents may be present;
- identifying the hazardous characteristics of known infectious or potentially infectious agent or material (see the classification of infective microorganisms by risk group);
- activities in the laboratory that can result in a person's exposure to an agent (Table 6.5); and

- likelihood that such an exposure will cause a laboratory-associated infection and probable consequences of such an infection.

Risk assessment guides the selection of appropriate biosafety levels and required microbiological practices and safety equipment (primary barriers) and facility level safeguards (secondary barriers) that can prevent laboratory-associated infections. Table 6.6 gives detailed information on biosafety levels.

The risk assessment process should be integrated within the overall management of laboratory services. Risk assessment can be simplified into the following steps.

Approach to risk assessment

- Identify hazards and who might be harmed (agent risk group, procedure, facility, staff, animals).
- Evaluate the risk (agent and procedure), consider the existing controls and assess the extent of the risks that remain.
- Mitigate the risk.
- Conduct a trial run using nonvirulent strains or simulants.
- Reassess the risk (any incidents/deviations).
- Remove gloves before handling phones, instruments or computers.
- Wear goggles and masks or face shields when splashing or spattering of specimens is expected.
- Never store food or drinks in refrigerators or freezers containing microorganisms or clinical specimens.
- Hand hygiene must be strictly followed especially after removing gloves and other protective wear, before leaving the laboratory, before eating or drinking, after using the lavatory, and when hands are visibly contaminated.

Good housekeeping practices

- Work areas should be kept free of clutter, dirty glassware and contaminated articles such as paper towels or lint-free tissues.
- Decontaminate equipment and work benches upon entering the laboratory and before leaving the work area with a freshly made 1:10 dilution of household bleach.
- Clean up spills immediately and properly as per laboratory policy.
- Do not submit worksheets that have become contaminated; transfer results and data to new worksheets before submission.

Table 6.5. Possible routes of exposure to infectious agents in the clinical laboratory

Route	Situation
Ingestion	Mouth pipetting Splashed infectious material Contaminated clothing, devices, fingers or gloves Contaminated pens or pencils inserted into the mouth Consumed food/drink
Inoculation	Needle-stick accident Cuts from sharp objects
Skin and mucous membrane contamination	Splashes into eyes, mouth, nose membrane Spills or splashes on intact or non-intact skin
Inhaled infectious aerosol	Streaking media Flaming or cooling inoculating loop Mixing microbial suspensions by pipette Expelling air from a syringe Withdrawing needle from rubber stopper Separating needle from syringe Centrifuging specimens Mixing instruments such as blenders or shakers Pouring or decanting fluids Opening culture containers or blood tubes Spilling infectious material

Source: Laboratory safety manual, Medical Laboratory Science Program, University of Utah

Good laboratory practices (GLP)

- Use appropriate PPE.
- Do not operate new or unfamiliar equipment until proper training and authorization have been given.
- The international biohazard warning symbol and sign must be displayed on the doors of the rooms where microorganisms of risk Group 2 or higher risk groups are handled.
- All persons entering the laboratory must have approval of the laboratory in-charge.
- Minimize use of sharps. Sharps should be discarded in biohazard sharps containers that are tamper-proof, puncture-proof and leak-proof, labelled and colour-coded appropriately.
- Stocks and other cultures must be stored in a leak-proof container when work

Table 6.6. Summary of recommended biosafety levels for infectious agents

BSL	Agents	Practices	Primary barriers	Facilities (secondary barriers)
1	Not known to consistently cause diseases in healthy adults	Standard microbiological practices	<ul style="list-style-type: none"> • No primary barriers required. • PPE: laboratory coats and gloves; eye, face protection, as needed 	Laboratory bench and sink required
2	<ul style="list-style-type: none"> • Agents associated with human disease • Routes of transmission include percutaneous injury, ingestion, mucous membrane exposure 	BSL-1 practice plus: <ul style="list-style-type: none"> • Limited access • Biohazard warning signs • “Sharps” precautions • Biosafety manual defining any needed waste decontamination or medical surveillance policies 	Primary barriers: <ul style="list-style-type: none"> • Biosafety cabinets or other physical containment devices used for all manipulations of agents that cause splashes or aerosols of infectious materials • PPE: Laboratory coats, gloves, face and eye protection, as needed 	BSL-1 plus: <ul style="list-style-type: none"> • Autoclave available

Table 6.6. Summary of recommended biosafety levels for infectious agents (*continued*)

BSL	Agents	Practices	Primary barriers	Facilities (secondary barriers)
3	Indigenous or exotic agents that may cause serious or potentially lethal disease through the inhalation route of exposure	BSL-2 practice plus: <ul style="list-style-type: none"> • Controlled access • Decontamination of all waste • Decontamination of laboratory clothing before laundering 	Primary barriers: <ul style="list-style-type: none"> • Biosafety cabinets or other physical containment devices used for all open manipulations of agents • PPE: Protective laboratory clothing, gloves, face, eye and respiratory protection, as needed 	BSL-2 plus: <ul style="list-style-type: none"> • Physical separation from access corridors • Self-closing, double-door access • Exhaust air not recirculated • Negative airflow into laboratory • Entry through airlock or anteroom • Handwashing sink near laboratory exit
4	<ul style="list-style-type: none"> • Dangerous/exotic agents which pose high individual risk of aerosol-transmitted laboratory infections that are frequently fatal, for which there are no vaccines or treatments 	BSL-3 practices plus: <ul style="list-style-type: none"> • Clothing change before entering • Shower on exit • All material decontaminated on exit from facility 	Primary barriers: <ul style="list-style-type: none"> • All procedures conducted in Class III biosafety cabinets or Class I or II biosafety cabinets in combination with full-body, air-supplied, positive pressure suit 	BSL-3 plus: <ul style="list-style-type: none"> • Separate building or isolated zone • Dedicated supply and exhaust, vacuum and decontamination systems • Other requirements outlined in the text

Table 6.6. Summary of recommended biosafety levels for infectious agents (*continued*)

BSL	Agents	Practices	Primary barriers	Facilities (secondary barriers)
	<ul style="list-style-type: none"> • Agents with a close or identical antigenic relationship to an agent requiring BSL-4 until data are available to redesignate the level • Related agents with unknown risk of transmission 			

Source: Biosafety in microbiological and biomedical laboratories, CDC

The above table relates but does not “equate” risk groups to the biosafety level of laboratories designed to work with organisms in each risk group. Some hazard group 2 biological agents, such as *Neisseria meningitidis*, are seen as higher risk to laboratory workers on the basis that they are transmitted by the airborne route. If an accident involving such agents was to occur in a BSL-2 laboratory, it would not be possible to seal the laboratory for fumigation, or maintain an inward airflow to prevent escape of the agent. It is important that such eventualities are considered as part of a risk assessment exercise and selection of appropriate control measures. Laboratory SOPs need to specify how the work may be conducted safely.



Fig. 6.1. Biohazard warning sign for laboratory doors

is complete. A sealed, leak-proof container, labelled with a biohazard symbol (Fig. 6.1), must be used to transport stocks and cultures from one room to another.

- Cultures should be disinfected/inactivated prior to disposal, either by chemical disinfection or autoclaving.
- Broken glass must be handled using a forceps/tongs, not to be picked up by laboratory personnel by hand. Broken glass must be disposed of in appropriately colour-coded puncture-proof boxes with the biohazard symbol.
- Staff must be aware of the location of eyewash stations and showers and must be trained on biosafety including spill management.

Procedures for taking blood specimens

- All blood should be considered potentially infectious. The following precautions are needed when taking specimens:
 - blood specimens from all patients should be collected in a separate area;
 - blood should not be taken in any room normally used as a laboratory or office; and

- o protective clothing should be worn, which includes a clean laboratory coat or gown and gloves.

Handling specimens submitted to the laboratory⁹⁷

- All specimens are to be received in a closed container labelled with appropriate patient information along with a duly filled specimen referral form.
- Test tube racks or trays must be used to transport specimens in the laboratory.
- Review, revise and modify the assessment – particularly if the nature of the work changes or if developments suggest that it may no longer be valid.

In evaluating the risks, the key points to consider are the following.

- Listing of risk groups for microbiological agents that are involved (see Annex 12 for classification of risk groups);
- Pathogenicity of the agent and infectious dose;
- Potential outcome of exposure;
- Natural route of infection;
- Other routes of infection, resulting from laboratory manipulations (parenteral, airborne, ingestion);
- Stability of the agent in the environment;
- Concentration of the agent and volume of concentrated material to be manipulated;
- Prevalence of particular infections in the local community;
- Information available from animal studies and reports of laboratory-acquired infections or clinical reports;
- Laboratory activity planned (sonication, aerosolization, centrifugation, etc.);
- Likelihood of infection occurring (including during normal work and in the event of an accident);
- Risks to laboratory staff and others such as visitors, cleaners, maintenance staff, contractors;
- Competency of laboratory staff in handling the pathogen, whether the staff is trained to handle the pathogen/procedure in a safe manner; and
- Local availability of effective prophylaxis or therapeutic interventions.

Risks must be assessed at all sites where diagnostic testing is carried out, including hospital wards, clinics, health centres and surgeries. If the assessments show that risks cannot be adequately controlled, either appropriate arrangements must be made or the specimens may be sent elsewhere for processing. SOPs must be in place in the laboratory for any anticipated accidents or contamination. The laboratory must also keep a record of occurrence of any accidents in the laboratory, staff exposures, action taken and procedures put in place to prevent future occurrences.

Biosafety levels

Laboratory facilities are designated as Biosafety levels 1 to 4 based on a composite of design features, construction, containment facilities, equipment, practices and operational procedures required for working with agents from various risk groups.⁹⁸

The principal hazardous characteristics of an agent are: its capability to infect and cause disease in a susceptible human or animal host, its virulence as measured by the severity of disease, and the availability of preventive measures and effective treatments for the disease.

- Biosafety level 1 (BSL-1) is the basic level of protection and is appropriate for agents that are not known to cause disease in normal, healthy humans.
- Biosafety level 2 (BSL-2) is appropriate for handling moderate-risk agents that cause human disease of varying severity by ingestion or through percutaneous or mucous membrane exposure.
- Biosafety level 3 (BSL-3) is appropriate for agents with a known potential for aerosol transmission, for agents that may cause serious and potentially lethal infections and that are indigenous or exotic in origin.
- Exotic agents that pose a high individual risk of life-threatening disease by infectious aerosols, and for which no treatment is available, are restricted to high containment laboratories that meet biosafety level 4 (BSL-4) standards (Table 6.6).

Safety equipment

Biosafety cabinets or safety centrifuge cups must be used to minimize aerosol hazards.⁹⁹

Biosafety cabinets

These are to be used when performing procedures with high potential for producing infectious aerosols. These include:

- Open-fronted Class I and Class II biosafety cabinets are primary barriers that offer significant levels of protection to laboratory personnel and to the environment when used with good microbiological techniques.
- The Class II biological safety cabinet also provides protection from external contamination of the materials (e.g. cell cultures, microbiological stocks) being manipulated inside the cabinet.
- The gas-tight Class III biological safety cabinet provides the highest attainable level of protection to personnel and the environment.

- Biological safety cabinets must be validated with appropriate methods before being taken into use.
- Recertification should take place at regular intervals, at least once a year or more frequently when required.

Safety centrifuge cups

These are enclosed containers designed to prevent aerosols from being released during centrifugation.

Decontamination

Steam autoclaving is the preferred method for all decontamination processes. Materials for decontamination and disposal should be placed in containers, e.g. autoclavable plastic bags that are colour-coded according to the Biomedical Waste Management Rules, 2016 (amended 2018, 2019).

Handling laboratory waste

A well-managed and monitored biomedical waste management system must be in place in the laboratory in accordance with the Biomedical Waste Management Rules, 2016 (amended 2018, 2019).^{100,101} (See also Chapter 5 and Annex 8.)

7. Healthcare-associated infections and their surveillance

A. Surveillance of healthcare-associated infections

Surveillance of HAIs allows the health system to (i) estimate the burden of diseases in terms of cases reported, deaths occurred and costs incurred; (ii) detect outbreaks and emerging pathogens and pattern of resistance; and (iii) monitor the quality of IPC measures/strategies.

Surveillance of HAIs is a basic requirement for organizing and maintaining an effective IPC programme and to substantially reduce morbidity and mortality.¹⁰²

Routine HAI surveillance in HCFs should be conducted by an infection control officer or ICN by systematically collecting patient-based, prospective, priority-directed data that yield risk-adjusted rates of incidence. Risk-adjusted rates are controlled for variations in the distribution of major risk factors associated with the occurrence of an HAI event. Such rates enable comparison between units within an HCF and between HCFs.

Types of surveillance appropriate for HAIs¹⁰³

- **Active surveillance.** This involves systematic collection of data by a designated trained hospital infection control professional/nurse. Information is accumulated by using a variety of data sources within and beyond the wards. (Passive surveillance consists of reporting of any occurrence of suspected HAI by clinicians or ward staff nurses, and is not an efficient method to track HAIs.)
- **Process and outcome surveillance.** This is an audit of a practice or process of IPC such as hand hygiene or care bundles. Outcome surveillance aims to detect an HAI event such as BSI, UTI, etc.
- **Clinical/patient-based surveillance.** This involves counting of HAIs, assessing risk factors, and monitoring patient care procedures and practices

for adherence to the principles of IPC. This also requires ward rounds and discussion with caregivers.

- **Laboratory-based surveillance.** This surveillance is based solely on the findings of laboratory studies of clinical specimens. The microbiology laboratory also carries out studies on patterns of AMR for common isolates and new or emerging pathogens and patterns of resistance. This information is reported to the HICC and various clinical units of the HCF.
- **Priority-directed and comprehensive surveillance.** Priority-directed surveillance, also called targeted, focused or surveillance by objectives, focuses on specific events, processes, organisms and/or patient populations. On the other hand, comprehensive surveillance is resource-intensive, continuous monitoring of all patients for all HAI events and/or processes.

HAI surveillance with limited resources

In situations where no data exist and resources are limited, efforts of surveillance should be focused on areas that have vulnerable patients and on procedures that are more prone to HAIs, such as surgical units, ICU, NICU, burns unit, etc.¹⁰⁴

HCFs with limited resources and minimal trained staff should carry out the following basic surveillance.

Process surveillance

This involves auditing certain IPC practices (e.g. hand hygiene) against a standard such as an evidence-based practice, guideline or policy. This guidance or policy should be available to the staff and they must have received the training according to their role in the HCF (doctor, nurse, attendant, housekeeping, etc.).

The practices to be monitored include the following.

- Hand hygiene
- Urinary catheter insertion
- Using multi-dose vials
- Safe injection practice
- Preparation of surgical incision site
- Insertion of vascular catheter
- Waste segregation
- Handling of sharps

Observational forms or checklists should be developed for each IPC practice that is subjected to process surveillance (see Annex 13).

Outcome surveillance

This includes surveillance for HAI rates for the following common types of HAIs.

- Surgical site infection
- Urinary tract infection
- Respiratory tract infection
- Bloodstream infection
- Gastrointestinal infection

Prevalence survey

HCFs that have not started outcome surveillance, have limited resources and do not have any data on HAI rates in their facility, can undertake a prevalence survey. The staff carrying out the prevalence survey should be trained to identify existing cases of HAIs based on signs and symptoms of infection and simplified surveillance criteria.¹⁰⁵

On any one day (or during a period decided by the HICC), the designated staff should carry out a prevalence survey in a designated area of the HCF depending upon the size of the hospital and available resources.

Data to be collected

- Clinical chart review for patients having fever and on antimicrobial therapy (which is a sensitive indicator of HAIs).
- Review the microbiology reports if available.
- Data collected for a probable case includes patient number, age, gender, location, associated comorbidity such as diabetes, type of infection, site and severity of infection, investigations done for infection.
- In case of an SSI, whether surgery was performed at the hospital within the preceding 30 days (or within 1 year if an implant was in place), the date of surgery and type of surgery are recorded.

Denominators

- Number of patients present/admitted in the ward on that day
- For device-related HAIs: total device days of the existing patients in the ward
- Reporting and feedback

Reporting to the HICC and feedback to the wards/units is essential. This gives:

- an estimate of the burden of HAIs in the hospital;
- comparison between wards and units;

- the interventions that are needed; and
- priority for interventions.

Prevalence surveys should be repeated at specified intervals for trends and effectiveness of interventions.

Incidence surveys

The minimum outcome incidence rates that should be calculated on a continuing basis are SSIs and device-related infections in the ICU.

Minimum requirements

- Administrative support
- Surveillance coordinator: Infection control physician/doctor or ICN in collaboration with the link nurse from the unit/department and other clinical members.
- Data entry and analysis. It is helpful to have a hospital information system. At least a computer system is required to enter and analyse data.
- Microbiology laboratory: This is one of the core components of an IPC programme. Besides being an adjunct to diagnosis and treatment, the microbiology laboratory is essential for detection of the source and mode of transmission of infection. This is possible only through microbiology culture and identification and further characterization at the minimum through an antibiogram. The laboratory also detects emerging pathogens and resistance.

Data sources

Clinical ward

- Patients who have devices inserted and undergone procedures that have a risk of infection such as indwelling vascular or urinary catheters, surgical operations
- Record of fever and other clinical signs consistent with infection
- Antimicrobial therapy
- Laboratory tests such as microbiology cultures
- Medical and nursing chart reviews

Laboratory reports

Daily review of laboratory reports may be helpful in identifying HAIs.

- Review patients who have isolation of organisms potentially associated with infection.
- Patterns of AMR can help in identifying issues of emerging resistance.

Laboratory reports alone cannot be relied upon for the following reasons.

- Specimens may not be appropriate.
- Some pathogens may be difficult to isolate.
- Isolation of an organism may represent colonization and not infection.

Laboratory reports are necessary for the diagnosis of UTI, BSI and MDRO surveillance.

Data to be collected

- Patient number, date of admission to hospital
- Demographic details and risk factors: age, gender, severity of underlying illness, diabetes and any primary diagnosis, indwelling devices, operative procedure, other treatments such as chemotherapy, date, type of HAI event, microorganisms isolated and antimicrobial susceptibility.

The infections should meet the basic definition of HAI, i.e. should be detected after 48 hours (>2 calendar days) of hospitalization.

Surgical site infection

SSIs are potential complications associated with any type of surgical procedure. Although SSIs are among the most preventable HAIs, they still represent a significant burden in terms of patient morbidity, mortality and additional costs to health systems. SSIs are both the most frequently studied and the leading HAIs reported from hospitals in LMICs.

The WHO report on the global burden of endemic HAI provided SSI data from LMICs. The pooled SSI incidence was 11.8 per 100 surgical patients undergoing surgical procedures (95% CI 8.6–16.0) and 5.6 per 100 surgical procedures (95% CI 2.9–10.5).

Definition

SSI refers to an infection that occurs after surgery in the part of the body where the surgery took place. SSIs can sometimes be superficial infections involving the skin only. Other SSIs are more serious and can involve tissues under the skin, organs, or implanted material.

SSI is also defined as an infection that occurs within 30 days after the operation and involves the skin and subcutaneous tissue of the incision (superficial incisional) and/

or the deep soft tissue (for example, fascia, muscle) of the incision (deep incisional) and/or any part of the anatomy (for example, organs and spaces) other than the incision that was opened or manipulated during an operation (organ/space).

In some cases, SSI may appear up to 90 days after surgery. These are operations involving surgical implants and these conditions are listed at the end of this chapter.

Superficial incisional SSI

- Discharge of pus from the superficial incision
- Pain, tenderness, localized swelling, redness or heat
- Positive culture from aseptically collected specimen

Deep incisional SSI

Infection appears within 30 days* of the procedure or within one year if there is an implant or foreign body, such as a prosthetic heart valve or joint prosthesis.¹⁰⁶

- Pus discharge from the deep incision (muscle and fascial layers)
- Spontaneous dehiscence or “gaping” of wound
- Fever >38 °C, localized pain or tenderness
- Positive culture from aseptically collected specimen

Organ/space SSI

Infection appears in an organ or space within 30 days* of the procedure in the organ/space that is opened or manipulated during the operative procedure.

- There is purulent drainage from a drain that is placed into the organ/space.
- Organisms are identified from fluid or tissue in the organ/space by a culture.
- An abscess or other evidence of infection involving the organ/space is detected on gross anatomical or histopathological examination, or imaging test evidence is suggestive of infection.

*According to the National Healthcare Safety Network (NHSN), 30–90 days are taken as the duration after surgical operation for the detection of deep incisional and organ space SSI. This is dependent upon the type of operative procedure. The NHSN list of operative procedures for which either a 30-day or 90-day duration is considered for detection of SSI is given in Annex 13.5.

The criteria required to diagnose infection have to be uniform to accurately identify any increase or decrease in infection. Correct identification of SSI helps us to find out if an intervention to reduce the occurrence of SSI is effective. Uniformity also assists in comparing SSI rates between facilities (Box 7.1).

Box 7.1. Calculation of SSI rates

- SSI rates per 100 operative procedures are calculated by dividing the number of SSIs by the number of specific operative procedures and multiplying the result by 100.
- SSIs will be included in the numerator of a rate based on the date of procedure, not the date of the HAI event.
- SSI rates can be calculated separately for different types of operative procedures and stratified by the wound classification (clean, clean contaminated, contaminated, dirty).

Classification of the surgical wound

All surgical wounds are not uniformly prone to infection.

- The type of wound influences the risk of infection.
- It also aids in finding the source of infection.
- It permits the diagnosis of infection even if culture facilities are not available.
- It helps in determining whether antibiotics are necessary.

Table 7.1 gives the classification of surgical wounds into various types based on contamination with microorganisms and risk of infection.

Risk factors for SSI

Many factors influence surgical wound healing and determine the potential for infection. These include patient-related and process/procedural-related variables that affect a patient's risk of developing an SSI.¹⁰⁷

Risk factors for SSI are:

- Host factors
 - Extremes of age
 - Concurrent disease, malnutrition
 - Underlying clinical condition
 - Skin infections
- Surgical procedure
 - Surgical category: clean, clean contaminated or dirty
 - Implant or prosthesis
 - Poor surgical technique
 - Excessive use of diathermy
 - Duration of surgical procedure

Table 7.1. Classification of surgical wounds

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

- o Haemorrhage, necrosis, haematoma
- o Presence of drains
- Preoperative preparation
 - o Inadequate skin preparation – e.g. inappropriate skin disinfectant
 - o Shaving the day before surgery
 - o Inappropriate antibiotic prophylaxis – inappropriate choice, inadequate dose, inappropriate timing (not within 60 minutes of incision)
- OT – design, discipline, staff
 - o Increased traffic and movement of staff
 - o Inappropriate clothing
 - o Inadequate ventilation

- o Inadequate sterilization and disinfection
- o Open containers of sterile solutions
- o Inadequate cleaning and “breathing time”

Data to be collected^{108–113}

- Patient details: age, gender and location
- The severity and the extent of the infection in the patient
- The type of operation and location of the operation (surgical OT, emergency, gynae OT, etc.)
- Classification of operation: clean, clean contaminated, contaminated, dirty
- The time period between the operation and the development of the infection (the beginning of the operation is the time the surgical incision is made and the end of operation is when the sponge counts are made after wound closure).
- Underlying patient status whether diabetic, infection elsewhere in the body, other comorbidities.
- Microbiological culture: type of specimen, date, organism, antimicrobial susceptibility.

Operated patients should be followed up for at least 30 days after the procedure.

Recommendations for the prevention of SSIs

The following recommendations are important for preparing SSIs and are based on WHO global guidelines on the prevention of SSIs.^{114,115}

Preoperative recommendations

- Whenever possible, efforts shall be made to identify and treat all infections remote to the surgical site before elective operation and postpone elective operations on patients with remote site infections until the infection has resolved.
- Ensure adequate control of serum blood glucose levels in all diabetic patients.
- Preoperative bathing of patient by a plain or antimicrobial/medicated soap.
- Administration of surgical antimicrobial prophylaxis (SAP) is prior to the surgical incision when indicated (depending on the type of operation). Various antimicrobials have different half-lives. The timing of administration should be within 120 minutes before incision, while considering the half-life of the antimicrobial.
- Mechanical bowel preparation alone (without the administration of oral antibiotics) should NOT be used in adult patients undergoing elective colorectal surgery.

- In patients undergoing any surgical procedure, hair should either NOT be removed or, if absolutely necessary, should only be removed with a clipper. Shaving is strongly discouraged at all times, whether preoperatively or in the OT.
- Patients undergoing cardiothoracic and orthopaedic surgery with known nasal carriage of *Staph. aureus* should receive perioperative intranasal applications of mupirocin 2% ointment with or without a combination of chlorhexidine (CHG) body wash.¹¹⁶
- Preparation of the surgical site: alcohol-based antiseptic solutions based on CHG for surgical site skin preparation in patients undergoing surgical procedures (CHG is a better choice than povidone-iodine because of rapid onset and persistent antimicrobial activity).
- Antimicrobial sealants should not be used after surgical site skin preparation for reducing SSI.
- Enhance nutritional support for underweight patients who undergo major surgical operations by administration of oral or enteral multiple nutrient-enhanced nutritional formulas.

Urinary tract infection

Positive urine culture limited to one-two species of organisms with 10^5 CFU/ml, with or without clinical symptoms.

At least one of following factors with no other recognized cause:

- Fever ($>38^{\circ}\text{C}$)
- Suprapubic tenderness
- Urgency
- Frequency
- Dysuria

Indwelling urinary catheter (IUC): A drainage tube, which is inserted into the urinary bladder through the urethra, is left in place, and connected to a drainage bag. This is also called a Foley catheter.

Catheter-associated urinary tract infection

CAUTI criteria: A UTI where an IUC was in place for >2 calendar days on the date of infection, with the day of catheter insertion being day 1.

Calculation of incidence

Patient-days and urinary catheter days are the denominators used to determine incidence rates for UTI and CAUTI, respectively.

Urinary catheter days is the number of patients with a catheter in the ICU under surveillance each day.

Patient-day denominator is calculated as the total number of patients per day in the ICU under surveillance.

NICUs may collect the denominator data stratified by categories of birth weight

- <1000 g;
- <1001–1500 g;
- <1501–2500 g; and
- > 2500 g.

Data should be analysed for all UTIs combined and stratified by device association (e.g. CAUTI vs non-CAUTI). Incidence rates should be calculated for both total UTIs and CAUTI, as described below.

UTI incidence rate (UTI per 1000 patient-days): divide the number of reported UTIs by the number of patient-days and then multiply by 1000.

CAUTI rate (CAUTI per 1000 urinary catheter days): divide the number of reported CAUTI by the number of urinary catheter days and then multiply by 1000.

Respiratory tract infection

Respiratory symptoms with at least two of the following signs appearing during hospitalization:

- Cough
- Purulent sputum
- New infiltrate on chest radiograph consistent with infection

Ventilator-associated pneumonia

If the patient is on mechanical ventilation and signs of infection appear after 2 days of stability/improvement on ventilator, VAP is recognized by the following criteria:¹¹⁷

- Worsening oxygenation
- Temperature $>38^{\circ}\text{C}$ or $<36^{\circ}\text{C}$, or white blood cell count $\geq 12\,000 \text{ cells/mm}^3$ or $\leq 4\,000 \text{ cells/mm}^3$

Box 7.2. Role of quantitative microbiology culture

In the absence of purulence, quantitative or semi-quantitative microbiology culture of respiratory secretions are required. The significant counts of organisms in the various specimens are:

- Endotracheal aspirate >105 CFU/ml
- Bronchoalveolar lavage >104 CFU/ml
- Lung tissue >104 CFU/ml
- Protected specimen brush >103 CFU/ml

- Purulent respiratory secretions (>25 neutrophils and <10 squamous cells/low power field) and positive microbiology culture of either sputum, endotracheal aspirate, bronchoalveolar lavage, lung tissue, protective specimen brush (Box 7.2).

The definition criteria for VAP has many limitations in its differentiation from other complications that occur in mechanically ventilated patients.

Calculation of incidence

- Device days and patient-days are used for denominators.
- Ventilator days, which are the number of patients managed with a ventilatory device, are collected daily, at the same time each day, according to the chosen location.

The VAP rate per 1000 ventilator days is calculated by dividing the number of VAPs by the number of ventilator days and multiplying the result by 1000.¹¹⁸

Bloodstream infection

Criteria for BSI

- A recognized pathogen isolated from blood culture and pathogen not related to infection at another site.
- Symptoms and signs of septicaemia
- In patients >12 months of age: fever >38 °C, chills or hypotension
- In patients <12 months of age, fever (>38 °C), hypotension, hypothermia (<36 °C), apnoea, bradycardia
- And one of the following:
 - Common skin commensals (coagulase-negative staphylococci, diphtheroids) isolated from two blood cultures drawn on separate occasions on the same day or next consecutive day.

- o Common skin commensal isolated from a patient with an intravascular access device*.
- o In the absence of culture positivity, positive antigen test on blood for *N. meningitidis*, pneumococci, *H. influenzae*, group B streptococci.

*Catheter tip cultures should not be used to determine whether a patient meets the case definition for BSI.

Vascular catheter infection

Signs of inflammation, lymphangitis or purulent discharge from the site of the catheter. Most intravascular catheters are inserted into peripheral veins for venous access and are called peripheral vascular catheters.

Central line-associated bloodstream infection

Central lines are intravascular catheters that terminate at (or open at) the heart or close to the heart in one of the great vessels. Central lines can be temporary or permanent.

Temporary central lines are non-tunneled, non-implanted lines, e.g lines which are commonly used for acute management in ICU, peripherally inserted central catheter lines for parenteral nutrition, etc.

Permanent central lines can be tunneled catheters (including long-term dialysis catheters) or implanted catheters (including ports for chemotherapy).

The following are the great vessels that define a central line:

- Aorta
- Pulmonary artery
- Superior or inferior vena cava
- Brachiocephalic vein
- Internal jugular vein
- Subclavian vein
- External and common iliac vein
- Femoral vein
- Umbilical artery/vein (in neonates)

Recognized pathogen: An organism recognized as a cause of BSI

Common commensal: An organism that can commonly exist on body surfaces without causing disease. It is often referred to as a “contaminant” when isolated in blood culture, e.g. coagulase-negative staphylococci and diphtheroids (Box 7.3).

Box 7.3. Rules for two matching blood cultures

Samples taken at the same time:

- Should be from different sites (e.g. one from the right arm and other from the left arm) using a separate sterile needle and syringe for each blood draw
OR
- If samples taken from the same site, there must be: (i) two separate blood draws, each using a separate sterile needle and syringe; (ii) site disinfection between draws

Samples taken at different times:

- Second sample collection must be on the same day or next day (consecutive days)

Calculation of incidence rate

- Central line days: the denominator is calculated as the number of patients with one or more temporary central lines on each unit under surveillance, each day. Surveillance staff should record the number of patients in the surveillance unit who have at least one central line in place. If a patient has more than one central line in place, it is still counted only as one central line day.
- Patient-days: the denominator is calculated as the total number of patients per day in the unit under surveillance. Patient-days should be collected at the same time as central line days.
- NICU patient-days: the denominator may be stratified by categories of birth weight:¹¹⁹
 - <1000 g;
 - <1001–1500 g;
 - <1501–2500 g; and
 - > 2500 g.

Calculation of incidence

BSI rate (BSI per 1000 patient-days): divide the total number of reported BSI by the number of patient-days and then multiply by 1000.

CLABSI rate (CLABSI per 1000 central line days): divide the total number of reported CLABSI by the number of central line days and then multiply by 1000.

Device utilization rates: the device utilization rates for central lines and ventilators are calculated by dividing the number of days of device use by the number of patient-days.

Gastrointestinal infection

Infectious gastroenteritis is common in paediatric and geriatric units. Diarrhoea is defined as the passage of three or more loose or liquid stools per day (or more frequent passage than is normal for the individual).

Diarrhoea occurring in a patient after 48 hours of admission is designated as an HAI. There are three clinical types of diarrhoea:

- Acute watery diarrhoea – lasts several hours or days, and includes cholera
- Acute bloody diarrhoea – also called dysentery
- Persistent diarrhoea – lasts 14 days or longer

Diarrhoea in neonatal patients

Infection can begin as gastroenteritis in neonatal patients but then spread to the bloodstream and present as septicaemia or BSI. If two sites of infection are present in one patient it will be considered as two infections.

The rate of infectious diarrhoea is calculated as

- Number of HAI patients with diarrhoea divided by the number of patient-days; then multiply by 1000.
- Neonatal patients can be categorized according to birth weight:
 - <1000 g;
 - <1001–1500 g;
 - <1501–2500 g; and
 - > 2500 g.

Patients with multidrug-resistant organisms

Contact precautions need to be initiated in patients that present with MDRO, including MRSA, VRE, multidrug-resistant Gram-negative organisms. With the exception of patients presenting with diarrhoea or bowel incontinence who can be identified without difficulty, it may be difficult to identify patients for whom contact precautions need to be initiated. Identification of infection/colonization with MDRO can be attempted by:

- Identifying patients with an established history of infection or colonization with MDRO through health records
- Possible selective microbiological screening for MDRO.

Environmental controls to prevent transmission of MDRO

Environmental cleaning and disinfection are very important in the emergency

department as there are multiple opportunities for contamination of the environment and patient care equipment in the emergency department.

- Patients colonized or infected with MDRO can transfer microorganisms to their clothes, linen, guard rails, over-bed tables, blood pressure cuffs, the floor, and many other sites in their immediate vicinity.
- Environmental contamination with MDRO can contaminate HCWs' hands during patient care.
- Patients can also acquire MDRO when placed in a room previously occupied by a MDRO colonized patient due to environmental contamination.
- Frequently touched items in the emergency department such as computer keyboards, telephones, and door handles, stethoscopes are frequently contaminated and have the potential to transmit the contaminating MDRO, and should be routinely disinfected.
- Non-critical* equipment (e.g. blood pressure cuffs) and environmental surfaces (e.g. bed rails, patient furniture, floors) should be routinely cleaned and disinfected.
- Semi-critical and critical items should be high level disinfected or sterilized as required in the CSSD or dedicated area.

*See Chapter 4 for Spaulding's classification of patient care items into non-critical, semi-critical and critical.

Prevention of infection related to vascular access

Care bundles should be applied for prevention of catheter-related infections.

Insertion bundle

- Hand hygiene
- Use of the femoral vein should be avoided in adults.
- Maximal sterile barrier precautions (including mask, cap, sterile gown, and sterile gloves) should be used by the catheter inserter.
- The patient should be covered with a large sterile drape. For patients older than 2 months, a skin preparation solution containing more than 0.5% chlorhexidine gluconate and 70% isopropyl alcohol should be applied to the insertion site and allowed to dry before the skin is punctured.
- Checklists should be used to ensure that all steps have been followed.

Catheter care (maintenance)

- Aseptic technique should be used to prevent contamination of the catheter system, including the use of a surgical mask for staff and patient and clean

gloves for all catheter system connect, disconnect and dressing procedures.

- The hub of the catheters can be soaked in povidone-iodine solution or wrapped with gauze saturated with povidone-iodine solution for 5 minutes before removing the caps.
- A fresh pair of disposable gloves should be worn for the connection procedure (dialysis session initiation).
- After removing the cap, the hub should be wiped with CHG, alcohol or povidone-iodine.
- The catheter hub should be connected immediately to limit exposure to air. This procedure should also be followed at the time the patient is disconnected at the end of the dialysis session or for any other reason. Catheter manipulation should be kept to an absolute minimum; if there are flow problems they must be definitively addressed as quickly as possible.

Exit-site care

- The catheter exit-site dressing should be changed every 3 days (after each HD session) if gauze/ tape, or every 7 days if transparent dressing is used in addition to whenever the dressing is wet or soiled.
- The catheter insertion site should be cleaned/disinfected at the time of the dressing change with CHG/alcohol or povidone-iodine solution; ointment should be applied (povidone-iodine or triple antibiotics).

Intraoperative factors

Site preparation

- Thoroughly wash and clean the surgical site to remove gross contamination before performing antiseptic skin preparation.
- Use an appropriate chlorhexidine-alcohol based antiseptic agent for skin preparation.
- Apply preoperative antiseptic skin preparation in concentric circles moving toward the periphery. The prepared area must be large enough to extend the incision or create new incisions or drain sites, if necessary.

Other intraoperative interventions

- Drapes and gowns: Both sterile disposable non-woven or sterile, reusable woven drapes and gowns can be used during surgical operations for the purpose of preventing SSI. Plastic adhesive incise drapes with or without antimicrobial properties for the purpose of preventing SSI are not recommended.

- Use of protocols for intensive perioperative blood glucose control for both diabetic and non-diabetic adult patients undergoing surgical procedures to reduce the risk of SSI is suggested.
- Maintenance of adequate circulating volume control/normovolaemia. Fluid therapy should be goal directed.
- Triclosan-coated sutures are suggested independent of the type of surgery.
- Use of warming devices in the OT and during the surgical procedure should be used for patient body warming for reducing SSI.
- Wound protector devices are suggested in clean-contaminated, contaminated and dirty abdominal surgical procedures for reducing SSI.
- Irrigation of the incisional wound with an aqueous PVP-I solution before closure for preventing SSI, particularly in clean and clean-contaminated wounds. Saline irrigation is not recommended. Antibiotic incisional wound irrigation should not be used for preventing SSI.
- Laminar airflow ventilation systems should not be used to reduce the risk of SSI for patients undergoing total arthroplasty surgery.

Postoperative factors

- A surgical incision that has been closed by primary closure should be covered with a sterile dressing till 48 hours. For an incision with delayed primary closure or healing by second intention, the incision should be packed with a sterile dressing. Use of an advanced dressing over a standard dressing on primarily closed surgical wounds is not recommended.
- The wound drain should be removed when clinically indicated.

National HAI Surveillance Network

HCFs with adequate capacity and resources can opt to join the National HAI Surveillance Network.¹²⁰ Data collection formats for surveillance of BSI and CAUTI and a checklist for VAP are given in Annexes 13.1–13.4.

B. Management of HAI outbreaks

An outbreak is defined as an occurrence of disease at a rate greater than that expected within a specific geographical area over a defined time period.¹²¹ In the context of HAIs, the geographical area may be a hospital, ward, intensive care unit (ICU) or operation room. When there are more cases of infection with the same organism than would normally be expected in one area or period, this constitutes an outbreak. It is important to investigate an HAI outbreak immediately, as the availability and quality of microbiological evidence and epidemiological data diminishes rapidly with time between illness and investigation.

“Outbreaks” vs “Clusters”

Sometimes small outbreaks are referred to as clusters (e.g. HBV and HCV). A cluster is an aggregation of cases grouped with respect to person, place and time which are suspected to be greater than the number expected.¹²² Functionally, there is no major difference since both outbreaks and clusters need to be investigated to uncover the factor(s) responsible and to guide implementation of IPC measures (Box 7.4).

Commonly detected organisms in HAI outbreaks

- Methicillin-resistant *Staphylococcus aureus* (MRSA)
- Carbapenem-resistant Enterobacteriaceae (CRE)
- Multi-resistant *Klebsiella* spp. or *Pseudomonas* spp.

Box 7.4. “Outbreak” vs “Pseudo-outbreak”

An “outbreak” is generally an increase in clinical disease or clinically relevant lab reports (e.g. dengue or HIV serology or flu PCR). A “pseudo-outbreak” is generally an increase in reports or positive cultures without evidence of disease.

This may be a surveillance or laboratory artifact due to:

- New definitions
- Improved surveillance
- New practitioners
- New lab tests or change in testing frequency
- Poor sample collection
- Laboratory error or contamination

- Diarrhoeal pathogens (e.g. *Salmonella* spp., *Shigella* spp., *Campylobacter* spp., norovirus)
- Respiratory pathogens (e.g. influenza, RSV)

There are also reports of HAI outbreaks caused due to *M. tuberculosis*, HBV, HCV, HIV, HAV, HEV, etc.

Identifying a potential outbreak

An outbreak can be identified by regular reviews of surveillance and laboratory data. Clinician reports of notifiable diseases can provide an alert to an unusual increase in a disease. In many outbreaks due to common encountered pathogens, comparison is made with previous occurrence of the same infection.

Some outbreaks are easy to investigate, e.g. unusual or important organisms. Others are not that easy, e.g. a 50% increase in SSIs for one quarter or doubling of MRSA BSIs for one month. Occurrence of any unusual organism needs to be investigated.

There might be various modes of transmission of outbreak pathogens in healthcare facilities (Box.7.5). Sometimes outbreaks occur in the community and the hospital acts as an amplifier, e.g. the sick patient admitted to the hospital (index case) transmits the infection to other patients and staff and the number of cases with infection increase. This has happened in the outbreaks of SARS, influenza, Ebola and Nipah virus outbreaks.

Outbreaks should be investigated to:

- Define the magnitude of the outbreak in terms of time, place and person
- Identify the cause of the outbreak and mode of transmission
- Control the outbreak

Box. 7.5. Modes of transmission of outbreak pathogens¹²³

- Common source
- Human reservoir
- Cross-infection (person to person)
- Airborne
- Other environmental (e.g. fomite or medical device)
- Zoonotic and vector-borne
- Uncertain

- Prevent similar outbreaks in the future
- Evaluate existing IPC strategies

Steps involved in HAI outbreak investigation

The following steps are very useful when investigating an outbreak. It is important to remember that they are provided as a guideline. Although the steps are listed sequentially the process of outbreak investigation may occur in a different order, often simultaneously or repeated many times as new information is received.

1. Verification of diagnosis
2. Confirm the existence of the outbreak
3. Inform key stakeholders about the investigation
4. Construct a case definition
5. Identify the cases and collect information
6. Examine descriptive epidemiological features of cases
7. Observe and review patient care
8. Generate a hypothesis and test the hypothesis
9. Collect and test environmental samples
10. Implement control and prevention measures
11. Follow-up and communicate results (staff, patients, press, public)

Before investigating an outbreak, a thorough literature review must be done to get a good understanding of the suspected disease and where and how to start the investigation.

Investigating an HAI outbreak may vary based on the type of setting, site of infection/disease, type of pathogen involved, etc. For example, a respiratory infection outbreak in an intensive care unit of a hospital may require a better understanding of a patient's location within the hospital, history of ventilation, and receipt of respiratory treatments/medications. In contrast, an outbreak of infections associated with an inpatient facility may require a better understanding of vascular access type or details about procedures/infusions received in that facility, etc.^{124,125}

1. Verification of diagnosis

Verification of diagnosis is the first step in an outbreak investigation as sometimes spurious or misinterpreted reports might give a false alarm. It is therefore necessary to have on-the-spot verification of diagnosis as quickly as possible. Common steps involved in verification of the diagnosis in an HAI are

- Evaluating the clues

- Evaluating signs and symptoms
- Laboratory findings
- Duration of symptoms
- Suspected exposure
- Suspected virus, bacteria or toxin
- Hospital onset

2. Confirm the existence of the outbreak

The next step is to confirm if an outbreak exists. This is done by review of surveillance data or reports from clinical departments and the laboratory. Confirm that the cases have the same disease. Confirm that the number of cases exceeds what would be expected for the population over the specific time period (Fig. 7.1).

Laboratory confirmation

- Laboratory confirmation is required to have a definite diagnosis.
 - Identifying the pathogen will help identify the potential incubation period, which will pinpoint at what time the exposure took place.

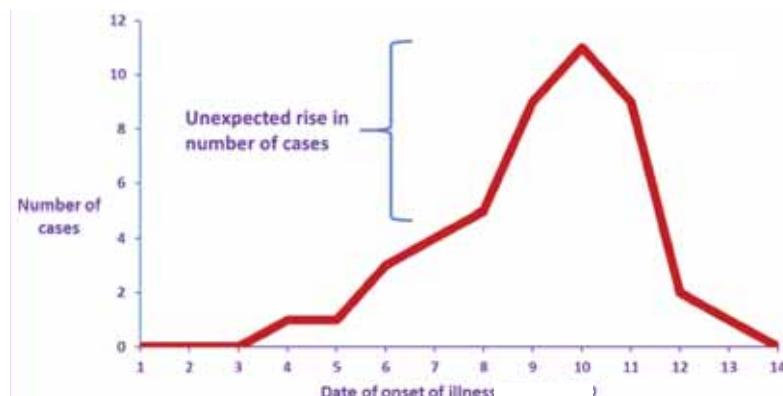


Fig. 7.1. Distribution of cases from a surveillance system confirming an outbreak

- It is essential to test clinical specimens such as blood, urine, etc. to determine the agent causing the illness.
- Sometimes the investigation must move forward before a definitive diagnosis is reached.
- Since laboratory results can take time, do not wait for laboratory diagnosis.
- Once an agent is identified, the laboratory may be able to conduct further tests, to “fingerprint” the agent and verify that all cases/patients are related to the outbreak.

3. Inform key stakeholders about the investigation

- Appropriate health facility staff (clinicians, nurses, etc.)
- Hospital Infection Control Committee (HICC)
- Infection control staff
- Hospital administration
- Laboratory staff with request to save all isolates that might be part of outbreak
- Notify local and national public health officials at NCDC as appropriate

4. Construct a case definition

This is one of the most important steps in identifying the cases in outbreak investigation. Before counting cases, the investigating team must decide what to count, that is, what to call a case by using a set of standard criteria for classifying whether a person has a particular disease, syndrome, or other health condition called as case definition. Some case definitions, particularly those used for national surveillance, have been developed and adopted as national standards that ensure comparability. Using an agreed upon standard case definition ensures that every case is equivalent, regardless of when or where it occurred, or who identified it.

Elements of a case definition include:

- Clinical criteria (signs and symptoms)
- Person, place and time criteria
- Laboratory test

*Classification of a case definition:*¹²⁶

- **The suspected case.** A patient with compatible clinical symptoms, but maybe not all symptoms, and a likely epidemiological link has not yet been confirmed.
- **The probable case.** This means that the clinical symptoms and epidemiology are compatible with the case definition.
- **A confirmed case.** This is the strongest level of certainty. A suspected or probable case who has had a positive laboratory test for the disease. Laboratory confirmation may not always be possible and often unavailable early on in an investigation.

5. Identify the cases and collect information

With every case detected, one can gather more information about potential exposures, personal characteristics, and the geographical extent of the potential outbreak.

Active case finding

Case finding helps in providing more information about an outbreak and defining the exposed population. The following sources can help in case finding:¹²⁷

- Microbiology data
- Infection control or surveillance records
- Discussion with clinician
- Medical records, operative notes
- Pathology reports
- Pharmacy records, such as antimicrobial usage
- Central service/supply records, CSSD registers
- Occupational health records (NSI register, vaccination records)
- Log books
- Hospital billing records

Potential risk factors or exposures

- Medications
- Procedures
- Dates of admission and discharge
- Facility locations or units
- Healthcare providers
- Host factors (age, gender, immunity)

Data collection

The data should be confidential. Any written materials containing personal identifiers should be stored in a secure, locked location.

- Demographic information identifies who is at risk. Demographic information that may be collected are age, gender, occupation, place of occupation and travel history.
- Clinical information should be collected to verify that the case definition has been met, to characterize the disease and to create an epidemic curve. This includes the symptoms, the date of symptom onset, the severity of illness, and lab test results.
- Risk factor information is dependent upon the specific outbreak and allows the investigating team to accordingly focus on the investigation. Since it is done in the preliminary stages of an investigation, risk factor information is usually confined to general potential risk factors and well-established risk factors.

Data collection tool/ form

The data of each individual should be collected in a standard data collection form/tool. These forms should be designed specifically for investigation to describe cases and potential risk factors depending on the type of infection. The tool should be administered only by a trained investigator or team involved in the outbreak investigation.

6. Examine descriptive epidemiological features of cases

Descriptive epidemiology is a very important part of the investigation since it drives all the investigation efforts and includes the following details:¹²⁸

Who is at risk?

- Describes data by person, place and time
- Characterizes the outbreak
- Identifies the population at risk
- Provides clues about the agent, source or mode of transmission
- Provides information to begin control measures

Line-list

This is created from case data.

- Each row is a case
- Each column is a variable of interest
- Signs and symptoms, onset date
- Medications, intravenous solutions
- Invasive procedures, surgery
- Staff contact
- Host factors (e.g. age, underlying disease?)
- Lab results

Table 7.2 shows a sample line-list of cases during an HAI outbreak in a paediatric ICU.

Epidemic curve

Epidemic curve is a graphic representation of the distribution of cases by time of onset of illness.

In an epidemic

- Y-axis: Number of cases of illness

Table 7.2. Sample line-list from XYZ hospital during an outbreak in paediatric ICU

Case ID	Hospital name	Unit Type	Age	Gender	Date of Admission	Location prior to admission	Outcome	Organism	Date of Sample collection
19.2 A	XYZ hospital	Paediatric ICU	11	F	18/08/19	Home	Died	<i>Elizabethkingia meningoseptica</i>	21/08/19
19.2 B	XYZ hospital	Paediatric ICU	4	F	20/08/18	Home	Undergoing treatment	<i>Elizabethkingia meningoseptica</i>	20/08/19
19.2 C	XYZ hospital	Paediatric ICU	3	M	20/08/18	Home	Transferred to ward 21	<i>Elizabethkingia meningoseptica</i>	22/08/19
19.2 D	XYZ hospital	Paediatric ICU	2	F	20/08/18	Home	Discharged	<i>Elizabethkingia meningoseptica</i>	20/08/19

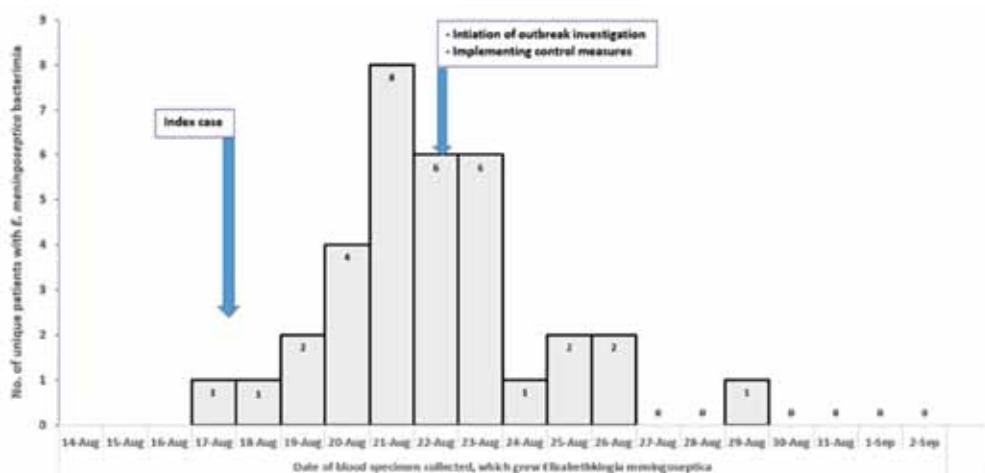


Fig. 7.2. Distribution of bloodstream infection cases in an HAI outbreak reported through surveillance in hospital "XYZ" August 2019 (N=34)

- X-axis: Date or time of illness onset
- Unit of time often based on incubation period

The epidemic curve should distinguish between confirmed and probable cases. The shape of the epidemic curve may suggest a single point source, ongoing transmission or an intermittent source.

The epidemic curve helps us to:

- understand the magnitude of the outbreak;
- show the time trend of the outbreak;
- define the incubation period or exposure period; and
- show the pattern of spread and highlight outliers.

Figure 7.2 shows a sample epidemic curve with distribution of cases during an imaginary outbreak in a paediatric ICU. Observe how the outbreak investigation and concurrent control measures help in reducing the number of new infections.

Outliers in an outbreak

This may be an early case or a late case. It may represent an unrelated incident worth examining carefully and may point directly to the source.

Describe the data by “place”

A spot map will help in identifying clustering of cases in and around a particular area of the hospital. Before beginning the investigation, it is advisable to have a detailed

and current map of the health facility with patient flow mechanisms. If this is not available it may be necessary to prepare such a map for the health facility/inpatient wards or ICU.

Calculating the attack rates

These data allow the calculation of an attack rate, defined by:

- The number of people who are infected divided by the total number of people at risk; and
- The attack rate can also be calculated stratified by relevant characteristics such as sex, age, location or specific exposure (ventilation, catheterization, OTs and occupational exposure).

Descriptive analysis results

At the end of descriptive analysis, it should be possible to:

- Identify the group at risk: number of people affected, time of onset and place of onset and personal characteristics.
- Tentatively identify the source and route of infection:
- This information will help to suggest the intervention so as to control the outbreak or chances of occurrence of new cases and to take initial precautionary measures suggested by the IPC team or HICC, such as
 - Suggest and implement immediate control measures
 - Review and augment standard work precautions as a rapid response measure
 - Increase the frequency and efficiency of environmental cleaning
 - Antibiotic restrictions
 - Exclusion of cases from high-risk activities
 - Isolation and/or cohorting (charting and grouping) of patients
 - Restricting movement of patients, staff and visitors
 - Screening of patients with isolation of patients and cohorting of contacts
 - Prophylactic treatment/immunization
- Provision of health information and advice
- Formulate a hypothesis on the type of infection (exogenous, endogenous).

7. Observe and review patient care

Initial observations can be useful in facilitating the creation of a standard observation tool, if needed. Clinical observations for who and what to observe are generally driven by the line-list and may include:¹²⁹

- Medication details
- Vascular access care
- Hand hygiene practices
- Adherence to isolation precautions
- Surgical practices
- Sterilization practices
- Respiratory care practices

8. Generate a hypothesis and test the hypothesis

A hypothesis in the context of an outbreak investigation is an educated guess about an association between an exposure and the outcome of interest or disease which can be tested. Descriptive data collected in the previous step of the investigation provide information that is very useful in the development of hypotheses.¹³⁰

Any hypotheses that are generated by investigators will need to be tested to confirm the association. Hypotheses can be tested in an analytical study, such as a case-control study that compares exposures among case patients to hospital-matched controls.

Comparing hypotheses with established facts such as laboratory evidence, clinical evidence, environmental and epidemiological evidence can be helpful in guiding more investigation when the source remains unclear or to support a hypothesis.

9. Collect and test environmental samples

Outbreaks are one of the reasons for performing environment surface sampling. This can be a powerful and definitive aspect of an investigation. However, environmental testing can have the following fallacies. A negative culture may mean that:

- the right samples may not have been collected;
- the methodologies may not be standardized (there may be overgrowth of other organisms, some samples require neutralization steps to get rid of disinfectants, etc.);
- even using the best methods, the yield can still be low;
- the organism may have been present but is not there now;
- environmental pathogens may have adapted to low nutrition environments and need special media to grow;
- there may be limited bacterial yield in getting the bacteria off the surface onto the swab; and
- there may be limited yield getting the bacteria off the swab into the media.

Guidance for collection of environmental samples

- Culture should be done after the data have been received from the line-list and observations.
- Culture should be done only of things that are likely routes of transmission (high-touch surfaces).
- Culture should be guided by the epidemiology of the organism (e.g. *Serratia* spp. – fluids, VRE objects/surfaces)
- Epidemiological typing of the organisms isolated using phenotypic and genotypic methods may be performed to identify the characteristics of the pathogen causing the outbreak.

10. Implement control and prevention measures

The primary goal is to stop transmission, not necessarily to find the source. Thus, a variety of control measures should be implemented targeting various possibilities based on initial observations.¹³¹ A few of the immediate control measures to be implemented are given in Table 7.3.

Examples of HAI outbreak control measures

- Reinforcing hand hygiene
- Establishing a barrier between infected/colonized patients and non-infected/colonized patients
- Enhanced cleaning
- Review disinfection of environment, equipment
- Remove suspected common source(s)

Table 7.3. Immediate control measures for outbreak management

Type of transmission suspected	Suggested action
Cross-transmission (transmission between individuals)	Patient isolation and barrier precautions determined by infectious agent(s)
Hand transmission	Improvements in handwashing; cohorting
Airborne agent	Patient isolation with appropriate ventilation
Agent present in water, waterborne agent	Checking of water supply and all liquid containers; use of disposable devices
Foodborne agent	Elimination of the food at risk
Vector-borne agent	Vector control

- Isolation, cohorting of patients in ward/ICU
- Multi-dose medications, antiseptics, etc.
- Restrict use of antibiotics to which the organism is resistant
- Close unit to new admissions till issue is resolved

11. Follow-up and communicate findings

Many times, we may have to conduct a follow up or “definitive” investigation by refining the case definition on initial findings to make it possible to detect the real cases and continue surveillance efforts based on the refined case definition. If required, modify the preventive and control measures of your findings from ongoing surveillance or follow-up investigation to provide better epidemiological evidence about source and mode of transmission.

Ongoing case finding and surveillance – If active surveillance is being done it should continue, and if not, it should be initiated. Ongoing surveillance is needed to monitor the outbreak to determine if the IPC activities are working and target areas where they need to be directed. Another reason to conduct surveillance is to ensure that the outbreak has not spread to new areas.

Assess infection control measures – Review the infection control measures to determine if they need to be continued, changed or reduced.

Communicate findings

A final report of the outbreak investigation should be shared with all the key stakeholders and HICC, which describes the outbreak, interventions and effectiveness of measures taken, and summarizes the learnings. It should also make recommendations to prevent future occurrence.

Outbreaks are sentinel events that help us understand and confront emerging challenges in implementing quality healthcare services. They can play an important role in developing recommendations that improve overall patient care and provide important opportunities for education.

8. Preventing infections among healthcare workers

Healthcare workers (HCWs) perform a wide range of activities in varying environments that can put their health and well-being at risk of harm. The administration of an HCF has the responsibility for the safety and health of its employees (Box 8.1). At the same time, HCWs are also responsible for adopting safe work practices and taking necessary precautions to mitigate the risk during the course of their work.

Workers at risk in the healthcare environment

- Hospital staff
 - Medical staff
 - Cleaning staff
 - Laboratory technicians
- Employees of healthcare (contractual) services
 - Cleaning services
 - Property management
 - Environmental hygiene services: collection and disposal of healthcare waste

Box 8.1. Hazards in the healthcare environment

- Physical: e.g. injuries while lifting, shifting patients
- Chemical: e.g. exposure to toxic chemicals such as disinfectants
- Biological: e.g. infections transmitted in the healthcare environment
- Radiation: e.g. radiation in X-ray and radiotherapy units
- Psychological: e.g. stress due to understaffing, night shifts
- Ergonomic: e.g. backache or neck ache or eye strain due to poorly designed seats, computer workstations
- Accidents/falls due to lack of patient safety arrangements

Biological hazards

These hazards refer to organisms or organic material produced by these organisms which are harmful to human health. These include parasites, viruses, bacteria, fungi and proteins.

Major biological hazards are:

- Bloodborne infections: e.g. HBV, HCV, HIV
- Respiratory infections: e.g. influenza, TB
- Others: e.g. viral haemorrhagic fevers (VHFs) such as Ebola virus disease (EVD)

The infections can be transmitted by:

- Percutaneous and mucocutaneous routes
- Contact with body fluids or contaminated objects
- Respiratory route

Adherence to standard precautions and transmission-based precautions help in protecting HCWs as well as patients from transmission of infection in HCFs (see Chapter 4).

Safe work practices help in preventing exposure to hazards in the workplace. (For special precautions during pandemic-prone diseases, see Chapter 7.)

Bloodborne infections in healthcare settings

Of the 35 million HCWs worldwide, three million experience percutaneous exposure to bloodborne pathogens every year. Of these, there are two million exposures to HBV, 0.9 million to HCV and 170 000 to HIV. This results in 70 000 HBV, 15 000 HCV and 1 000 HIV infections. More than 90% of these infections occur in developing countries.¹³²

The challenges faced in preventing these infections are:

- Limited knowledge on transmission of infections in the workplace
- Common unsafe practices
- Lack of standardized procedures
- Inadequate supplies and use of PPE
- Lack of regulation and policy to protect HCWs from exposure

Needle-stick injury

Needle-stick injury is a cutaneous cut, scratch or puncture from a needle that was contaminated with a patient's blood, whether or not the injury drew blood. According

to CDC, the risk of transmission for bloodborne infections after needle-stick injury contaminated with infected blood is on average 6–30% for HBV, 2.7–10% for HCV and 0.3% for HIV.¹³²

Worldwide, the most common causes for needle-stick injury in healthcare settings are two-handed capping of the needle after use, and unsafe collection and disposal of sharps waste. Unsafe collection and disposal can affect not only those directly dealing with sharps but a wide range of persons, including patients, cleaning services, visitors and the community at large.

Needle-stick injuries that carry the maximum risk of exposure to bloodborne infections are the hollow bore needles. The risk is directly related to the quantity of blood that they can carry in the lumen.

Human factors affecting safety

A number of individual factors affect a person's performance, thus predisposing them to error. Two factors with the greatest impact are fatigue and stress. Strong scientific evidence links fatigue and impaired performance, making it a known risk factor for safe practice. It is important to recognize that low levels of stress are also counterproductive, as they can lead to boredom and failure to attend to a task with appropriate vigilance.¹³³

Training and education of HCWs

Training and education should be provided to all HCWs in IPC, including supervisory, managerial staff and contractual housekeeping staff. They should be taught IPC principles, policies and procedures relevant to their work. Emphasis should be put on safety of the worker as well as the patient. The aim is to inform and educate HCWs about the infectious hazards they will face during their employment and their role in minimizing spread to others. Special attention should be given to hand hygiene. The training should be participatory, and based on the skills and competency of HCWs.^{134,135}

Components of education and training

Training and education should include:

- Information on modes of transmission of infectious diseases, level of occupational risk (to reduce fear of contact with infected patients) prevention and control

- Safe work practices
- Handling of PPE and clothing
- Reporting of the exposure incident
- Techniques on stress management, provision of appropriate staffing levels, shift, rotation, counselling, support and communication skills
- Regulations and policies

Safe work practices

Some key features of safe work practices are:

- Standard precautions
- Transmission-based precautions
- Hand hygiene
- PPE
- Safe injection practice

In the event of an epidemic, special isolation precautions as per directives from public health authorities and PPE are required.

Occupational health programme

An occupational health programme is essential for an effective IPC programme and has implications for patient safety. The components of such a programme are:

- Evaluation for general health of employees, including infectious diseases at entry, periodically as required
- Screening for vaccination for childhood communicable diseases (measles, rubella, chickenpox, diphtheria, pertussis, tetanus)
- Hepatitis B status and immunization
- Influenza vaccine, TST status
- Screening for tuberculosis
- Surveillance and management of exposure risk: hazard identification, risk assessment and control, post-exposure management
- Education and training

Pre-employment assessment

Before being allowed to work in high-risk areas, all staff should be assessed and offered testing and/or vaccination for specific infectious diseases. Details of medical history, particularly for infectious diseases such as rubella, measles, mumps, chickenpox (varicella), hepatitis B, immune disorders and skin conditions, and for prior exposure to tuberculosis should be recorded.

Laboratory and other testing should include a routine TST.

Except in cases of outbreaks, routine screening of HCWs for a carrier state is not recommended. Besides following safe work practices, HCWs can be protected from HAIs by preventive health checkups once a year, immunization, and PEP after accidental occupational exposure to a patient's blood and body fluids.

Occupational vaccination programme

- A vaccination policy (also for contractual staff)
- Maintenance of vaccination records
- Providing information about vaccine-preventable diseases and offering vaccination for the same
- Modification of duties if an HCW has an infection that has a risk of transmission during exposure-prone procedures
- Explaining the consequences of vaccine refusal
- Vaccine refusal, contraindication to vaccination and vaccine non-response may be managed by ensuring appropriate work placements, work adjustments and work restrictions. This should be documented.

Vaccination requirements based on risk stratification

Based on their work activities and risk of exposure to blood and body substances, HCWs can be categorized into risk category A, B and C and pre-employment vaccination requirements are worked out accordingly:¹³⁶

Category A: High risk (direct contact with blood or body substances): doctors, nurses, medical and nursing students, dentists, laboratory staff, maintenance engineers who service medical equipment, CSSD staff, cleaning staff, staff responsible for biomedical waste management.

Category B: Low risk (indirect contact with blood and body substances): at risk of infection by airborne or droplet routes but rarely have direct contact with blood or body substances (e.g. catering staff and ancillary staff).

Category C: Minimal risk (minimal patient contact): similar risk of exposure to blood and body fluids as the general public, e.g. office clerical staff, gardening staff and kitchen staff. Immunization requirements can be considered based on their actual job requirement.

Based on this categorization, immunization requirements are considered as follows:

Hepatitis B

- HBV vaccine to risk category A, B and C

- Immune test for anti-HBs should be considered
- Anti-HBs >10 at any stage after vaccination indicates lifelong immunity to hepatitis

Influenza: Provide seasonal influenza vaccine annually to risk categories A and B.

Tetanus toxoid: Can be given to risk categories A and B if no vaccination was provided in past 6 months.

Rabies: PEP to be considered for HCWs handling rabies cases, risk category A.

Chickenpox (varicella)

- Provide vaccination to risk categories A and B, to staff working in infectious disease (ID) wards
- HCWs can be considered immune if they have a documented medical history of chickenpox or shingles.

Staff records

Healthcare management should maintain records of screening results and immunizations provided, including history of vaccine-preventable disease, date and results of serology, record of vaccine refusal. Date of giving the vaccine and batch number, type and brand name of vaccine. Records need to be secure and maintained in accordance with confidentiality.

Post-exposure management programme

Post-exposure management is an essential component of the IPC programme and a policy must be in place to prevent and manage infections in HCWs.

Components of post-exposure management

- Create awareness about the reporting facility regarding sharp injuries/exposure among the staff¹³⁷
- Conduct orientation of new employees to IPC policies of the facility
- Develop specific post-exposure policies, and ensure their compliance
- Educate and train the staff on standard work precautions, risk associated with exposure, vaccination and prophylaxis/treatment options available
- Prompt reporting and record-keeping of all occupational exposures
- Evaluation of type of exposure and risk of seroconversion involved
- Counselling and treatment of exposures, post-exposure vaccination/drugs/immunoglobulin
- Follow-up testing

Steps of post-exposure management to bloodborne infections^{138,139}

- Exposure site should be washed with soap and water
- Prompt reporting of exposure
- Type and severity of exposure should be assessed and recorded (skin/percutaneous/mucous membrane exposure; depth of injury, volume of blood/body fluid/body secretions)
- Exposure source, whether known case of infection with HIV, HBV or HCV
- Vaccination status of exposed person
- Investigations for the infection status of the exposed person and the source
- Treatment/vaccination of the exposed person if required

See Annex 4 for details of post-exposure management of bloodborne infections.

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Annexes

Annex 1: Acknowledgements

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Annex 2: IPC precautions pending confirmation of diagnosis

Clinical syndrome or condition [±]	Suspected pathogens‡	Empirical precautions (always includes standard precautions)
Diarrhoea		
Acute diarrhoea with a likely infectious cause (incontinent or diapered patient)	Enteric pathogens§	Contact precautions (paediatrics and adult)
Meningitis		
	<i>Neisseria meningitidis</i>	Droplet precautions for first 24 hours of antimicrobial therapy; mask and face protection for intubation
	Enteroviruses	Contact precautions for infants and children
	<i>Mycobacterium tuberculosis</i>	Airborne precautions if pulmonary infiltrate present
		Airborne precautions plus contact precautions if potentially infectious draining body fluid present
Rash or exanthema, generalized, aetiology unknown		
Positive history of travel to an area with an ongoing outbreak of VHF in the 10 days before onset of fever	Ebola, Lassa, Marburg viruses	Droplet precautions plus contact precautions, with face/eye protection, emphasizing safety sharps and barrier precautions when blood exposure likely. N95 or higher-level respiratory protection when aerosol-generating procedure performed
Vesicular	Varicella–zoster, herpes simplex, variola, vaccinia viruses	Airborne plus contact precautions
	Vaccinia virus	Contact precautions only if herpes simplex, localized zoster in an immunocompetent host, or vaccinia virus likely
Maculopapular with cough, coryza and fever	Rubeola (measles) virus	Airborne precautions
Respiratory infections		
Cough/fever/upper lobe pulmonary infiltrate in an HIV-negative patient or a patient at low risk for HIV infection	<i>M. tuberculosis</i> , respiratory viruses, <i>S. pneumoniae</i> , <i>Staph. aureus</i>	Airborne precautions plus contact precautions

Clinical syndrome or condition ⁺	Suspected pathogens [‡]	Empirical precautions (always includes standard precautions)
Cough/fever/pulmonary infiltrate in any lung location in an HIV-infected patient or a patient at high risk for HIV infection	<i>M. tuberculosis</i> , respiratory viruses, <i>S. pneumoniae</i> , <i>Staph. aureus</i> (MSSA or MRSA)	Airborne precautions plus contact precautions; eye/face protection if aerosol-generating procedure performed or contact with respiratory secretions anticipated; droplet precautions instead of airborne precautions if tuberculosis unlikely and airborne infection isolation room and/or respirator unavailable (tuberculosis more likely in HIV-infected than in HIV-negative individuals)
Cough/fever/pulmonary infiltrate in any lung location in a patient with a history of recent travel (10–21 days) to countries with active outbreaks of SARS, avian influenza	Severe acute respiratory syndrome virus (SARS-CoV), avian influenza, novel coronavirus, <i>M. tuberculosis</i>	Airborne plus contact precautions plus eye protection; droplet precautions instead of airborne precautions if tuberculosis unlikely
Respiratory infections, particularly bronchiolitis and pneumonia, in infants and young children	Respiratory syncytial virus, parainfluenza virus, adenovirus, influenza virus, human metapneumovirus	Contact plus droplet precautions; discontinue droplet precautions if adenovirus and influenza ruled out
Skin or wound infection		
Abscess or draining wound that cannot be covered	<i>Staph. aureus</i> (MSSA or MRSA), group A	Contact precautions plus droplet precautions for the first 24 hours of appropriate antimicrobial therapy if invasive group A streptococcal disease suspected

Source: Adapted from Guideline for Isolation Precautions: preventing transmission of infectious agents in healthcare settings

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

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

[‡]The organisms listed under the column "Potential pathogens" are not intended to represent the complete, or even most likely, diagnoses, but rather possible aetiological agents that require additional precautions beyond Standard Precautions until they can be ruled out.

[§]These pathogens include enterohaemorrhagic *E. coli* O157:H7, *Shigella* spp., hepatitis A virus, noroviruses, rotavirus, and *C. difficile*.

Annex 3: Observation forms for audit of hand hygiene compliance

Observation Form											
Facility:			Period Number*:			Session Number*:					
Service:			Date: (dd/mm/yy)			/ /			Observer: (initials)		
Ward:			Start/End time: (hh:mm)			: : :			Page N°:		
Department:			Session duration: (mm)						City**:		
Prof.cat		Prof.cat		Prof.cat		Prof.cat		Prof.cat			
Code		Code		Code		Code		Code			
N°		N°		N°		N°		N°			
Opp.	Indication	HH Action	Opp.	Indication	HH Action	Opp.	Indication	HH Action	Opp.	Indication	HH Action
1	<input type="checkbox"/> bef-pat. <input type="checkbox"/> bef-asept. <input type="checkbox"/> aft-b.f. <input type="checkbox"/> aft-pat. <input type="checkbox"/> aft.p.surr.	<input type="checkbox"/> HR <input type="checkbox"/> HW <input type="radio"/> missed <input type="radio"/> gloves	1	<input type="checkbox"/> bef-pat. <input type="checkbox"/> bef-asept. <input type="checkbox"/> aft-b.f. <input type="checkbox"/> aft-pat. <input type="checkbox"/> aft.p.surr.	<input type="checkbox"/> HR <input type="checkbox"/> HW <input type="radio"/> missed <input type="radio"/> gloves	1	<input type="checkbox"/> bef-pat. <input type="checkbox"/> bef-asept. <input type="checkbox"/> aft-b.f. <input type="checkbox"/> aft-pat. <input type="checkbox"/> aft.p.surr.	<input type="checkbox"/> HR <input type="checkbox"/> HW <input type="radio"/> missed <input type="radio"/> gloves	1	<input type="checkbox"/> bef-pat. <input type="checkbox"/> bef-asept. <input type="checkbox"/> aft-b.f. <input type="checkbox"/> aft-pat. <input type="checkbox"/> aft.p.surr.	<input type="checkbox"/> HR <input type="checkbox"/> HW <input type="radio"/> missed <input type="radio"/> gloves
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6	<input type="checkbox"/> bef-pat. <input type="checkbox"/> bef-asept. <input type="checkbox"/> aft-b.f. <input type="checkbox"/> aft-pat. <input type="checkbox"/> aft.p.surr.	<input type="checkbox"/> HR <input type="checkbox"/> HW <input type="radio"/> missed <input type="radio"/> gloves	6	<input type="checkbox"/> bef-pat. <input type="checkbox"/> bef-asept. <input type="checkbox"/> aft-b.f. <input type="checkbox"/> aft-pat. <input type="checkbox"/> aft.p.surr.	<input type="checkbox"/> HR <input type="checkbox"/> HW <input type="radio"/> missed <input type="radio"/> gloves	6	<input type="checkbox"/> bef-pat. <input type="checkbox"/> bef-asept. <input type="checkbox"/> aft-b.f. <input type="checkbox"/> aft-pat. <input type="checkbox"/> aft.p.surr.	<input type="checkbox"/> HR <input type="checkbox"/> HW <input type="radio"/> missed <input type="radio"/> gloves	6	<input type="checkbox"/> bef-pat. <input type="checkbox"/> bef-asept. <input type="checkbox"/> aft-b.f. <input type="checkbox"/> aft-pat. <input type="checkbox"/> aft.p.surr.	<input type="checkbox"/> HR <input type="checkbox"/> HW <input type="radio"/> missed <input type="radio"/> gloves
7	<input type="checkbox"/> bef-pat. <input type="checkbox"/> bef-asept. <input type="checkbox"/> aft-b.f. <input type="checkbox"/> aft-pat. <input type="checkbox"/> aft.p.surr.	<input type="checkbox"/> HR <input type="checkbox"/> HW <input type="radio"/> missed <input type="radio"/> gloves	7	<input type="checkbox"/> bef-pat. <input type="checkbox"/> bef-asept. <input type="checkbox"/> aft-b.f. <input type="checkbox"/> aft-pat. <input type="checkbox"/> aft.p.surr.	<input type="checkbox"/> HR <input type="checkbox"/> HW <input type="radio"/> missed <input type="radio"/> gloves	7	<input type="checkbox"/> bef-pat. <input type="checkbox"/> bef-asept. <input type="checkbox"/> aft-b.f. <input type="checkbox"/> aft-pat. <input type="checkbox"/> aft.p.surr.	<input type="checkbox"/> HR <input type="checkbox"/> HW <input type="radio"/> missed <input type="radio"/> gloves	7	<input type="checkbox"/> bef-pat. <input type="checkbox"/> bef-asept. <input type="checkbox"/> aft-b.f. <input type="checkbox"/> aft-pat. <input type="checkbox"/> aft.p.surr.	<input type="checkbox"/> HR <input type="checkbox"/> HW <input type="radio"/> missed <input type="radio"/> gloves
8	<input type="checkbox"/> bef-pat. <input type="checkbox"/> bef-asept. <input type="checkbox"/> aft-b.f. <input type="checkbox"/> aft-pat. <input type="checkbox"/> aft.p.surr.	<input type="checkbox"/> HR <input type="checkbox"/> HW <input type="radio"/> missed <input type="radio"/> gloves	8	<input type="checkbox"/> bef-pat. <input type="checkbox"/> bef-asept. <input type="checkbox"/> aft-b.f. <input type="checkbox"/> aft-pat. <input type="checkbox"/> aft.p.surr.	<input type="checkbox"/> HR <input type="checkbox"/> HW <input type="radio"/> missed <input type="radio"/> gloves	8	<input type="checkbox"/> bef-pat. <input type="checkbox"/> bef-asept. <input type="checkbox"/> aft-b.f. <input type="checkbox"/> aft-pat. <input type="checkbox"/> aft.p.surr.	<input type="checkbox"/> HR <input type="checkbox"/> HW <input type="radio"/> missed <input type="radio"/> gloves	8	<input type="checkbox"/> bef-pat. <input type="checkbox"/> bef-asept. <input type="checkbox"/> aft-b.f. <input type="checkbox"/> aft-pat. <input type="checkbox"/> aft.p.surr.	<input type="checkbox"/> HR <input type="checkbox"/> HW <input type="radio"/> missed <input type="radio"/> gloves

* To be completed by the data manager.

** Optional, to be used if appropriate, according to the local needs and regulations.

General Recommendations

(refer to the Hand Hygiene Technical Reference Manual)

1. In the context of open and direct observations, the observer introduces him/herself to the health-care worker and to the patient when appropriate, explains his/her task and proposes immediate informal feed back.
2. The health-care worker, belonging to one of the main four following professional categories (see below), is observed during the delivery of health-care activities to patients.
3. Detected and observed data should be recorded with a pencil in order to be immediately corrected if needed.
4. The top of the form (header) is completed before starting data collection (excepted end time and session duration).
5. The session should last no more than 20 minutes (\pm 10 minutes according to the observed activity); the end time and the session duration are to be completed at the end of the observation session.
6. The observer may observe up to three health-care workers simultaneously, if the density of hand hygiene opportunities permits.
7. Each column of the grid to record hand hygiene practices is intended to be dedicated to a specific professional category. Therefore numerous health-care workers may be sequentially included during one session in the column dedicated to their category. Alternatively each column may be dedicated to a single health-care worker only of whom the professional category should be indicated.
8. As soon as you detect an indication for hand hygiene, count an opportunity in the appropriate column and cross the square corresponding to the indication(s) you detected. Then complete all the indications that apply and the related hand hygiene actions observed or missed.
9. Each opportunity refers to one line in each column; each line is independent from one column to another.
10. Cross items in squares (several may apply for one opportunity) or circles (only a single item may apply at one moment).
11. When several indications fall in one opportunity, each one must be recorded by crossing the squares.
12. Performed or missed actions must always be registered within the context of an opportunity.
13. Glove use may be recorded only when the hand hygiene action is missed while the health-care worker is wearing gloves.

Short description of items

Facility:	to complete according to the local nomenclature	
Service:	to complete according to the local nomenclature	
Ward:	to complete according to the local nomenclature	
Department:	to complete according to the following standardized nomenclature:	
	medical, including dermatology, neurology, haematology, oncology, etc.	surgery, including neurosurgery, urology, EENT, ophthalmology, etc.
	mixed (medical & surgical), including gynaecology	obstetrics, including related surgery
	paediatrics, including related surgery	intensive care & resuscitation
	emergency unit	long term care & rehabilitation
	ambulatory care, including related surgery	other (to specify)
Period N°:	1) pre- / 2) post-intervention; and then according to the institutional counter.	
Date:	day (dd) / month (mm) / year (yy)	
Start/end time:	hour (hh) / minute (mm).	
Session duration:	difference between start and end time, resulting in minutes of observation.	
Session N°:	attributed at the moment of data entry for analysis.	
Observer:	observer's initials (the observer is responsible for the data collection and for checking their accuracy before submitting the form for analysis).	
Page N°:	to write only when more than one form is used for one session.	
Prof.cat:	according to the following classification:	
1. nurse / midwife	1.1 nurse, 1.2 midwife, 1.3 student.	
2. auxiliary		
3. medical doctor	3.1 in internal medicine, 3.2 surgeon, 3.3 anaesthetist / resuscitator / emergency physician, 3.4 paediatrician, 3.5 gynaecologist, 3.6 consultant, 3.7 medical student.	
4. other health-care worker	4.1 therapist (physiotherapist, occupational therapist, audiologist, speech therapist), 4.2 technician (radiologist, cardiology technician, operating room technician, laboratory technician, etc), 4.3 other (dietician, dentist, social worker and any other health-related professional involved in patient care), 4.4 student.	
Number:	number of observed health-care workers belonging to the same professional category (same code) as they enter the field of observation and you detect opportunities.	
Opp(portunity):	defined by one indication at least	
Indication:	reason(s) that motivate(s) hand hygiene action; all indications that apply at one moment must be recorded	
bef.pat: before touching a patient	aft.b.f: after body fluid exposure risk	
bef.asept: before clean/aseptic procedure	aft.pat: after touching a patient	
	aft.p.surr: after touching patient surroundings	
HH action:	response to the hand hygiene indication(s); it can be either a positive action by performing handrub or handwash, or a negative action by missing handrub or handwash	
HR: hand hygiene action by handrubbing with an alcohol-based formula	Missed: no hand hygiene action performed	
HW: hand hygiene action by handwashing with soap and water		

Observation Form – Basic Compliance Calculation

Session N°	Facility:			Period:			Setting:			Total per session		
	Prof.cat.		Prof.cat.	Prof.cat.		Prof.cat.	Prof.cat.					
	Opp (n)	HW (n)	HR (n)	Opp (n)	HW (n)	HR (n)	Opp (n)	HW (n)	HR (n)	Opp (n)	HW (n)	HR (n)
1												
2												
3												
4												
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17												
18												
19												
20												
Total												
Calculation	Act (n) =		Act (n) =		Act (n) =		Act (n) =		Act (n) =			
	Opp (n) =		Opp (n) =		Opp (n) =		Opp (n) =		Opp (n) =			
Compliance	$\text{Compliance (\%)} = \frac{\text{Actions}}{\text{Opportunities}} \times 100$											

Instructions for use

1. Define the setting outlining the scope for analysis and report related data according to the chosen setting.
2. Check data in the observation form. Hand hygiene actions not related to an indication should not be taken into account and vice versa.
3. Report the session number and the related observation data in the same line. This attribution of session number validates the fact that data has been taken into count for compliance calculation.
4. Results per professional category and per session (vertical):
 - 4.1 Sum up recorded opportunities (opp) in the case report form per professional category: report the sum in the corresponding cell in the calculation form.
 - 4.2 Sum up the positive hand hygiene actions related to the total of opportunities above, making difference between handwash (HW) and handrub (HR): report the sum in the corresponding cell in the calculation form.
 - 4.3 Proceed in the same way for each session (data record form).
 - 4.4 Add up all sums per each professional category and put the calculation to calculate the compliance rate (given in percent)
5. The addition of results of each line permits to get the global compliance at the end of the last right column.

Observation Form – Optional Calculation Form

(Indication-related compliance with hand hygiene)

Session N°	Facility:			Period:			Setting:								
	Before touching a patient			Before clean/ aseptic procedure			After body fluid exposure risk			After touching a patient			After touching patient surroundings		
	Indic (n)	HW (n)	HR (n)	Indic (n)	HW (n)	HR (n)	Indic (n)	HW (n)	HR (n)	Indic (n)	HW (n)	HR (n)	Indic (n)	HW (n)	HR (n)
1															
2															
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20															
Total	Calculation			Act (n) =			Act (n) =			Act (n) =			Act (n) =		
	Indic1 (n) =			Indic2 (n) =			Indic3 (n) =			Indic4 (n) =			Indic5 (n) =		
Ratio act / indic*															

Instructions for use

1. Define the setting outlining the scope for analysis and report related data according to the chosen setting.
2. Check data in the observation form. Hand hygiene actions not related to an indication should not be taken into account and vice versa.
3. If several indications occur within the same opportunity, each one should be considered separately as well as the related action.
4. Report the session number and the related observation data in the same line. This attribution of session number validates the fact that data has been taken into count for compliance calculation.
5. Results per indication (indic) and per session (vertical):
 - 4.1 Sum up indications per indication in the observation form: report the sum in the corresponding cell in the calculation form.
 - 4.2 Sum up positive hand hygiene actions related to the total of indications above, making the difference between handwash (HW) and handrub (HR): report the sum in the corresponding cell in the calculation form.
 - 4.3 Proceed in the same way for each session (observation form).
 - 4.4 Add up all sums per each indication and put the calculation to calculate the ratio (given in percent)

*Note: This calculation is not exactly a compliance result, as the denominator of the calculation is an indication instead of an opportunity. Action is artificially overestimated according to each indication. However, the result gives an overall idea of health-care worker's behaviour towards each type of indication.

Annex 4: Post-exposure management for blood-borne infections, HIV, HBV and HCV

Definitions^a

Occupational exposure refers to exposure to potential blood-borne infections (HIV, HBV and HCV) that may occur in healthcare settings during performance of work activities.

Post-exposure prophylaxis (PEP) refers to comprehensive medical management to minimize the risk of infection among healthcare workers (HCWs) following potential exposure to blood-borne pathogens (HIV, HBV, HCV). This includes counselling, risk assessment, relevant laboratory investigations based on informed consent of the source and exposed person, first aid and depending on the risk assessment, the provision of short term (four weeks) of antiretroviral drugs, with follow up and support.

Post-exposure prophylaxis (PEP) for HIV^b

Eligibility for PEP

- PEP should be offered, and initiated as early as possible, to all individuals with exposure that has the potential for HIV transmission, and ideally within 2 hours (but certainly within the first 72 hours) of exposure and the risk evaluated as soon as possible.
- Exposures that may warrant occupational PEP include:
 - Parenteral or mucous membrane exposure (splashes to the eye, nose or oral cavity)
 - The following bodily fluids may pose a risk of HIV infection: blood, blood-stained saliva, breast-milk, genital secretions and cerebrospinal, amniotic, rectal, peritoneal, synovial, pericardial or pleural fluids.

Exposures that do not require PEP include:

- When the exposed individual is already HIV-positive
- When the source is established to be HIV-negative
- Exposure to bodily fluids that does not pose a significant risk: tears, non-blood-stained saliva, urine and sweat.

Post-exposure prophylaxis regimen for HIV

In contrast to the earlier recommendation of two antiretroviral drugs, recent guidelines including WHO 2014^c, WHO 2018^d, DHHS 2013^e, BHIVA^f and NACO^g prefer three antiretroviral drugs for PEP, irrespective of the degree of exposure (irrespective of

^anaco.gov.in

^bRecommendations based on WHO guideline for post-exposure prophylaxis, <http://www.who.int/hiv/publications/arv2013/December2014-ARVs supplement-chap5.pdf>

^cWHO guideline for post-exposure prophylaxis, <http://www.who.int/hiv/publications/arv2013/December2014-ARVs supplement-chap5.pdf>

^dWHO, 2018. Updated recommendations on first-line and second-line antiretroviral regimens and post-exposure prophylaxis and recommendations on early infant diagnosis of HIV: interim guidelines. Supplement to the 2016 consolidated guidelines on the use of antiretroviral drugs for treating and preventing HIV infection. Geneva: <https://www.who.int/hiv/publications/ARV2018update/en/>

^eUpdated U.S. Public Health Service guidelines for the management of occupational exposures to HIV and recommendations for post-exposure prophylaxis. 2013 <https://stacks.cdc.gov/view/cdc/20711>

^fEAGA guidance on HIV post-exposure prophylaxis Update 2015 <https://www.gov.uk/government/publications/eaga-guidance-on-hiv-post-exposure-prophylaxis>

^ghttp://naco.gov.in/sites/default/files/NACO%20-%20National%20Technical%20Guidelines%20on%20ART_October%202018%20%281%29.pdf

percutaneous or mucous membrane exposure and irrespective of mild, moderate or severe exposure).

This change was aimed at simplification of the recommendation to improve uptake and completion rates for PEP. This shift towards recommending a three-drug regimen for everyone was based on the availability of less toxic and better-tolerated medications, the difficulty in evaluating the risk of drug resistance and need to simplify prescribing.

Follow up

HIV antibody testing should be done for at least 6 months post-exposure (e.g. at baseline, 6 weeks, 3 months, and 6 months) to ensure no transmission has occurred.

Prophylaxis for HBV

- HCWs have a higher risk of exposure to HBV infection than the general population, hence routine vaccination against HBV is necessary for personnel who are likely to come in contact with blood, body fluids or sharps.
- The HBV vaccine is generally administered in a three-dose vaccine series at 0-, 1- and 6-month schedules. The vaccine should be administered intramuscularly in the deltoid muscle because gluteal injection leads to poor immunogenicity.
- The efficacy of the vaccine is >90% after the third dose in terms of formation of a protective antibody titre.
- Test for anti-HBs titres after 1–2 months of completion of 3 doses of vaccine. A sero-protective (adequate) level of anti-HBs is defined as $\geq 10 \text{ mIU/ml}$.
- Those whose anti-HBs titres are below protective titre of 10 mIU/ml should repeat the 3-dose vaccine series or be evaluated for hepatitis B surface antigen (HBsAg) positivity.
- Approximately 50% of individuals who did not respond to the first series of the HBV vaccine respond to the second series of the vaccine. If the HCW does not respond to the second series, he/she should be labelled as a non-responder.

Post-exposure prophylaxis for HBV^h

- If the source is HBV-positive: Appropriate and timely prophylaxis can prevent HBV infection and subsequent development of chronic infection or liver disease. The mainstay of PEP is hepatitis B vaccine, but in certain circumstances, hepatitis B immune globulin is recommended in addition to vaccine for added protection.
- If the source is known or shown to be positive for HBsAg, the level of anti-HBs antibodies in the HCW is important. If the injured HCW is immunized (anti-HBs antibodies $>10 \text{ IU/ml}$)
 - whether from vaccination or past infection they are protected, and there is no need for hepatitis B immunoglobulin after a potential or confirmed exposure to hepatitis B.
- When a source patient is unknown, the exposed HCW should be managed as if the source patient were HBsAg-positive.
- When indicated, immune prophylaxis should be initiated as soon as possible, preferably within 24 hours.
- If the HCW is unimmunized or a non-responder (did not seroconvert to the vaccine) or has antibody levels to HBsAg $<10 \text{ IU/ml}$, and sustains a needle-stick injury from a patient with evidence of chronic HBV (HBsAg-positive), they should be given HBIG (hepatitis B hyper-

^hCDC Guidance for Evaluating Health-Care Personnel for Hepatitis B Virus Protection and for Administering post-exposure Management MMWR 2013;62(RR10):1–19.

immune globulin) 0.06 ml/kg as soon as possible, preferably within 24 hours and should simultaneously start/reinitiate the course of HBV immunization with three doses of hepatitis B vaccine at a different site for unimmunized/Previously unfinished second hepatitis B series. The second and third doses should be separated by at least 2 months' interval.

- If the HCW has had two series of the HBV vaccine and was still a non-responder, they should receive a second dose of HBIG, 1 month after the first dose.
- Following completion of three-dose vaccination series, the level of immunity (antibodies to surface antigen, i.e. anti-HBs titres) should be checked 1–2 months later. Those whose anti-HBs titres are <10 mIU/ml should complete a second three-dose vaccine series or be evaluated for HBsAg positivity. If HBsAg is positive after exposure, the person should be counselled regarding the modes of prevention of HBV transmission to others and to seek treatment for HBV.

Table 1. Post-exposure prophylaxis for percutaneous or per mucosal exposure to hepatitis B virus

Vaccination/serostatus		Source		
		HBsAg-positive	HBsAg-negative	Unknown
Unvaccinated	Hepatitis B immunoglobulin (HBIG) single dose and initiate vaccination		Initiate vaccination	Initiate vaccination
Responder to vaccine (protected)	No treatment		No treatment	No treatment
Non-responder				
After one series (3-dose) of vaccination	HBIG single dose and initiate revaccination		No treatment	If source known to be high-risk: treat as if source were HBsAg-positive (HBIG single dose and initiate revaccination)
After 2 series (6 doses) of vaccination	HBIG two doses (separated by 1 month)		No treatment	If source known to be high-risk: (treat as if source were HBsAg-positive) HBIG single dose and initiate revaccination
Antibody response unknown	Test exposed person for anti-HBs: <ul style="list-style-type: none"> • If ≥ 10 mIU/ml: no treatment • If <10 mIU/ml: HBIG single dose and vaccine booster 		No treatment	Test exposed person for anti-HBs <ul style="list-style-type: none"> • If ≥ 10 mIU/ml: no treatment • If <10 mIU/ml: initiate revaccination

Source: Adapted from Immunization of Health-Care Personnel: Recommendations of the Advisory Committee on Immunization Practices (ACIP) MMWR 2011 /60(RR07)

Table 2. Post-exposure management of healthcare personnel after occupational percutaneous and mucosal exposure to blood and body fluids, by hepatitis B vaccination and response status of the individual

Healthcare personnel status	Post-exposure testing		Post-exposure prophylaxis		Post-vaccination serological testing
	Source patient (HBsAg)	HCP testing (anti-HBs)	HBIG	Vaccination	
Documented responder (after ≥3 doses)	No action needed				
Documented non-responder (after 6 doses)	Positive/Unknown		HBIG x 2 1 month apart		No
	Negative	No action needed			
Response unknown (after 3 doses)	Positive/Unknown	<10 mIU/ml	HBIG x 1	Initiate re-vaccination	Yes
	Negative	<10 mIU/ml	None		
	Any result	≥10 mIU/ml	No action needed		
Unvaccinated/incompletely vaccinated or vaccine refusers	Positive/Unknown		HBIG x 1	Complete vaccination	Yes
	Negative		None	Complete vaccination	Yes

Exposure to hepatitis C virus

- Over 60% of persons infected with HCV may develop chronic liver disease.
- Depending on whether active viral replication is occurring for HCV, the risk of transmission after a sharps injury from an HCV-infected person varies from 3% to 10%. The routes of infection are similar to HBV infection.
- No post-exposure therapy is available for HCV, but seroconversion (if any) must be documented.
- The exposed HCW should be retested for HCV antibodies at 3 and 6 months with monitoring of clinical signs and symptoms. Preferably the exposed HCW should be under the care of a hepatologist/physician so that HCV infection if happens is detected at the earliest (liver enzymes monitored and in case these increase that may indicate infection) and treatment for HCV can be instituted.
- No recommendations exist regarding restriction of professional activities of HCWs with an HCV infection. Standard precautions and other infection control practices should be followed.
- As for HBV infection, the source person must be tested for HCV infection.
- For any occupational exposure to blood-borne pathogens, counselling and appropriate clinical and serological follow-up must be provided.

Standard guidelines for pre-test counselling or pre-test discussions for HIV, HBV and HCV must be followed when testing the source and the HCW.

Annex 5: Cleaning, sterilization and disinfection

5.1. Procedures for cleaning, disinfection and sterilization based on infection risk

A. Procedures for non-critical patient-care items

Article	Standard procedure
Ambu bag and mask (Disposable preferred; change mask after each patient)	Clean with detergent and water and dry Preferably get autoclave ones, now available and autoclave after each use in CSSD
Ampoules	Wipe neck with 70% alcohol
Aprons (Disposable recommended)	If reusable, clean with detergent and water, dry and disinfect with 70% alcohol
Baths	Clean after each use with detergent and water In case of baths by infected patients/open wound, disinfect with sodium hypochlorite (5.25–6.15% household bleach diluted 1:500 to provide >100 ppm available chlorine)
Baby baths	Clean with detergent and water
Baby equipment (feeding bottles and teats) (Disposable preferred)	If reusable, return to CSSD for heat sterilization or Wash in hot water and detergent and rinse followed by immersion in 1% hypochlorite solution (freshly made)
Baby-weighing scale/ changing table	Fresh liner should be used for each baby Clean tray with detergent and water after use If visibly soiled, clean first with friction and then wipe down with LLD
Bed pans and urine bottles (Disposable preferred; wash hands thoroughly after handling)	Preferably wash in machine with heat disinfection cycle Alternatively, clean and disinfect with 0.5% sodium hypochlorite or phenolic germicide (used according to the manufacturers' instructions) Dry completely before reuse
Bed and couch frames	Clean with detergent and water between patients; wipe with LLD like 70% alcohol/phenolic germicide if disinfection is necessary.* For isolation rooms, after cleaning, wipe with disinfectant (sodium hypochlorite or phenolic germicide).*
Blood pressure apparatus and cuff (Disposable preferred; after use in isolation facility, lauder cuffs in washing machine)	Clean cuffs, tubing, bulb (if manual) with 70% alcohol/other LLD after each use. If visibly soiled, wash in soap/detergent and water, rinse and hang to dry.
Brushes (nail, avoid use) (Disposable nail brushes preferred)	If reusable, heat-sterilize

Article	Standard procedure
Boots	Clean with detergent water. If visibly soiled, disinfect with LLD.
Canes, walkers, crutches, wheel chairs and rehabilitation equipment	Clean with detergent and water If soiled, clean patient contact surfaces by wiping with sodium hypochlorite (>100 ppm available chlorine)/ 70–90% alcohol or phenolic germicide at a concentration recommended for low-level disinfection
Cloth appliances (neck and arm traction, etc.)	Wash after each use with detergent in hot water, rinse well and dry before reuse.
Denture pots (Disposable may be used)	To be cleaned by patient themselves with detergent and water
Drainage bottles (Disposable preferred; after use in isolation, wipe with sodium hypochlorite (1–2%) and dry)	If reusable, rinse and return to CSSD for heat disinfection Clean with detergent and water and disinfect with 0.5% hypochlorite and dry
Duvets (Disinfect with sodium hypochlorite (>100 ppm available chlorine) if contaminated)	Heat disinfect or wash with detergent and dry
Doppler (fetal/vascular)	Wipe head of Doppler after each use with 70% IPA
Earpieces for otoscopes (To be returned to CSSD after use in isolation)	Clean with detergent and water and dry
High-touch surfaces (door knobs, phones, keyboards, light, switches, bedside tables, drawer pulls and other “hand-touch” items) (Choice dependent on material)	Clean at least twice daily and when soiled. Clean with 70% alcohol/sodium hypochlorite/some iodophors/quaternary ammonium compounds If visibly soiled, clean with soap/detergent first.
IV monitoring pumps and feed pumps (After use, in isolation, wipe with sodium hypochlorite 2%).)	Clean with detergent and water and dry Disinfect with LLD (70% alcohol or sodium hypochlorite)
IV stands	Clean with detergent and water; dry before use
Incubator Infant incubators (Avoid using phenolic disinfectants)	Clean with detergent and water and thoroughly dry; disinfect (if needed) with chlorine-releasing agent (125 ppm) or 70% alcohol
Leads and monitors	Disassemble, clean with detergent and water and dry
Mattresses and pillows	Clean with detergent and water between patients and as required
Metal basin/Kidney tray (Disposable preferred)	Wash after each use with enzymatic detergent and rinse well; then autoclave
Otoscope handle	Wipe all surfaces with 70% alcohol/any other LLD
Otoscope speculum (Disposable preferred)	If reusable, wash and disinfect after each use Soak for 20 minutes in IPA (70%)

Article	Standard procedure
Pressure-relieving devices	Clean with detergent and water and dry
Pulse oximeter probe (Disposable preferred)	Wipe inside and outside with 70% IPA or any other LLD
Reflex hammer	Wipe handle and head after each use with IPA or LLD
Soap dispensers and dishes Spillage (Avoid use of soap dishes; use liquid soap dispensers)	Clean nozzle and outside daily and dry Clean inside of the container with detergent before refilling Do not top-up soap
Sputum pots/containers	Use disposable only, with close filling lid Discard into clinical waste for incineration If reusable, empty with extreme caution and steam sterilize
Stethoscopes	Clean with detergent and water and dry Wipe with 70% alcohol Wipe bell and tubing after each use with 70% IPA or LLD
Suction bottles	If disposable, seal when 75% full and place in yellow plastic bag If reusable, clean with sodium hypochlorite and dry Must be heat disinfected/sterilized. Change daily and in between each patient. Store dry when not in use.
Telephone/ Mobile	Disinfect with 70% alcohol
Thermometer (Use individual thermometers; do not mix oral and rectal thermometers)	Cover with disposable sleeve before use and store dry in individual holder (inverted) Clean and wipe with 70% alcohol after every use
Trolleys (dressing)	Clean daily with detergent and water. After each use, wipe with 70% alcohol/sodium hypochlorite (>100 ppm available chlorine)
Urine-measuring jugs	Heat disinfect after each use in bed pan washer
Vomit bowls	Empty contents into sluice, rinse, wash and disinfect with hot water and detergent
Wheel chairs	Clean between patients with detergent and water
X-ray equipment (Wipe with 70–90% alcohol/any other LLD)	Clean with cloth dampened dust with detergent and water

* used according to the manufacturers' instructions

B. Procedures for semi-critical items

Item	Method
Anaesthesia equipment (airways, endotracheal tubes, etc.)	Preferably sterilize by heat
Applanators (tonometer prisms)	Wipe tips clean. Immerse in sodium hypochlorite (500 ppm available chlorine) up to 10 mm Disinfect with 3% H ₂ O ₂ /70% isopropyl alcohol Prepare fresh solution of hypochlorite at the start of clinic After disinfection, rinse thoroughly in tap water and dry
Breast pumps	Wash with detergent and water, immerse in sodium hypochlorite (>100 ppm available chlorine). Dry before use.
Breast pump accessories	Disinfect by boiling for 5 minutes Long-handled tongs that have been disinfected Dry on a paper towel
Cervical caps	Wash with soap and hot water; dry. Soak in 70% alcohol for 20 minutes/1:10 dilution of household bleach, rinse with water and dry. Store in clear plastic bags at a cool, dry place
Cryosurgical probes	Autoclave if possible If heat labile, use low-temperature sterilization or ethylene oxide Less acceptable alternative: immerse in 2% glutaraldehyde
Diagnostic ultrasound transducers (transvaginal/transrectal/transoesophageal/endobronchial)	Sterilization with H ₂ O ₂ /PAA-based systems (if compatible with them)/ EO/ high-level disinfection with compatible, instrument grade disinfectant according to the manufacturers' instructions Transducer heads may be disinfected with 70% alcohol Store to prevent recontamination <i>Note:</i> Activity of alcohol against HPV is unknown
Diaphragm fittings Rings and pessaries Ear suction tips	Wash with soap and water, followed by immersion in 70% alcohol for 15 minutes Heat/sterilize/boil Immerse in 2% glutaraldehyde
Syringe nozzle and ear speculum, ear suction tip	Sterilize with heat, boil/immerse in 2% glutaraldehyde (if plastic), iodophors or alcohol Sterilize by heat/immerse in glutaraldehyde (2%)
Laryngeal mirror	High-level disinfection/sterilization with heat or immerse in glutaraldehyde

5.2. Procedures for cleaning and sanitation of environment

Procedures for cleaning and sanitation various areas/items in the hospital

Area/items	Process	Item/equipment	Method/procedure
General clinical areas	Dust mops Mop (No broom will be used for sweeping)	Sweeping	<p>Sweep with the dust mop or damp mop to remove surface dust. Sweep under the furniture and remove dust from corners. Gathered dust must be removed using a hearth brush and shovel.</p> <ul style="list-style-type: none"> The sweep tool should be cleaned or replaced after use.
Ceiling and walls	Sweeping tool Duster Bowl/ small bucket of soap solution Plain water	Damp dusting	<ul style="list-style-type: none"> Damp dusting with a long handled tool for the walls and ceiling done with very little moisture, just enough to collect the dust. Damp dusting should be done in straight lines that overlap one another. Change the mop head/cover when soiled.
Floors (clinical areas) – daily mopping	Detergent/sanitizer–hot water Three buckets (one with plain water and one with solution; one bucket for hypochlorite (1:50 dilution))	Cleaning Daily mopping	<ul style="list-style-type: none"> Prepare cleaning solution using cleaning agent with warm water (detergent/sanitizer). Use the three-bucket technique for mopping the floor, one bucket with plain water and one with the detergent solution. First mop the area with the warm water and detergent solution. After mopping clean the mop in plain water and squeeze it. Repeat this procedure for the remaining area. Mop area again using hypochlorite 1:50 dilution after drying the area. In between mopping if solution or water is dirty change it frequently. Mop the floor starting at the far corner of the room and work towards the door. Clean articles between cleaning. <p><i>Note:</i> Mopping should be done thrice a day, in each shift</p>
	Care of mop	Hot water Detergent Hypochlorite 1:1000	<ul style="list-style-type: none"> Clean with hot water and detergent solution, disinfect it with hypochlorite and keep for drying upside down.

Area/Items	Process	Item/equipment	Method/procedure
Walls and doors, door knobs	Damp cloth or Sponge squeeze mop Detergent	Thorough washing	<ul style="list-style-type: none"> The walls and doors are to be washed with a brush, using detergent and water once a week (usually on Sundays); gently apply cloth to soiled area, taking care not to remove paint, then wipe wall with warm water to remove excess cleaning agent. Door knobs and other frequently touched surfaces should be cleaned daily.
Floors	Scrubbers Hot water Detergent Mop	Thorough washing	<ul style="list-style-type: none"> Scrub floors with the hot water and detergent with using minimal water. (Do not pour the water.) Clean with plain water Mop area, and allow to dry Hypochlorite 1:100 mopping can be done.
Isolation room	Detergent/Sanitizer-warm water Three buckets (one with plain water and one with solution); separate bucket for hypochlorite (1:50 dilution)	Terminal cleaning	<ul style="list-style-type: none"> Before cleaning an isolation room, liaise with infection control team for details of any special requirements. Staff will be instructed on specific cleaning procedures required with reference to <ul style="list-style-type: none"> Safety uniform to be worn. Chemicals or disinfectants to be used. Also, if bed screen and shower screen are to be cleaned or changed, refer cleaning in isolation rooms.
All clinical areas/Laboratories	Hypochlorite 1:100 (1%) Rag piece Absorbent paper Unsterile gloves Spill care kit Mop Hot water	Blood and body fluid spill care	<ul style="list-style-type: none"> Wear non-sterile gloves. Cover the spill with hypochlorite (1:100). For large spills, cover with rag piece/absorbent paper for 10–20 minutes contact time. Clean up spill and discard into infectious waste bin, and mop area with soap and hot water. Clean the mop and mop area with 1% hypochlorite. Wash mop with detergent and hot water and allow it to dry.
Book case, files, lockers, tables, cupboard, wardrobes, benches, shelves and cots	Damp duster Warm water Detergent Dry duster	Damp dusting	<ul style="list-style-type: none"> Damp dust with warm water and detergent.

Area/Items	Process	Item/equipment	Method/procedure
Cots, railings and lockers	Detergent/ Sanitizer-hot water Three small buckets/or big bowls One with plain water One with solution One for hypochlorite 1:100 dilution	Daily dusting	<ul style="list-style-type: none"> Damp dust with warm water and detergent followed by disinfection with hypochlorite or as per hospital policy.
Bathroom showers	Warm water Detergent powder Nylon Scrubber Hypochlorite 1:100 dilution	Cleaning	<ul style="list-style-type: none"> Thoroughly scrub the basin/ tiles with warm water and detergent inside and outside. Special attention to soap runs under the basin. Tap fittings to be washed and dried. <i>Note:</i> Do not use powder cleanser dry as it can scratch the chrome on the taps. If required disinfection to be done.
Taps and fittings	Warm water Detergent powder Nylon scrubber	Cleaning	<ul style="list-style-type: none"> Wipe over taps and fittings with a damp cloth and detergent. If heavily soiled, sprinkle a little powder cleanser onto a wet cloth, fold cloth over and rub into a paste and polish. <p><i>Note:</i> Do not use powder cleanser dry as it can scratch the chrome on the taps.</p> <ul style="list-style-type: none"> Care should be taken to clean the underside of taps and fittings. Taps should be dried after cleaning
Mirrors and Glass	Warm water Detergent water/ cleaning solution Damp cloth Wiper	Cleaning	<ul style="list-style-type: none"> Using warm water and a small quantity of detergent and using a damp cloth, wipe over the mirror and surround, then using a dry lint-free cloth, buff the mirror and glass to a clean dry finish.
Sluice room Stainless steel/ Any other sink	Powder cleanser Detergent powder Wiper Cloth	Cleaning	<ul style="list-style-type: none"> Sinks are to be cleaned with a powder cleanser. First wet the sink. Sprinkle on a little powder cleanser and work around the surface with a cloth, include the plug hole. Do not use the powder cleanser on dry sink. After removing spillage and any stains, flush away with running water. Wipe down the surface of the sink.

Area/Items	Process	Item/equipment	Method/procedure
Bed pans, urinals kidney trays, sputum mugs, urine measuring jugs	Detergent water Brush scrubber Hypochlorite (1:50)	Cleaning and disinfection	<ul style="list-style-type: none"> After washing with soap and water immerse in 1:50 dilution of hypochlorite for 20 minutes. Keep it for air dry in a stand in such a way that water will drain downward.
Suction bottles	Soap and water Hypochlorite 1%	Cleaning and Disinfection	<ul style="list-style-type: none"> Should be emptied in sluice room. If soiled with blood and body fluids they should be decontaminated with 1% hypochlorite. Wash with detergent and disinfect with hypochlorite for 20 minutes. Must be cleaned daily and in between each patient. To be stored dry when not in use.
Suction tubing	Tap water Detergent	Cleaning	<ul style="list-style-type: none"> After each use should be cleaned under running water and with a detergent. Should be sent to CSSD for further cleaning and sterilization. For each patient separate sterile suction tubing should be used.
Suction catheters (rubber and plastics)	Tap water Steel basin with Chlorhexidine-cetrimide solution for onsite rubber catheters cleaning (if they are reused)	Cleaning	<ul style="list-style-type: none"> Use sterile suction catheter for tracheotomy suctioning each time. After use of suction catheter suck catheter with the plain water and discard catheters in soap solution and sent to the CSSD. Collect rubber catheters in chlorhexidine-cetrimide solution. Clean it under running water. Send it to CSSD for further cleaning and sterilization as disposal.
Pantry furniture	Duster	Dusting	<ul style="list-style-type: none"> Damp dust
Telephone	Warm water detergent solution Duster	General cleaning	<ul style="list-style-type: none"> Damp dust with warm water and detergent. Paying special attention to the ear and mouth piece and dry it properly.
Desks	Damp cloth Furniture polish	Dusting	<ul style="list-style-type: none"> Wipe top sides and draw handles with a damp cloth. Wooden desks should be cleaned with furniture polish and buffed to clear glows. Pen holder etc. to be cleaned or dusted.
Chairs (Vinyl)	Warm water and detergent	Cleaning	<ul style="list-style-type: none"> Wipe down with warm water and detergent. Remove any marks under arms and seat. Check for damage to stoppers, if stopper require replacement, report to maintenance department.

Area/Items	Process	Item/equipment	Method/procedure
Fabric chairs	Vacuum cleaner Warm water and detergent Stain remover	Cleaning	<ul style="list-style-type: none"> • Vacuum the cloth area of the chair and wipe down remainder of the chair with warm water and detergent. Remove stains from fabric with stain remover.
Furniture and fittings	Warm water and detergent Rag piece	Dusting	<ul style="list-style-type: none"> • Using warm water and detergent, damp dust all furniture and fittings, including chairs, sofas, stools, beds, tables, cupboards, wardrobes, lockers, trolleys, benches, shelves and storage racks, waste/bins, fire extinguishers, oxygen cylinders, televisions window sills and dry properly.
Bed tables, bedside lockers	Warm water and detergent Wiper Duster	Cleaning	<ul style="list-style-type: none"> • Wipe down over bed table. Wipe top and underneath base and stand, using warm water and detergent. Dry on completion. • Wipe down the bedside. Remove marks from fronts of draws and sides. Using warm water and detergent, wash the top to remove any sticky marks and dust.
Light switches and over-bed lights	Damp cloth (never wet) Detergent Warm water	Cleaning	<ul style="list-style-type: none"> • Light switches to be cleaned of dust, spots and finger marks. Clean with a damp cloth (never wet) and detergent. • Over-bed lighting to be damp dusted. Light housing to be wiped down with warm water and detergent.
Screens and Screen rails	Damp	Dusting	<ul style="list-style-type: none"> • Screen rails should be damp dusted using warm water and detergent. This includes rail supports. • Screens to be replaced on a set rotation basis or as soon as they are visibly soiled.
Curtains, blinds and drapes	Vacuum cleaner Soft clothes Water Mild soap solution	Cleaning	<ul style="list-style-type: none"> • Curtains blinds should be vacuumed, then wiped down with moist, soft cloth. • Always start at the top and work down • Solution for cleaning blinds should not contain strong detergents. Cloth should not be wet or these conditions could stain the blind. • Always use fresh cleaning solution and replace if it becomes soiled. • Rinse cleaning cloth regularly.

Area/Items	Process	Item/equipment	Method/procedure
Air-vents and filters	Vacuum cleaner Duster Detergent solution	Cleaning	<ul style="list-style-type: none"> Vents are vacuumed to remove any dust and wipe out with a cloth and detergent. Some vents require removal to wash the back and entrance of the ducting. Metal vents and filters are washed under running water and dried with a lint-free cloth to remove stubborn soil age. It should be done in collaboration with the engineering department.
Stethoscope	Detergent and water Alcohol-based rub	Cleaning	<ul style="list-style-type: none"> Should be cleaning with detergent and water. Should be wiped with hand rub before each patient contact.
Thermometer	Detergent and water Alcohol rub Individual thermometer holder	Cleaning	<ul style="list-style-type: none"> Should be stored dry in individual holder. Clean with detergent and tepid water and wipe with alcohol rub in between patient use. Store in individual holder inverted. Preferably one thermometer for each patient.
Injection and dressing trolley	Detergent and water Duster Disinfectant (70% alcohol)	Cleaning	<ul style="list-style-type: none"> To be cleaned daily with detergent and water. After each use should be wiped with disinfectant.
Refrigerators	Detergent and water Absorbent paper or clean cloth	Cleaning (weekly)	<ul style="list-style-type: none"> Empty the fridge and store things appropriately. Defrost, decontaminate and clean with detergent. Dry it properly and replace the things. Weekly cleaning is recommended.
Linen Coloured clothes	Linen disinfectant	Washing	<ul style="list-style-type: none"> Linen contaminated with blood and body fluids should be immersed in compatible (linen-friendly) disinfectant as per recommendation or detergent disinfectant. Bag it in leak-proof bags and send to the laundry for washing. <p><i>Note:</i> During washing soiled linen, the washing person should be given PPE.</p>
White clothes	Sodium hypochlorite 1% Tap water	Washing	<ul style="list-style-type: none"> Should be washed under running water and soaked in 1:100% sodium hypochlorite for 20 minutes. <p><i>Note:</i> PPE should be worn while washing soiled linen.</p>

Area/Items	Process	Item/ equipment	Method/procedure
Mattress and pillow cover	Sodium hypochlorite 1% Tap water	Washing	<ul style="list-style-type: none"> Mattress and pillows should be covered with a reusable mattress cover. It should be changed for each patient and when soiled sent to the laundry according to schedule.
BP cuffs and covers	Detergent Hot water	Washing	<ul style="list-style-type: none"> Cuffs should be wiped with alcohol-based disinfectant and regular laundering is recommended for the cover.
Hair removal clippers	Soap and water Disinfectant	Disinfection	<ul style="list-style-type: none"> Safety – single use disposable blades Electric razors should be disinfected between use.
Soap dispensers	Detergent and water	Cleaning	<ul style="list-style-type: none"> Daily dusting Should be cleaned weekly with detergent and water and dried.
ICU HEPA Air-conditioner	Soap and water	Cleaning	<ul style="list-style-type: none"> Regular maintenance air-conditioners according to norms. Regular (twice a week) cleaning of AC filters with the soap and water or according to engineering department's policy. Dry and replace.
Footwear	Detergent and water	Cleaning	<ul style="list-style-type: none"> Bone marrow transplant unit footwear should be cleaned with detergent on a daily basis. After washing, dry properly and keep it in shoe racks.
Water jars	Vim powder Soap and water	Cleaning	<ul style="list-style-type: none"> Recommended boiled water for drinking Water jars should be scrubbed/cleaned with soap and water and boiled water before filling with water.
Kidney trays, sputum mugs, bed pans, urine measuring mugs	Detergent and water Hypochlorite	Cleaning	<ul style="list-style-type: none"> After washing with soap and water immerse in 1:50 dilution of hypochlorite for 20 minutes (each use) Dry in a stand such that water will drain downwards. Hypochlorite should be prepared fresh daily in tap water

Area/Items	Process	Item/equipment	Method/procedure
General cleaning	Detergent and warm water Mop Two buckets Clean utility gloves Hand mops	Daily mopping floors Thorough washing	<ul style="list-style-type: none"> Two-hourly mopping with hypochlorite with the two-bucket technique is recommended. Scrub floors with hot water and detergent with using minimal water. (Do not pour the water.) Clean with plain water. Allow to dry Hypochlorite 1:50 mopping can be done. <p><i>Note:</i> Recommend general cleaning procedure</p>
Ventilators Ventilator tubing	Alcohol-based disinfectant Detergent and water	Disinfection	<ul style="list-style-type: none"> Should be cleaned with an alcoholic disinfectant. Change of circuit after every patient as per policy and when necessary, if the circuit is reusable, it can be sent to CSSD for sterilization after detergent and water cleaning.
Humidifiers	Detergent and water	Cleaning	<ul style="list-style-type: none"> Should be cleaned with detergent and water and allow to dry. If an HME humidifier is used, it should be disposed of within 24 hours or according to need.
Infusion pumps	Detergent and water Alcoholic disinfectant	Daily cleaning	<ul style="list-style-type: none"> Should be damp dusted with detergent and water and dried after each use. Wiping with the alcoholic disinfectant can be done.
Resuscitation bag with mask	Chlorhexidine-cetrimide	Sterilization	<ul style="list-style-type: none"> After use on a patient, it should be kept in the disinfectant for 30 minutes, washed sent to CSSD.
Laryngoscope Magill's forceps	Detergent and water Chlorhexidine-cetrimide High-level disinfection		<ul style="list-style-type: none"> After use, wash it under running tap water after removal of the bulb and blade. Wipe bulb with disinfectant or detergent and water. Blade should be washed under running water and immersed in high-level disinfectant as per recommendation. Wash and dry it Wipe with alcohol-based rub.
Pressure bags	Detergent and water	Cleaning	<ul style="list-style-type: none"> Should be cleaned with detergent and water and dried.

Cleaning of toilets

Areas	Agents / Toilet cleaner	Procedure
Toilet pot/ commode	Hypochlorite/ Soap powder/ long handle angular brush	Inside of toilet pot/commode: Scrub with the recommended agents and the long handle angular brush. Outside: Clean with recommended agents; use a nylon scrubber.
Lid/commode	Nylon scrubber and soap powder	Wet and scrub with soap powder and the nylon scrubber inside and outside
Toilet floor	Soap powder and scrubbing brush/ nylon broom	Scrub floor with soap powder and the scrubbing brush Wash with water Use hypochlorite 1:50 dilution
Tap	Nylon scrubber and soap powder	Wet and scrub with soap powder and the nylon scrubber.
Outside sink	Soap powder and nylon scrubber	Scrub with the nylon scrubber.

Note: Dry the floors with a separate drying mop.

General

- Lint-free dusters/mops should be used; and washed with soap and water after every use, and dried.
- Brooms are not to be used in the hospital.
- The three-bucket technique should be used on every floor to facilitate hygienic cleaning of environment.

Housekeeping in the isolation room

- Before admission
The admitting physician should inform the sister in-charge of isolation ward at least one hour before admission, mentioning the diagnosis, sex and the general state of the patient.
- Prerequisites for isolation
 - A handwashing sink and running water should be available at the entrance of each room to facilitate handwashing.
 - Cover the mattress and pillows with an impervious cover such as Mackintosh so that it can easily be damp dusted. Clean gowns should always be available.
 - Separate urinals, bedpans and thermometers/BP apparatus are to be used for each patient.
 - Bins lined with the appropriate colour-coded plastic liner should be available in each room for disposal of biomedical waste.
 - Rooms should be well lit, and isolated according to disease conditions.
- Cleaning procedure for isolation room
 - Linen should be stripped from the bed with care taken not to shake the linen during this action. Linen should be soaked in disinfectant, i.e. hypochlorite 1:50 for 20 minutes for white clothes and coloured linen as per hospital policy suitable high-level disinfectant to be used and then sent to the laundry.
 - All other articles such as IV stands and furniture should be cleaned with detergent and disinfected followed by high-level disinfectant.

- o Walls should be cleaned with detergent and mopped with a high-level disinfectant.
- o The bathrooms should be cleaned with detergent and water followed by disinfection with hypochlorite 1:50 dilution.
- At discharge (terminal disinfection):
 - o The pillows and mattress covers are to be cleaned with detergent, disinfected with a high-level disinfectant and sent to the laundry.
 - o Bed sheets, curtains, gowns and dusters must be removed, soaked in with a high-level disinfectant for one hour and then sent to laundry.
 - o After disinfection, wash the room, wall, window, doors, bathroom, sink and furniture with soap solution after doing thorough high dusting in that cubicle.
 - o Soak bed pan, urinal, kidney basin in with a high-level disinfectant for one hour, wash with detergent and dry it under sunlight.
 - o Bath basin, multi-bin, bucket, jugs, mugs are washed with soap solution and dried in sunlight.
 - o Rubber sheets (Mackintosh) are to be cleaned with detergent and water, dried, powdered and replaced.

Cleaning in special areas

- Operation theatre: See IPC in Surgical Unit in Chapter 6 and Annex 9.1
- Dialysis unit: See IPC in Dialysis Unit in Chapter 6

5.3. Specific measures for environmental and equipment cleaning/disinfection in haemodialysis units

Environmental and equipment cleaning has a major role in the prevention of infection in the HD unit.

Environmental cleaning

Thorough cleaning and disinfection of surfaces in the patient zone (chair, armrests, bedside table top/counter, and drawer/ cupboard handles) and high touch surfaces (the exterior surfaces of the HD machine, computer screens, and keyboards) should be performed between all patient treatments. Enough time should be provided between treatments so that this can be done.

Details of cleaning methodology for environmental surfaces in the dialysis unit can be obtained from APIC Guide to the Elimination of Infections in Haemodialysis.^a

Equipment cleaning

Dialysis Unit equipment includes HD machines, dialysers, water supply/treatment/distribution systems, component parts such as tubing and filters, acid and bicarbonate concentrate solutions, and instruments including blood pressure cuff, stethoscope, haemostats, scissors and clamps.

Infections can be caused by contamination of supplies/equipment with bloodborne viruses and pathogenic bacteria. Cleaning and disinfection of equipment and proper handling of reusable and disposable supplies is critical to the safety of patients in this high-risk area.

There should be written protocols for cleaning and disinfecting surfaces and equipment in the dialysis unit. Instructions should includethe steps for careful mechanical cleaning before disinfection. For equipment where the manufacturer has provided instructions for disinfection and sterilization, manufacturer's instructions should be followed.

Details on cleaning and disinfection of dialysis equipment can be obtained from APIC Guide to the Elimination of Infections in Haemodialysis^a and CDC Recommendations for prevention of infections among chronic haemodialysis patients.^b

^aAPIC Guide to the Elimination of Infections in Hemodialysis <https://apic.org/wp-content/uploads/2019/02/APIC-Hemodialysis.pdf>

^bAnitha Vijayan, John M. Boyce. What We Learned from Ebola Preparing Dialysis Units for the Next Outbreak. Clin J Am Soc Nephrol. 2018;13:1–3.

Annex 6: Policy for visitors and attendants

The following points should be considered for visitors and attendants.

1. Limit visitors to persons necessary for patient's emotional well-being and care. Visitor restrictions apply to all visitors, including staff members and their families. Visitors should limit their movement within the facility. Visitors should not sit on hospital beds or put their feet on beds.
2. Visitors should clean their hands with hand rub before entering and when leaving the room. An alcohol hand rub should be available at the entrance of the facility/unit/ward, along with a poster displaying instructions for using the hand rub.
3. Before entering the room, visitors must enquire at the nursing station for instructions and for gown and mask, if indicated. Visitors' bags and other belongings should be left outside the patient area.
4. Flowers/bouquet should not be allowed in patient room.
5. The patient and the relatives must be educated about the cause, spread and prevention of infection, if any. The need for isolation and restriction of visitors should be discussed with them.
6. The ward nursing staff and the doctors concerned shall have the responsibility of informing the patients' relatives of the measures to be taken and the importance of restriction of visitors. This should be done at the time of patients' admission.
7. Children below 12 years should not be allowed into isolation areas. One attendant should be allowed to stay in the ward with the patient who should be taught to practice hand hygiene before and after touching the patient.
8. Mobile phones have the potential to transmit infection by contact. There should be a policy on the use of mobile phones and visitors should be taught to decontaminate the phone with a hand rub.

- Notice to be put up in visitors' reception/waiting area: "Please do not visit your relative or friend (the patient) if you have a cold, cough, rash or any other communicable disease or have diarrhoea or vomiting within the last 48 hours."
- Notice to be put up in the patients' room: "While you are visiting the hospital please do not use the patients' toilets. There are separate toilets for visitors."

Annex 7: Airborne isolation, droplet and contact precautions for healthcare staff, patients and visitors

Target group	Airborne isolation precautions	Droplet precautions	Contact precautions
Hospital staff	<ul style="list-style-type: none"> • Clean hands between tasks and upon entering and exiting your hospital room • Place a sign on your room door to let staff know what to do. • Close the door to your room. 	<ul style="list-style-type: none"> • Clean hands frequently • Put a sign on your door to let staff know what to do. • Wear a mask and eye protection. • Place masks outside your door for use by hospital staff and visitors. 	<ul style="list-style-type: none"> • Clean hands frequently. • Put a sign on your door to let staff know what to do. • Wear gloves and gowns when entering your room.
Patients	<ul style="list-style-type: none"> • Clean hands frequently, especially after coughing and sneezing. • Keep room door closed at all times. • Be sure visitors read the sign on your door. • Leave your room only when medically necessary and wear a mask when you do. • Limit visitors to a few family members and friends who have immunity to your illness. 	<ul style="list-style-type: none"> • Clean hands frequently, especially after coughing and sneezing. • Be sure visitors entering your room have read the sign on your door. • Leave your room only when medically necessary and wear a mask when you do. • Limit visitors to a few family members and friends. Brothers and sisters of paediatric patients on droplet precautions are discouraged from visiting. 	<ul style="list-style-type: none"> • Clean your hands frequently. • Be sure visitors read the sign on your door. • Limit visitors to a few family members and friends.
Visitors	<ul style="list-style-type: none"> • Clean hands when entering and exiting patient's room. • Confirm that you have been vaccinated or have had the patient's disease to develop immunity. • Go to the nurse's station, if you have any questions. 	<ul style="list-style-type: none"> • Clean hands upon entering and exiting your room. • Wear a mask and eye protection before entering the room and while visiting. • Go to the nurse's station, if you have any questions. 	<ul style="list-style-type: none"> • Clean hands upon entering and exiting your room. • Avoid contact with dressings, tubes, bed sheets and other items the patient may touch. • Do not go into the rooms of other patients. • Go to the nurse's station, if you have questions.

Adapted from https://www.ucsfhealth.org/education/hospital_precautions/

Annex 8: Biomedical Waste Management and Handling (Principle) Rules, 2016

8.1. Duties of occupier*

- a. Take all necessary steps to ensure that biomedical waste is handled without any adverse effect to human health and the environment and in accordance with these rules;
- b. Make a provision within the premises for a safe, ventilated and secured location for storage of segregated biomedical waste in coloured bags or containers in the manner as specified in Schedule I, to ensure that there shall be no secondary handling, pilferage of recyclables or inadvertent scattering or spillage by animals and the biomedical waste from such place or premises shall be directly transported in the manner as prescribed in these rules to the common biomedical waste treatment facility or for the appropriate treatment and disposal, as the case may be, in the manner as prescribed in Schedule I (Annex 8.2)
- c. Pre-treat the laboratory waste, microbiological waste, blood samples and blood bags through disinfection or sterilization on-site in the manner as prescribed by the World Health Organization (WHO) guidelines on Safe Management of wastes from health-care activities and WHO blue book, 2014 and then sent to common BioMedical Waste Treatment facility for final disposal;
- d. Phase out the use of chlorinated BMW disposable plastic bags (excluding blood bags, uro bags, etc.) and gloves (the definition of chlorinated plastic bags is mentioned in BMWM [Amendment] Rules, May 2019);
- e. Dispose of solid waste other than biomedical waste in accordance with the provisions of respective waste management rules made under the relevant laws and amended from time to time (Solid Waste Rules, 2016 as amended);
- f. Not to give treated biomedical waste with municipal solid waste;
- g. Provide training to all its health-care workers and others, involved in handling of biomedical waste at the time of induction and thereafter at least once every year and the details of training programmes conducted, number of personnel trained and number of personnel not undergone any training shall be provided in the Annual Report;
- h. Immunize all its health-care workers and others, involved in handling of biomedical waste for protection against diseases including hepatitis B and tetanus that are likely to be transmitted by handling of biomedical waste, in the manner as prescribed in the National Immunization Policy or the guidelines of the Ministry of Health and Family Welfare issued from time to time;
- i. Establish a bar-code system for bags or containers containing biomedical waste to be sent out of the premises for further treatment and disposal in accordance with the guidelines issued by the Central Pollution Control Board (Guidelines for bar-code system for effective management of BMW CPCB, April 2018 as amended) by March 2019;
- j. Ensure segregation of liquid chemical waste at source and ensure pre-treatment or neutralization before mixing with other effluent generated from health-care facilities;
- k. Ensure treatment and disposal of liquid waste in accordance with the Water (Prevention and Control of Pollution) Act, 1974 (6 of 1974);
- l. Ensure occupational safety of all its health-care workers and others involved in handling of biomedical waste by providing appropriate and adequate personal protective equipment;
- m. Conduct health check up at the time of induction and at least once in a year for all its health-care workers and others involved in handling of biomedical waste and maintain the records for the same;
- n. Maintain and update on day-to-day basis the biomedical waste management register and

- display the monthly record on its website according to the biomedical waste generated in terms of category and colour coding as specified in Schedule I;
- o. Report major accidents including accidents caused by fire hazards, blasts during handling of biomedical waste and the remedial action taken and the records relevant thereto, (including nil report) in Form I to the prescribed authority and also along with the annual report;
 - p. All the healthcare facilities (any number of beds) shall make available the annual report on its website within a period of two years from the date of publication of Biomedical Waste Management (Amendment) Rules, 2018, published 16 March 2018);
 - q. Inform the prescribed authority immediately in case the operator of a facility does not collect the biomedical waste within the intended time or as per the agreed time;
 - r. Establish a system to review and monitor the activities related to biomedical waste management, either through an existing committee or by forming a new committee and the committee shall meet once in every six months and the record of the minutes of the meetings of this committee shall be submitted along with the annual report to the prescribed authority and the healthcare establishments having less than 30 beds shall designate a qualified person to review and monitor the activities relating to biomedical waste management within that establishment and submit the annual report;
 - s. Maintain all record for operation of incineration, hydro or autoclaving etc., for a period of five years;
 - t. Existing incinerators to achieve the standards for treatment and disposal of biomedical waste as specified in Schedule II for retention time in secondary chamber and Dioxin and Furans within two years from the date of this notification.

*Biomedical Waste Management (Principle) Rules, 2016, GoI, 28 March 2016, BMWM (Amendment) Rules, 2018, BMWM (Amendment) Rules, 2019 Feb, May. Guidelines for management of Healthcare Waste as per BMWM rules, 2016, Central Pollution Control Guidelines, 2018.

8.2. Biomedical wastes categories and their segregation, collection, treatment, processing and disposal options

SCHEDULE I: [See rules 3(e), 4(b), 7(1), 7(2), 7(5), 7(6) and 8(2)]

Part-1

Category	Type of waste	Type of bag or container to be used	Treatment and disposable options
Yellow	(a) Human anatomical waste: Human tissues, organs, body parts and fetus below the viability period (as per the Medical Termination of Pregnancy Act 1971, amended from time to time)	Yellow-coloured non-chlorinated plastic bags	Incineration or plasma pyrolysis or deep burial*
	(b) Animal anatomical waste: Experimental animal carcasses, body parts, organs, tissues, including the waste generated from animals used in experiments or testing in veterinary hospitals or colleges or animal houses		
	(c) Soiled waste: Items contaminated with blood, body fluids like dressings, plaster casts, cotton swabs and bags containing residual or discarded blood and blood components		Incineration or plasma pyrolysis or deep burial* In the absence of above facilities, autoclaving or micro-waving/ hydroclaving followed by shredding or mutilation or combination of sterilization and shredding. Treated waste to be sent for energy recovery.
	(d) Expired or discarded medicines: Pharmaceutical waste like antibiotics, cytotoxic drugs including all items contaminated with cytotoxic drugs along with glass or plastic ampoules, vials, etc.	Yellow-coloured non-chlorinated plastic bags or containers	Expired cytotoxic drugs and items contaminated with cytotoxic drugs to be returned back to the manufacturer or supplier for incineration at temperature $>1200^{\circ}\text{C}$ or to common biomedical waste treatment facility or hazardous waste treatment, storage and disposal facility for incineration at $>1200^{\circ}\text{C}$. Or encapsulation or plasma pyrolysis at $>1200^{\circ}\text{C}$. All other discarded medicines shall be either sent back to manufacturer or disposed by incineration.

Category	Type of waste	Type of bag or container to be used	Treatment and disposable options
	(e) Chemical waste: Chemicals used in production of biological and used or discarded disinfectants.	Yellow-coloured containers or non-chlorinated plastic bags	Disposed of by incineration or plasma pyrolysis or encapsulation in hazardous waste treatment, storage and disposal facility.
	(f) Chemical liquid waste: Liquid waste generated due to use of chemicals in production of biological and used or discarded disinfectants, Silver X-ray film developing liquid, discarded formalin, infected secretions, aspirated body fluids, liquid from laboratories and floor washings, cleaning, house-keeping and disinfecting activities, etc.	Separate collection system leading to effluent treatment system	After resource recovery, the chemical liquid waste shall be pre-treated before mixing with other wastewater. The combined discharge shall conform to the discharge norms given in Schedule III.
	(g) Discarded linen, mattresses, beddings contaminated with blood or body fluid, routine mask and gown	Non-chlorinated yellow plastic bags or suitable packing material	Non-chlorinated chemical disinfection followed by incineration or plasma pyrolysis or for energy recovery. In the absence of above facilities, shredding or mutilation or combination of sterilization and shredding. Treated waste to be sent for energy recovery or incineration or plasma pyrolysis.
	(h) Microbiology, biotechnology and other clinical laboratory waste: Blood bags, laboratory cultures, stocks or specimens of microorganisms, live or attenuated vaccines, human and animal cell cultures used in research, industrial laboratories, production of biological, residual toxins, dishes and devices used for cultures	Autoclave or microwave or hydroclave safe plastic bags or containers	Pre-treat to sterilize with non-chlorinated chemicals on-site as per World Health Organization guidelines on "Safe management of wastes from health care activities" and WHO Blue Book, 2014 and thereafter sent for incineration.

Category	Type of waste	Type of bag or container to be used	Treatment and disposable options
Red	Contaminated waste (recyclable) wastes generated from disposable items such as tubing, bottles, intravenous tubes and sets, catheters, urine bags, syringes (without needles and fixed needle syringes) and vacutainers with their needles cut) and gloves.	Red-coloured non-chlorinated plastic bags or containers	Autoclaving or micro-waving/hydroclaving followed by shredding or mutilation or combination of sterilization and shredding. Treated waste to be sent to registered or authorized recyclers or for energy recovery or plastics to diesel or fuel oil or for road making, whichever is possible. Plastic waste should not be sent to landfill sites.
White sharps bin (translucent)	Waste sharps, including metals: Needles, syringes with fixed needles, needles from needle tip cutter or burner, scalpels, blades, or any other contaminated sharp object that may cause puncture and cuts. This includes both used, discarded and contaminated metal sharps.	Puncture proof, Leak proof, tamper proof containers	Autoclaving or dry heat sterilization followed by shredding or mutilation or encapsulation in metal container or cement concrete; combination of shredding cum autoclaving; and sent for final disposal to iron foundries (having consent to operate from the State Pollution Control Boards or Pollution Control Committees) or sanitary landfill or designated concrete waste sharp pit.
Blue sharps bin	(a) Glassware: Broken or discarded and contaminated glass including medicine vials and ampoules except those contaminated with cytotoxic wastes.	Puncture-proof and leak-proof boxes or containers with blue-coloured marking	Disinfection (by soaking the washed glass waste after cleaning with detergent and sodium hypochlorite treatment) or through autoclaving or microwaving or hydroclaving and then sent for recycling.
	(b) Metallic body implants	Puncture-proof and leak-proof boxes or containers with blue-coloured marking	

*Disposal by deep burial is permitted only in rural or remote areas where there is no access to common biomedical waste treatment facility. This will be carried out with prior approval from the prescribed authority and as per the standards specified in Schedule II. The deep burial facility shall be located as per the provisions and guidelines issued by Central Pollution Control Board from time to time.

Part-2

1. All plastic bags shall be as per BIS standards as and when published, till then the prevailing Plastic Waste Management Rules shall be applicable.
2. Chemical treatment using at least 1% to 2% sodium hypochlorite having 30% residual chlorine for 20 minutes or any other equivalent chemical reagent that should demonstrate Log 10⁴ reduction efficiency for microorganisms as given in Schedule III.
3. Mutilation or shredding must be to an extent to prevent unauthorized reuse.
4. There will be no chemical pretreatment before incineration, except for microbiological, laboratory and highly infectious waste.
5. Incineration ash (ash from incineration of any biomedical waste) shall be disposed through hazardous waste treatment, storage and disposal facility, if toxic or hazardous constituents are present beyond the prescribed limits as given in the Hazardous Waste (Management, Handling and Transboundary Movement) Rules, 2008 or as revised from time to time.
6. Dead fetus below the viability period (as per the Medical Termination of Pregnancy Act 1971, amended from time to time) can be considered as human anatomical waste. Such waste should be handed over to the operator of common biomedical waste treatment and disposal facility in yellow bag with a copy of the official Medical Termination of Pregnancy certificate from the Obstetrician or the Medical Superintendent of hospital or healthcare establishment.
7. Cytotoxic drug vials shall not be handed over to unauthorized person under any circumstances. These shall be sent back to the manufacturers for necessary disposal at a single point. As a second option, these may be sent for incineration at common biomedical waste treatment and disposal facility or TSDFs or plasma pyrolysis at temperature >1200°C.
8. Residual or discarded chemical wastes, used or discarded disinfectants and chemical sludge can be disposed at hazardous waste treatment, storage and disposal facility. In such case, the waste should be sent to hazardous waste treatment, storage and disposal facility through operator of common biomedical waste treatment and disposal facility only.
9. On-site pretreatment of laboratory waste, microbiological waste, blood specimens, and blood bags should be disinfected or sterilized as per the Guidelines of World Health Organization or National AIDS Control Organization and then given to the common biomedical waste treatment and disposal facility.
10. Installation of in-house incinerator is not allowed. However, in case there is no common biomedical facility within 75 km distance, the same may be installed by occupier after taking authorization from the State Pollution Control Board.
11. Syringes should be either mutilated or needles should be cut and or stored in tamper-proof, leak-proof and puncture-proof containers for sharps storage. Wherever the occupier is not linked to a disposal facility it shall be the responsibility of the occupier to sterilize and dispose in the manner prescribed.
12. Biomedical waste generated in households during healthcare activities shall be segregated as per these rules and handed over in separate bags or containers to municipal waste collectors. Urban local bodies shall have tie up with the common biomedical waste treatment and disposal facility to pick up this waste from the Material Recovery Facility (MRF) or from the house hold directly, for final disposal in the manner as prescribed in this Schedule.

8.3. Duties of the operator of a common biomedical waste treatment and disposal facility

It shall be the duty of every operator to:

- a. Take all necessary steps to ensure that the biomedical waste collected from the occupier is transported, handled, stored, treated and disposed of, without any adverse effect to the human health and the environment, in accordance with these rules and guidelines issued by the Central Government or, as the case may be, the Central Pollution Control Board from time to time;
- b. Ensure timely collection of biomedical waste from the occupier as prescribed under these rules;
- c. Establish bar coding and global positioning system for handling of biomedical waste in accordance with the guidelines issued by the Central Pollution Control Board by 27 March 2019;
- d. Inform the prescribed authority immediately regarding the occupiers which are not handing over the segregated biomedical waste in accordance with these rules;
- e. Provide training for all its workers involved in handling of biomedical waste at the time of induction and at least once a year thereafter;
- f. Assist the occupier in training conducted by them for biomedical waste management;
- g. Undertake appropriate medical examination at the time of induction and at least once in a year and immunise all its workers involved in handling of biomedical waste for protection against diseases, including hepatitis B and tetanus, that are likely to be transmitted while handling biomedical waste and maintain the records for the same;
- h. Ensure occupational safety of all its workers involved in handling of biomedical waste by providing appropriate and adequate personal protective equipment (PPE);
- i. Report major accidents including accidents caused by fire hazards, blasts during handling of biomedical waste and the remedial action taken and the records relevant thereto, (including nil report) in Form I (refer to rules) to the prescribed authority and also along with the annual report;
- j. Maintain a log book for each of its treatment equipment according to weight of batch; categories of waste treated; time, date and duration of treatment cycle and total hours of operation;
- k. Allow occupier, who are giving waste for treatment to the operator, to see whether the treatment is carried out as per the rules;
- l. Shall display details of authorization, treatment, annual report, etc. on its website; (m) after ensuring treatment by autoclaving or microwaving followed by mutilation or shredding, whichever is applicable, the recyclables from the treated biomedical wastes such as plastics and glass, shall be given to recyclers having valid consent or authorization or registration from the respective State Pollution Control Board or Pollution Control Committee;
- m. Supply non-chlorinated plastic coloured bags to the occupier on chargeable basis, if required;
- n. Common biomedical waste treatment facility shall ensure collection of biomedical waste on holidays also;
- o. Maintain all record for operation of incineration, hydro or autoclaving for a period of five years; and
- p. Upgrade existing incinerators to achieve the standards for retention time in secondary chamber and dioxin and furans within two years from the date of this notification.

8.4. Standards for treatment and disposal of biomedical waste

SCHEDULE II: [See rule 4(t), 7(1) and 7(6)]

1. Standards for incineration

All incinerators shall meet the following operating and emission standards.

A. Operating standards

1. Combustion efficiency (CE) shall be at least 99.00%.
2. The combustion efficiency is computed as follows:

$$\text{C.E.} = \frac{\% \text{CO}_2}{\% \text{CO}_2 + \% \text{CO}} \times 100$$

3. The temperature of the primary chamber shall be a minimum of 800 °C and the secondary chamber shall be minimum of 1050 °C ± 500 °C.
4. The secondary chamber gas residence time shall be at least two seconds.

B. Emission standards

S.No.	Parameter	Standards	Sampling duration in minutes, unless stated
		Limiting concentration in mg/Nm ³ unless stated	
1.	Particulate matter	50	30 or 1 NM ³ of specimen volume, whichever is more
2.	Nitrogen oxides NO and NO ₂	400	30 for online sampling or grab specimen
3.	HCl	50	30 or 1 NM ³ of specimen volume, whichever is more
4.	Total dioxins and furans	0.1 ngTEQ/Nm ³ (at 11%O ₂)	8 hours or 5 NM ³ of specimen volume, whichever is more
5.	Mercury and its compounds	0.05	2 hours or 1 NM ³ of specimen volume, whichever is more

C. Stack height

Minimum stack height shall be 30 metres above the ground and shall be attached with the necessary monitoring facilities as per requirement of monitoring of "general parameters" as notified under the Environment (Protection) Act, 1986 and in accordance with the Central Pollution Control Board Guidelines of Emission Regulation Part-III.

Note:

1. The existing incinerators shall comply with the above within a period of two years from the date of the notification.
2. The existing incinerators shall comply with the standards for dioxins and furans of 0.1 ngTEQ/Nm³, as given below within two years from the date of commencement of these rules.

3. All upcoming common biomedical waste treatment facilities having incineration facility or captive incinerator shall comply with standards for dioxins and furans.
4. The existing secondary combustion chambers of the incinerator and the pollution control devices shall be suitably retrofitted, if necessary, to achieve the emission limits.
5. Wastes to be incinerated shall not be chemically treated with any chlorinated disinfectants.
6. Ash from incineration of biomedical waste shall be disposed of at common hazardous waste treatment and disposal facility. However, it may be disposed of in municipal landfill, if the toxic metals in incineration ash are within the regulatory quantities as defined under the Hazardous Waste (Management and Handling and Transboundary Movement) Rules, 2008 as amended from time to time.
7. Only low sulphur fuel such as light diesel oil or low sulphur heavy stock or diesel, compressed natural gas, liquefied natural gas or liquefied petroleum gas shall be used as fuel in the incinerator.
8. The occupier or operator of a common biomedical waste treatment facility shall monitor the stack gaseous emissions (under optimum capacity of the incinerator) once in three months through a laboratory approved under the Environment (Protection) Act, 1986 and record of such analysis results shall be maintained and submitted to the prescribed authority. In case of dioxins and furans, monitoring should be done once in a year.
9. The occupier or operator of the common biomedical waste treatment facility shall install continuous emission monitoring system for the parameters as stipulated by State Pollution Control Board or Pollution Control Committees in authorization and transmit the data real time to the servers at State Pollution Control Board or Pollution Control Committees and Central Pollution Control Board.
10. All monitored values shall be corrected to 11% oxygen on dry basis.
11. Incinerators (combustion chambers) shall be operated with such temperature, retention time and turbulence, as to achieve Total Organic Carbon content in the slag and bottom ashes less than 3% or their loss on ignition shall be less than 5% of the dry weight.
12. The occupier or operator of a common biomedical waste incinerator shall use combustion gas analyser to measure CO₂, CO and O₂.

2. Operating and emission standards for disposal by plasma pyrolysis or gasification

A. Operating standards

All the operators of the plasma pyrolysis or gasification shall meet the following operating and emission standards:

1. Combustion Efficiency (CE) shall be at least 99.99%.
2. The combustion efficiency is computed as follows:

$$\text{C.E.} = \frac{(\% \text{CO}_2)}{(\% \text{CO}_2 + \% \text{CO})} \times 100$$

3. The temperature of the combustion chamber after plasma gasification shall be 1050±50 °C with gas residence time of at least 2 (two) second, with minimum 3% oxygen in the stack gas.
4. The stack height should be a minimum of 30 m above ground level and shall be attached with the necessary monitoring facilities as per requirement of monitoring of "general parameters" as notified under the Environment (Protection) Act, 1986 and in accordance with the CPCB Guidelines of Emission Regulation Part-III.

B. Air emission standards and air pollution control measures

1. Emission standards for incinerator, notified at Sl. No.1 above in this Schedule, and revised from time to time, shall be applicable for the plasma pyrolysis or gasification also.
2. Suitably designed air pollution control devices shall be installed or retrofitted with the plasma pyrolysis or gasification to achieve the above emission limits, if necessary.
3. Wastes to be treated using plasma pyrolysis or gasification shall not be chemically treated with any chlorinated disinfectants and chlorinated plastics shall not be treated in the system.

C. Disposal of ash vitrified material:

The ash or vitrified material generated from the "Plasma Pyrolysis or Gasification" shall be disposed off in accordance with the Hazardous Waste (Management, Handling and Transboundary Movement) Rules 2008 and revisions made thereafter in case the constituents exceed the limits prescribed under Schedule II of the said Rules or else in accordance with the provisions of the Environment (Protection) Act, 1986, whichever is applicable.

3. Standards for autoclaving of biomedical waste

The autoclave should be dedicated for the purposes of disinfecting and treating biomedical waste.

1. When operating a gravity flow autoclave, medical waste shall be subjected to:
 - a. a temperature of not less than 121 °C and pressure of 15 pounds per square inch (psi) for an autoclave residence time of not less than 60 minutes; or
 - b. a temperature of not less than 135 °C and a pressure of 31 psi for an autoclave residence time of not less than 45 minutes; or
 - c. a temperature of not less than 149 °C and a pressure of 52 psi for an autoclave residence time of not less than 30 minutes.
2. When operating a vacuum autoclave, medical waste shall be subjected to a minimum of three pre-vacuum pulse to purge the autoclave of all air. The air removed during the pre-vacuum, cycle should be decontaminated by means of HEPA and activated carbon filtration, steam treatment, or any other method to prevent release of pathogen. The waste shall be subjected to the following:
 - a. a temperature of not less than 121 °C and pressure of 15 psi per an autoclave residence time of not less than 45 minutes; or
 - b. a temperature of not less than 135 °C and a pressure of 31 psi for an autoclave residence time of not less than 30 minutes;
3. Medical waste shall not be considered as properly treated unless the time, temperature and pressure indicators indicate that the required time, temperature and pressure were reached during the autoclave process. If for any reasons, time temperature or pressure indicator indicates that the required temperature, pressure or residence time was not reached, the entire load of medical waste must be autoclaved again until the proper temperature, pressure and residence time were achieved.
4. Recording of operational parameters: Each autoclave shall have graphic or computer recording devices which will automatically and continuously monitor and record dates, time of day, load identification number and operating parameters throughout the entire length of the autoclave cycle.
5. Validation test for autoclave: The validation test shall use four biological indicator strips, one shall be used as a control and left at room temperature, and three shall be placed in

the approximate centre of three containers with the waste. Personal protective equipment (gloves, face mask and coveralls) shall be used when opening containers for the purpose of placing the biological indicators. At least one of the containers with a biological indicator should be placed in the most difficult location for steam to penetrate, generally the bottom centre of the waste pile. The occupier or operator shall conduct this test three consecutive times to define the minimum operating conditions. The temperature, pressure and residence time at which all biological indicator vials or strips for three consecutive tests show complete inactivation of the spores shall define the minimum operating conditions for the autoclave. After determining the minimum temperature, pressure and residence time, the occupier or operator of a common biomedical waste treatment facility shall conduct this test once in three months and records in this regard shall be maintained.

6. Routine test: A chemical indicator strip or tape that changes colour when a certain temperature is reached can be used to verify that a specific temperature has been achieved. It may be necessary to use more than one strip over the waste package at different locations to ensure that the inner content of the package has been adequately autoclaved. The occupier or operator of a common biomedical waste treatment facility shall conduct this test during autoclaving of each batch and records in this regard shall be maintained.
7. Spore testing: The autoclave should completely and consistently kill the approved biological indicator at the maximum design capacity of each autoclave unit. Biological indicator for autoclave shall be *Bacillus stearothermophilus* spores using vials or spore strips; with at least 1×10^6 spores. Under no circumstances will an autoclave have minimum operating parameters less than a residence time of 30 minutes, a temperature less than 121 °C or a pressure less than 15 psi. The occupier or operator of a common bio medical waste treatment and disposal facility shall conduct this test at least once in every week and records in this regard shall be maintained.

4. Standards of microwaving

1. Microwave treatment shall not be used for cytotoxic, hazardous or radioactive wastes, contaminated animal carcasses, body parts and large metal items.
2. The microwave system shall comply with the efficacy test or routine tests and a performance guarantee may be provided by the supplier before operation of the limit.
3. The microwave should completely and consistently kill the bacteria and other pathogenic organisms that are ensured by approved biological indicator at the maximum design capacity of each microwave unit. Biological indicators for microwave shall be *Bacillus atrophaeus* spores using vials or spore strips with at least 1×10^4 spores per detachable strip. The biological indicator shall be placed with waste and exposed to same conditions as the waste during a normal treatment cycle.

5. Standards for deep burial

1. A pit or trench should be dug about two meters deep. It should be half-filled with waste, then covered with lime within 50 cm of the surface, before filling the rest of the pit with soil.
2. It must be ensured that animals do not have any access to burial sites. Covers of galvanized iron or wire meshes may be used.

3. On each occasion, when wastes are added to the pit, a layer of 10 cm of soil shall be added to cover the wastes.
4. Burial must be performed under close and dedicated supervision.
5. The deep burial site should be relatively impermeable and no shallow well should be close to the site.
6. The pits should be distant from habitation, and located so as to ensure that no contamination occurs to surface water or ground water. The area should not be prone to flooding or erosion.
7. The location of the deep burial site shall be authorised by the prescribed authority.
8. The institution shall maintain a record of all pits used for deep burial.
9. The ground water table level should be a minimum of six meters below the lower level of deep burial pit.

6. Standards for efficacy of chemical disinfection

Microbial inactivation efficacy is equated to "Log10 kill" which is defined as the difference between the logarithms of number of test microorganisms before and after chemical treatment. Chemical disinfection methods shall demonstrate a 4 Log10 reduction or greater for *Bacillus Subtilis* (ATCC 19659) in chemical treatment systems.

7. Standards for dry heat sterilization

Waste sharps can be treated by dry heat sterilization at a temperature not less than 185 °C, at least for a residence period of 150 minutes in each cycle, which sterilization period of 90 minutes. There should be automatic recording system to monitor operating parameters.

1. Validation test for sharps sterilization unit
 - Waste sharps sterilization unit should completely and consistently kill the biological indicator *Bacillus stearothermophilus* or *Bacillus atropheausspores* using vials with at least \log_{10}^6 spores per ml. The test shall be carried out once in three months
2. Routine test
 - A chemical indicator strip or tape that changes colour when a certain temperature is reached can be used to verify that a specific temperature has been achieved. It may be necessary to use more than one strip over the waste to ensure that the inner content of the sharps has been adequately disinfected. This test shall be performed once in week and records in this regard shall be maintained.

8. Standards for liquid waste

1. The effluent generated or treated from the premises of occupier or operator of a common bio medical waste treatment and disposal facility, before discharge into the sewer should conform to the following limits

Parameters	Permissible limits
pH	6.5–9.0
Suspended solids	100 mg/L
Oil and grease	10 mg/L
BOD	30 mg/L
COD	250 mg/L
Bio-assay test	90% survival of fish after 96 hours in 100% effluent

Note:

- i. Above limits are applicable to the occupiers of healthcare facilities (bedded) which are either connected with sewerage network without terminal sewage treatment plant or not connected to public sewers.
- ii. For discharge into public sewers with terminal facilities, the general standards as notified under the Environment (Protection) Act, 1986 (29 of 1986) shall be applicable.
- iii. Healthcare facilities having less than ten beds shall have to install sewage treatment plant by 31 December 2019
- iv. Non-bedded occupiers shall dispose infectious wastes only after treatment by disinfection as per Schedule-II (6) of the principle rules.

2. Sludge from the effluent treatment plant shall be given to common biomedical waste treatment facility for incineration or to hazardous waste treatment, storage and disposal facility for disposal.

8.5. Form IV, Annual Report

Form IV

Annual Report

(BioMedical Waste Management Rules, 2016)

[To be submitted to the prescribed authority on or before 30 June every year for the period from January to December of the preceding year, by the occupier of healthcare facility (HCF) or common biomedical waste treatment facility (CBWTF)]

S.No.	Particulars	Details
1.	Particulars of the occupier	
	(i) Name of the authorized person (occupier or operator of facility)	
	(ii) Name of HCF or CBMWTF	
	(iii) Address for correspondence	
	(iv) Address of facility	
	(v) Tel. No, Fax. No	
	(vi) E-mail ID	
	(vii) URL or website	
	(viii) GPS coordinates of HCF or CBMWTF	
	(ix) Ownership of HCF or CBMWTF	(State government or private or semi government or any other)
	(x) Status of authorization under the BioMedical Waste (Management and Handling) Rules	Authorization No. valid up to
	(xi) Status of consents under Water Act and Air Act	Valid up to:
2.	Type of healthcare facility	
	(i) Bedded hospital	No. of beds.....
	(ii) Non-bedded hospital (clinic or blood bank or clinical laboratory or research institute or veterinary hospital or any other)	
	(iii) License member and its date of expiry	

3.	Details of CBMWTF			
	(i) Number healthcare facilities covered by CBMWTF			
	(ii) Number of beds covered by CBMWTF			
	(iii) Installed treatment and disposal capacity of CBMWTF _____ kg/day			
	(iv) Quantity of biomedical waste treated or disposed by CBMWTF _____ kg/day			
4.	Quantity of waste generated or disposed in kg per annum (on monthly average bases)			
	Yellow bin:			
	Red bin:			
	White sharps bin:			
	Blue sharps bin:			
5.	Details of the storage, treatment, transportation, processing and disposal facility			
	(i) Details of the on-site storage facility	Size :		
		Capacity :		
		Provision of on-site storage: (cold storage or any other provision)		
	(ii) Details of the treatment or disposal facilities	Type of treatment	Number of equipment	Capacity (kg/day)
		Incinerators:		
		Plasma pyrolysis:		
		Autoclaves:		
		Microwave:		
		Hydroclave:		
		Shredder:		
		Needle tip cutter or destroyer:		
		Sharps encapsulation or concreter pit:		
		Deep burial pits:		
	(iii) Quantity of recyclable wastes sold to authorized recyclers after treatment in kg per annum	Chemical		
		Disinfection:		
	Any other treatment:			
	(iv) Number of vehicles used for collection and transportation of biomedical waste	Red category (such as plastic, glass, etc.)		

	(v) Details of incineration ash and ETP sludge generated and disposed during the treatment of wastes in kg per annum	Quantity generated	Where disposed	
		Incineration Ash ETP Sludge		
	(vi) Name of the common biomedical waste treatment facility operator through which wastes are disposed of			
	(vii) List of member HCF not handed over biomedical waste			
6.	Do you have biomedical waste management committee? If yes, attach minutes of the meetings held during the reporting period			
7.	Details of trainings conducted on BMW management			
	(i) Number of trainings conducted on BMW management			
	(ii) Number of personnel trained			
	(iii) Number of personnel trained at the time of induction			
	(iv) Number of personnel not trained			
8.	Details of the accident occurred during the year			
	(i) Number of accidents occurred			
	(ii) Number of persons affected			
	(iii) Remedial action taken (provide details)			
9.	Are you meeting the standards of air pollution from the incinerator? How many times in last year could not meet the standards?			
	Details of continuous online emission monitoring systems installed			
10.	Liquid waste generated and treatment methods in place. How many times you have not met the standards in a year?			
11.	Is the disinfection method or sterilization meeting the log 4 standards? How many times you have not met the standards in a year?			

12.	Any other relevant information	(Air pollution control devices attached with the incinerator)
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Certified that the above report is for the period from

.....
.....
.....

Name and Signature
Head of the Institution

Date:

Place:

Annex 9: The operation theatre – preparation for surgery

9.1. Surgical attire

Function of the various items of surgical attire

Gloves: Protect the patient from organisms on the surgeon's hand and also protects the surgeon from contact with the blood and tissues of the patient.

Gown and waterproof apron: Protects the patient from organisms on the body surface and clothes of the surgical team and protects the clothes and body surface of the surgeon from the blood and tissues of the patient.

Mask: Protects the patient against microorganisms expelled during breathing, talking, laughing and coughing. It also protects the surgeon (the mouth and nose) from splashes of blood and secretions.

Eye protection or visors, these protect the eyes of the surgeon from splashes of blood and secretions.

Cap: Protects the patient from organisms shed from the hair and skin of the surgeon, should cover all the hair

Footwear; these should be made of sturdy, washable material with closed toes to protect the feet from splashes, and injury due to falling instrument If footwear are not available shoe covers can be worn. These are disposable or reusable.

Before entering the operation room, don the cap, face mask and eyewear. Some masks come with eye protection; however, these may not be available in resource limited settings. A simple method of making a mask with eye protection is by stapling or fixing a plastic transparent sheet to the mask so that when the mask is worn, the transparent sheet forms a shield in front of the eyes.

The steps of surgical scrub

1. The scrubbing facility: tap and sink
2. Remove rings, watch and bracelets.
3. Clean the fingernails.
4. Starting with the fingers, apply soap/antiseptic to all surfaces of hands.
5. Rub between fingers.
6. Continue to apply soap/antiseptic till the elbow.
7. Starting with fingers, rinse each hand and arm till the elbow with the hands above the level of the elbow.
8. Dry with a sterile towel beginning with the fingers and till the elbow.
9. Keep the scrubbed hands above the waist level.

Wearing the gown

The sterile gown is worn after surgical scrub. The gown should ideally be made of a waterproof material. If a waterproof gown is not available, a waterproof apron has to be worn under the gown.

- An assistant opens the sterile pack containing sterile gown (the sterile gown is folded inside out).
- Lift folded gown from pack, Stepping away from the table, locate neckband and grasp front of gown below the neckband.
- Allow the gown to unfold keeping inside of gown towards the body.

Note: Do not touch outside of gown with bare hands. The outside of the gown is the sterile surface.

- With hands at shoulder level, slip both arms into armholes simultaneously.
- The assistant brings the gown over the shoulders by touching the inside of the gown at the arm seams.

Gloves

After wearing the sterile gown, the sterile gloves are worn. Sterile surgical gloves should be worn in the following way.

- The outer package of gloves is opened by the assistant without touching the inner wrapper.
- Open inner glove wrapper exposing the cuffed gloves with palm up.
- Pick up one glove by the cuff touching only the inner portion of the cuff.
- While holding cuff in one hand with the fingers pointing downwards, slip other hand into the glove. Pick up the second glove by sliding the fingers of the gloved hand under the cuff of the second glove.
- Do not contaminate the gloved hand with the ungloved hand as the second glove is being put on. Keep hands at waist level in front of body with fingers clasped.

Removing the gloves

Important: After the surgical procedure the first thing to do is to remove the gloves
Do not allow the outside of the used glove to touch your skin.

- The gloves should be removed before touching anything.
- Rinse gloved hands in a disinfectant solution to remove blood and body fluids.
- Partly pull off one of the gloves by grasping it near the cuff.
- Keeping the first glove partly on, remove the second glove partly to avoid touching the outer surface of either glove.
- Both gloves are now turned partially inside out and can together be removed completely while avoiding touching the outside of the glove with bare hands.
- Wash hands after removing gloves, since gloves may contain nicks and tears which could allow blood and body fluids to contaminate the hands.

9.2. Cleaning of operation theatre

Daily cleaning procedure

- Before start of the first case, at least one hour before:
 - Damp dust with detergent-disinfectant all equipment, furniture and lights
 - Wipe surgical light reflector again with 70% alcohol to remove the film left by the detergent

- Between cases:
 - Place soiled towels, drapes and gowns in a clean laundry bag and send to laundry. Wet linen should be placed in plastic container so that bacteria do not pass through the moist material.
 - Soiled instruments must be placed in disinfectant and then send to the cleaning area, this prevents occupational hazard to the cleaner.
 - Wipe all used equipment, furniture and lights.
 - Move operating table to one side and wet vacuum or wet mop a 3–4 feet area around the operating site.
 - Empty suction bottle and wash the suction bottle and tubing with detergent–disinfectant. Best is disposable suction bottle.
- Terminal daily cleaning after scheduled cases are over:
 - Remove all portable equipment from the room
 - Wipe windowsills, overhead lights, equipment, furniture and waste containers with a cloth soaked in detergent disinfectant solution.
 - Wet vacuum or wet mop the entire floor area
 - Clean and disinfect the wheels/castors
 - Restock unsterile supplies
 - Check levels and dates of all sterile supplies and restock
 - Clean the air-conditioning grills
 - Clean scrub sinks with scouring powder
 - Empty all shelves, wipe with detergent–disinfectant and dry them before replacing the supplies.

Weekly general cleaning procedure

- Remove all portable equipment. Clean lights and fixtures with detergent disinfectant solution and cloth.
- Clean doors hinges and facings and rinse with solution.
- Wipe down the walls with a mop soaked in detergent disinfectant solution.
- Scrub the floor with floor cleaning machine and a phenol disinfectant detergent solution. Use a wet vacuum to pick up the fluid.
- Replace clean portable equipment, clean wheels and castors by rolling them across a towel saturated with detergent disinfectant.
- Wash and dry all furniture and equipment including
 - Operating room table
 - Suction holders
 - Foot and sitting stools
 - IV stands and all other stands
 - X-ray view boxes
 - All tables
 - Tubing to oxygen tanks
 - Waste containers and buckets

Note: Thorough washing and cleaning is essential. Fumigation and fogging have no role in the modern operation room. Fumigation with formalin is hazardous to persons and should not be done. It can also harm sensitive equipment.

Annex 10: Ventilation and design requirements

Ventilation and design requirements of the operation theatre are:[#]

- Airborne bacteria originate primarily from the skin of persons in the operation theatre (OT). The bacteria carried on the skin reach the air through skin scales, which are constantly being shed by the persons in the room. After remaining suspended in the air, the skin scales carrying bacteria settle on various surfaces, equipment and on the floor of the OT. Appropriately circulated clean filtered air will remove airborne organisms.
- Air should be circulated by positive pressure through high efficiency particulate air (HEPA) filters. These are special filters, which can remove particles greater than 0.3 micron. Bacteria will be removed, as the size of bacteria is 0.5–1 micron. HEPA filters should be monitored for efficiency on a regular basis and changed when required.
- The ventilation rate is expressed as the number of air changes per hour. For an OT, the recommended ventilation rate is 20 air changes per hour.
- To prevent contamination of the clean zones, the direction of airflow should be from the ultra-clean or aseptic zone to less clean zones in order of their cleanliness (see the concept of zoning). This is achieved by an appropriate pressure gradient. Highest positive pressure is maintained in the ultra-clean areas. The higher pressure allows air to flow to less clean areas around the doors and openings and prevents the entry of air from the less clean area.
- Within the rooms air inlets should be at high level and outlets at low level so that the clean air moves downwards through the room and towards the contaminated floor where it is exhausted through the outlet.
- The temperature in the OT should be between 18 and 24°C. The room should have central air-conditioning. Window air conditioners are a source of contamination and have no place in an OT.
- The surfaces of floors and walls of the OT should be as hard, non-porous and smooth as possible. Ceramic tiles are not ideal because the grouting between the tiles can harbour microorganisms. There should be no cracks and crevices since cracks and crevices can harbour microorganisms and cannot be cleaned properly. A special paint called epoxy paint is particularly suitable for the walls of the OT. The joint between the walls and floor should be curved for easy cleaning.
- The operation table should be placed away from the entrance.
- The openings should be fitted with swing doors.
- Since people are the main source of airborne contamination, the number of persons in the OT should be kept to a minimum. Opening and closing of doors should be avoided as this interferes with the direction of airflow.

Note: It is evident that older hospitals and some hospitals in India may not be able to achieve these standards. However, the principles underlying these standards should always be kept in view whenever new facility is designed and renovations should attempt to achieve these standards.

Annex 11: High risk pathogen – epidemic action plan

High-risk pathogens: Strategic planning and operational management for infection prevention and control

- High-risk pathogens
 - Filoviruses: Ebola, Marburg
 - Crimean Congo–haemorrhagic fever
 - Kyasanur forest disease
 - New strain of influenza
 - MERS-CoV, SARS-CoV, novel-CoV
 - Nipah virus
 - Multidrug-resistant or extremely drug resistant tuberculosis
 - Multidrug-resistant Gram-negative bacilli
- Strategic planning
 - Awareness of stakeholders
 - Healthcare facility administrators
 - Microbiologists
 - Infectious disease physicians
 - Nursing administration
 - Housekeeping manager
 - Public health
 - Senior clinicians
 - Surveillance information
 - Identifying surveillance information resources for incidence, prevalence, case definition, IPC, case management, laboratory diagnosis, notification
- NCDC, WHO, CDC
 - Creation of triaging system
 - Training of staff of first contact → security, reception (customer care), nurse, emergency doctors, on-call doctors
 - Design of the triage room
 - Creation of isolation facilities
 - Isolation of patients with suspected symptoms and signs → at reception
 - Isolation of suspected/confirmed cases for clinical management
 - Ensuring appropriate training of relevant staff
 - Doctors
 - Nurses
 - Housekeeping
 - Radiologists
 - Physiotherapist
 - Ensuring consumable availability
 - Personal protective equipment
 - Planning for availability of medicines
 - Specific antimicrobial agents for empirical or targeted therapy (e.g. antiviral agents)
 - Defining clinical referral pathways
 - Infectious diseases
 - Microbiology
 - Cardiologist
 - Respiratory physician/pulmonary medicine
 - Surgical
 - Obstetrics

- Paediatrics
 - Intensive care and anaesthesia
 - o Planning for intra-hospital transport: e.g. radiology, surgery
 - Identification of transport route
 - Use of PPE
 - Communication to other staff and visitors
 - Cleaning/ decontamination of the route
 - o Planning for patient transportation outside the hospital
 - Identification of High Security Infectious Disease Unit
 - Identification of ambulance and its requirements
 - Training of transportation team
 - Ambulance for patients on ventilator
 - o Planning for laboratory diagnosis
 - Identification of the referral laboratory
 - Guidelines for transportation of clinical specimens or isolates
 - o Planning for biomedical waste disposal
 - Guidelines for high-risk biomedical waste
 - Training of housekeeping staff
 - o Planning for public health notification
 - Identification and contact details of local and central public health authorities for discussion and communication
 - o Planning for staff health and staff absence related contingencies
 - Training of staff for prevention of infection by high-risk pathogens
 - Appropriate use of PPE
 - Staff quarantine
 - o Duration of quarantine
 - o Identifying quarantine area
 - Information about quarantine: dos and don'ts
 - o Planning for the dead patient – mortuary, post mortem, cremation/burial
 - Communication with public health
 - Guidelines to deal with the dead
- Operational management:
 - o Patient reception
 - Reception and security staff awareness about high-risk pathogen causing disease
 - o Triage
 - Training of triage staff (nurse) on triaging questions
 - Use of PPE
 - o Communication
 - Communication of triage nurse with ID physician or microbiologist in suspected cases
 - o Risk assessment
 - Checking current case definition
 - Reaching at a provisional and differential diagnosis
 - o Isolation
 - Isolation of suspected and confirmed cases
 - o Use of PPE by staff and care-givers
 - Appropriate use
 - Wearing and taking off the PPE
 - o Clinical management
 - Taking care to prevent sharps injury and splash exposure
 - Treatment administration as per standard guidelines
 - Care plan for patients requiring intensive care

- o Laboratory investigations – general
 - Communication to laboratory director and information cascade for general haematological, biochemical, cytological, histopathological, microbiological, clinical pathological investigations
 - Disposal of specimens, isolates, culture bottles and plates
 - Decontamination of equipment
 - Training of laboratory staff
 - Reducing non-essential investigations
- o Laboratory diagnosis of high-risk pathogen
 - Specimen/isolate packaging for referral laboratory as per WHO guidelines
 - Communication with referral laboratory
- o Radiology investigations
 - Reducing non-essential investigations
 - Transportation of patients to radiology → communication with radiology, patient transporters
 - Use of PPE
 - Environmental cleaning and decontamination
- o Staff quarantine
 - Duration of quarantine
 - Noting signs and symptoms
 - Plan for staff healthcare

Annex 12: Classification of infective microorganisms by risk group

Risk Group 1 (no or low individual and community risk): A microorganism that is unlikely to cause human or animal disease.

Risk Group 2 (moderate individual risk, low community risk): A pathogen that can cause human or animal disease but is unlikely to be a serious hazard to laboratory workers, the community, livestock or the environment. Laboratory exposures may cause serious infection, but effective treatment and preventive measures are available and the risk of spread of infection is limited.

Risk Group 3 (high individual risk, low community risk): A pathogen that usually causes serious human or animal disease but does not ordinarily spread from one infected individual to another. Effective treatment and preventive measures are available.

Risk Group 4 (high individual and community risk): A pathogen that usually causes serious human or animal disease and that can be readily transmitted from one individual to another, directly or indirectly. Effective treatment and preventive measures are not usually available.

Annex 13: Forms for surveillance of HAI*

(Adapted from NHSN by ICMR-AIIMS HAI surveillance network)

13.1. Denominator data collection forms

Hospital Name:	Surveillance Unit Number:	Month:	Year:	
Date	Number of patients	Number of patients with ≥ 1 central line	Number of patients with urinary catheter	Number of patients with ventilator
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				
31				
Total				

*ICMR-AIIMS HAI Surveillance Network was created in collaboration with the Centers for Disease Control and Prevention (CDC), Atlanta, USA as part of Global Health Security Agenda (GHSA) project for capacity building and strengthening of hospital infection control to detect and prevent antimicrobial resistance in India.

13.2. BSI case report form

Case ID:		
Hospital Name:		
Sex: <input type="checkbox"/> Male <input type="checkbox"/> Female	Date of Birth: ___ / ___ / ___	Birth weight: _____ grams (NICU only)
Date of hospital admission: ___ / ___ / ___ Date of admission to surveillance unit: ___ / ___ / ___		
Location prior to hospital admission: <input type="checkbox"/> Home / Community <input type="checkbox"/> Another hospital <input type="checkbox"/> Unknown		
List all other Case IDs assigned to this patient since hospital admission:		
1. BSI details		
Date of event (dd/mm/yyyy): ___ / ___ / ___		
Type of laboratory-confirmed BSI	<input type="checkbox"/> Recognized Pathogen** <input type="checkbox"/> Common Commensal (from ≥ 2 blood cultures)	
Fill out culture results in Section 5, organisms and antibiotic susceptibility		
1a. Inpatient locations		
List all locations, in chronological order, where patient was housed on the date of event:		
List all the locations, in chronological order, where patient was housed on the day before the date of event:		
2. Invasive devices: central lines		
Did the patient have a central line in place at any time on <ul style="list-style-type: none">• The date of event or• The day before the date of event?	<input type="checkbox"/> Yes <input type="checkbox"/> No (skip to 3, Infections at other body sites) <input type="checkbox"/> Unknown	
If YES, was the central line in place for >2 calendar days?	<input type="checkbox"/> Yes <input type="checkbox"/> No (skip to 3, Infections at other body sites) <input type="checkbox"/> Unknown	
If YES, type(s) of central line(s) in place (check all that apply)	<input type="checkbox"/> Non-tunneled short-term catheter (e.g. double or triple lumen) <input type="checkbox"/> Peripherally inserted central catheter (PICC) <input type="checkbox"/> Port-a-cath <input type="checkbox"/> Hemodialysis catheter <input type="checkbox"/> Tunneled catheter <input type="checkbox"/> Umbilical catheter <input type="checkbox"/> Unknown <input type="checkbox"/> Other, specify: _____	

Location(s) of central line(s) in place (check all that apply)	<input type="checkbox"/> Jugular <input type="checkbox"/> Subclavian <input type="checkbox"/> Femoral	<input type="checkbox"/> Brachial <input type="checkbox"/> Umbilical <input type="checkbox"/> Unknown	
	Other, specify: _____		
3. Infections at other body sites			
Was a positive, matching culture obtained from another body site(s) during the secondary BSI attribution period?	<input type="checkbox"/> Yes <input type="checkbox"/> No (skip to 4, outcome) <input type="checkbox"/> Unknown		
If YES, specify specimen(s) collected, date(s) of culture, and organism(s).	Specimen collected	Date of collection	Organism
	1.		
	2.		
	3.		
4. Outcome			
Patient outcome	<input type="checkbox"/> Discharged <input type="checkbox"/> Transferred to other hospital <input type="checkbox"/> Died <input type="checkbox"/> Unknown		
Date of discharge, transfer, or death (dd/mm/yyyy)	____ / ____ / ____		

**<http://www.cdc.gov/nhsn/XLS/master-organism-Com-Commensals-Lists.xlsx>. If an organism is not included on the complete list of common commensals, it must be treated as a recognized pathogen.

13.3. UTI case report form

Case ID:			
Hospital name:			
Sex: <input type="checkbox"/> Male <input type="checkbox"/> Female	Date of Birth: ___ / ___ / ___	Birth weight: ___ grams (NICU only)	
Date of hospital admission: ___ / ___ / ___ Date of admission to surveillance unit: ___ / ___ / ___			
Location prior to hospital admission:	<input type="checkbox"/> Home/Community <input type="checkbox"/> Another hospital <input type="checkbox"/> Unknown		
List all other Case IDs assigned to this patient since hospital admission:			
1. UTI details			
Date of event (dd/mm/yyyy):	___ / ___ / ___		
Type of UTI	<input type="checkbox"/> Culture confirmed UTI		
Fill out culture results in Section 4, organisms and antibiotic susceptibility			
1a. Inpatient locations			
List all locations, in chronology, where patient housed on date of event (DoE):			
List all locations, in chronology where patient housed day before DoE			
2. Invasive devices: urinary catheters			
Did the patient have a Foley catheter in place at any time on: • The date of event or • The day before the DOE?	<input type="checkbox"/> Yes <input type="checkbox"/> No (skip to 3, outcome) <input type="checkbox"/> Unknown		
If YES, was Foley catheter in place for >2 calendar days?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Unknown		
3. Outcome			
Patient outcome	<input type="checkbox"/> Discharged <input type="checkbox"/> Transferred to other hospital <input type="checkbox"/> Died <input type="checkbox"/> Unknown		
Date of discharge, transfer, or death (dd/mm/yyyy)	___ / ___ / ___		

13.4. Checklist for ventilator-associated pneumonia

Ventilator-associated pneumonia checklist		
Day/ Month		
Radiological (chest X-ray baseline)		
New or progressive and persistent infiltrate		
Consolidation		
Cavitation		
Clinical		
Fever		
WBC count		
Leukopenia (<4000 WBC/mm ³)		
Leucocytosis (>12000 WBC/mm ³)		
Sputum-purulent new-onset/ change		
New/ worsening cough/ dyspnoea/ tachypnoea		
Worsening gas exchange		
Sputum-purulent new-onset/ change		
New/worsening gas exchange/ dyspnoea/ tachypnoea		
Worsening gas exchange		
ABG	PO ₂	
	PCO ₂	
Worsening gas exchange (O ₂ desats, PO ₂ / FiO ₂ ←240, △O ₂ / ventilation demand)		
FiO ₂		
Mode of ventilator		
Ventilator		
Respiratory rate		
Laboratory		
(+) Blood culture with no other source		
BAL C/s		
Other		

13.5. Surveillance periods for SSI following selected NHSN operative procedures

Day 1 = the date of the procedure

30-day surveillance			
Code	Operative procedure	Code	Operative procedure
AAA	Abdominal aortic aneurysm repair	LAM	Laminectomy
AMP	Limb amputation	LTP	Liver transplant
APPY	Appendix surgery	NECK	Neck surgery
AVSD	Shunt for dialysis	NEPH	Kidney surgery
BILI	Bile duct, liver or pancreatic surgery	OVRY	Ovarian surgery
CEA	Carotid endarterectomy	PRST	Prostate surgery
CHOL	Gallbladder surgery	REC	Rectal surgery
COLO	Colon surgery	SB	Small bowel surgery
CSEC	Caesarean section	SPLE	Spleen surgery
GAST	Gastric surgery	THOR	Thoracic surgery
HTP	Heart transplant	THYR	Thyroid and/ or parathyroid surgery
HYST	Abdominal hysterectomy	VHYS	Vaginal hysterectomy
KTP	Kidney transplant	XLAP	Exploratory laparotomy
90-day surveillance			
Code	Operative procedure		
BRST	Breast surgery		
CARD	Cardiac surgery		
CBGB	Coronary artery bypass graft with both chest and donor site incisions		
CBGC	Coronary artery bypass graft with chest incision only		
CRAN	Craniotomy		
FUSN	Spinal fusion		
FX	Open reduction of fracture		
HER	Herniorrhaphy		
HPRO	Hip prosthesis		
KPRO	Knee prosthesis		
PACE	Pacemaker surgery		
PVBY	Peripheral vascular bypass surgery		
VSHN	Ventricular shunt		

Note: Superficial incisional SSIs are followed only for a 30-day period for all procedure types.

Secondary incisional SSIs are followed only for a 30-day period regardless of the surveillance period for the primary site.



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