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MINISTRY OF HEALTH - ETHIOPIA

NATIONAL INFECTION PREVENTION AND CONTROL REFERENCE MANUAL FOR HEALTHCARE SERVICE PROVIDERS AND MANAGERS

VOLUME 1: GENERAL INFECTION PREVENTION AND CONTROL



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FOREWORD

The Government of Ethiopia is committed to improving the quality of healthcare for its citizens. Among the many initiatives underway, the protection of patients and healthcare workers from infection and the reduction of antimicrobial resistance (AMR) at healthcare facilities have been given particular attention by the Federal Ministry of Health (FMOH). Infection prevention and control (IPC) is a critical component of quality health services. The FMOH is scaling up its health facility-related IPC activities and will use all opportunities to strengthen ongoing IPC activities. As in many of its programs, the FMOH's IPC endeavors are guided by current scientific evidence to establish optimal IPC practices and processes at healthcare facilities. Global estimates on healthcare-acquired infections show that hundreds of millions of patients are affected every year worldwide, with the burden of disease especially high in low- and middle-income countries.

Healthcare-associated infection causes a real threat to healthcare providers and communities at large and, at times, brings additional costs to patients, in particular, and to the healthcare system, in general. Because of inadequate IPC practices, healthcare providers and patients are at increased risk of acquiring serious infections, such as HIV, hepatitis B virus (HBV), hepatitis C virus (HCV), Ebola, and other emerging and reemerging bacterial or viral infections, including AMR and multidrug-resistant tuberculosis. Fortunately, most healthcare-associated infections at healthcare facilities can be prevented with the use of readily available, relatively inexpensive, and simple strategies.

In Ethiopia, where many healthcare settings are resource constrained, the control of the risk of acquiring healthcare-associated infection is very challenging. For the control measures or practices to be effective, material resources, human resources, training, policy, guidelines, and IPC programs are essential. IPC in healthcare settings is a broad, cross-cutting component of healthcare, which involves every aspect of patient care, food hygiene, housekeeping, laundry service, and waste management, among other components.

The FMOH has been implementing and revising sets of IPC guidelines to improve IPC practices in healthcare facilities over several years. This IPC reference manual is primarily intended for use by healthcare providers and health service managers. It will help users by providing clear guidance on the provision of standard IPC practices at their respective facilities. The material was developed by incorporating Ethiopian experiences, international best practices, and standardized recommendations. It is composed of innovative and evidence-based methods used widely all over the world to reduce the incidence of healthcare-associated infections and the associated healthcare costs. It is also expected that health bureaus, program managers, other stakeholders, and interest groups will benefit from consulting this reference manual. I wish to extend my heartfelt gratitude to all individuals and institutions that have contributed to the completion of this revised reference manual.

Lia Tadesse,M.D,MHA
Minister, Ministry of Health

ACKNOWLEDGMENT

Infection prevention and control (IPC) refers to measures aimed at preventing and controlling infections and transmission of infections in healthcare settings and the community. IPC is crucial in all healthcare facilities and is critical for a well-functioning healthcare system. Ensuring compliance with IPC practices depends on understanding the extent of the implementation of policies and guidelines. Many hospitals are inadequately staffed with healthcare workers with IPC expertise, and there is acute awareness of the need to address this problem. Implementation of IPC guidelines is essential in all healthcare facilities for the wellbeing and safety of patients, staff, and visitors.

IPC programmes have been demonstrated to be clinically and financially beneficial, resulting in significant cost savings from fewer Healthcare-Associated Infections (HAIs), shorter hospital stays, lower levels of antibiotic resistance, and lower costs of treating infections. These infections may already present at the time of admission or they may develop over time (nosocomial infections) in healthcare facilities.

The Infection Prevention and Control Policy, Strategy and Strategy Roadmap, and Monitoring and Evaluation Plan were created by the Ministry of Health and are currently being implemented throughout all the health care systems. Additionally, the updated guide manual will benefit users by offering clear instructions on how to implement conventional IPC practices at their own facilities. The Ministry of Health's updated reference manual on infection prevention and control (IPC) addresses growing concerns about ineffective IPC procedures in healthcare facilities nationwide as well as the need for ongoing readiness and response in the wake of the emergence of emerging and re-emerging infections like the ongoing Covid-19 pandemic. The road map for putting sustainable IPC measures into practice is provided in this document.

In order to implement the policy and guidelines, it is essential to establish a strategy work plan that will act as a road map for all stakeholders (the Ministry, development and implementing partners). This will make it easier to guarantee that we complete IPC and related tasks on schedule and in line with scope. I want to thank the National IPC TWG for their dedication in writing and reviewing this material.

The reference guide was created by taking into account Ethiopian experiences, global best practices, and predetermined suggestions. It is made up of cutting-edge, empirically supported techniques that are extensively employed around the globe to lower the prevalence of healthcare-associated infections and the corresponding healthcare costs. It is anticipated that this reference guide will be useful to health bureaus, programme managers, other stakeholders, and interest groups.

Finally, I want to express my sincere gratitude to all the people and organizations who helped produce and update this reference manual.

Abas Hassen, PhD
Lead Executive Officer
Health System Innovation and Improvement

The National Infection Prevention and Control reference manual for Health Care Settings has been updated through the contributions of many individuals and institutions that are committed to improve the infection prevention and control practice in health care settings.
FMOH would like to especially thank Jhpiego's headquarters and country office. This revised manual is adapted from Jhpiego's Infection Prevention and Control: Reference Manual for Health Care Facilities with Limited Resources, published in 2018. MOH would also like to acknowledge the Medicines, Technologies, and Pharmaceutical Services (MTaPS) program, which is funded by the US Agency for International Development (USAID), for providing financial and technical support for the revision of this document.
MOH would like to thank the National Technical Working Group on Infection Prevention and Control, for their expertise and time to review this national reference manual and everyone who contributed by reviewing and provide technical inputs in the revision of the guideline.

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LIST OF ACRONYMS

ABHR	Alcohol-Based Hand Rub
AFB	Acid-Fast Bacilli
AMR	Antimicrobial Resistance
AORN	Association of periOperative Registered Nurses
APIC	Association for Professionals in Infection Control and Epidemiology
AST	Antimicrobial Susceptibility Testing
3TC	Lamivudine
ARV	Antiretroviral
AZT	Zidovudine
CDC	Centers for Disease Control and Prevention
CJD	Creutzfeldt-Jakob Disease
CMV	Cytomegalovirus
CRE	Carbapenem-Resistant Enterobacteriaceae
CSSD	Central Sterile Supply Department
DHHS	Department of Health and Human Services
DMPA	Depot Medroxyprogesterone Acetate
DNA	Deoxyribonucleic Acid
EC	Exposure Code
EFDA	Ethiopian Food and Drug Administration
EFV	Efavirenez
EPI	Expanded Programme on Immunization
ETO	Ethylene Oxide
EVD	Ebola Virus Disease
FDA	United States Food and Drug Administration
FMOH	Federal Ministry of Health
H_2O_2	Hydrogen Peroxide
HAI	Healthcare-Associated/Acquired Infection
HAV	Hepatitis A Virus
HBeAg	Hepatitis B Envelope Antigen
HBsAg	Hepatitis B Surface Antigen
HBIG	Hepatitis B immune globulin
HBV	Hepatitis B Virus
HCP	Healthcare Provider
HCV	Hepatitis C Virus
HCW	Healthcare Worker
HCWM	Healthcare Waste Management
HLD	High-Level Disinfection
ICU	Intensive Care Unit
IP	Infection Prevention
IPC	Infection Prevention and Control
IUD	Intrauterine Device

IV	Intravenous
MDT	Multi-Disciplinary Team
MERS-CoV	Middle East Respiratory Syndrome-coronavirus
MRN	Medical Record Number
MRSA	Methicillin-Resistant *S. aureus*
MTaPS	Medicines, Technologies, and Pharmaceutical Services
MVA	Manual Vacuum Aspiration
nPEP	Non-Occupational Post-Exposure Prophylaxis
OPA	Orthophthalaldehyde
OSHA	Occupational Safety & Health Administration
PCR	Polymerase Chain Reaction
PEP	Post-Exposure Prophylaxis
PPE	Personal Protective Equipment
ppm	Parts Per Million
PS	Patient Safety
QUAT	Quaternary Ammonium Compound
RNA	Ribonucleic Acid
RSV	Respiratory Syncytial Virus
SARS-CoV	Severe Acute Respiratory Syndrome-Associated Coronavirus
SC	Status Code
SEARO	South East Asia Regional Office
SHEA	Society of Healthcare Epidemiology of America
SOP	Standard Operating Procedure
SSI	Surgical Site Infection
TB	Tuberculosis
TDF	Tenofovir
µm	Micrometer
UP	Universal Precautions
USAID	United States Agency for International Development
UV	Ultraviolet
VHF	Viral Hemorrhagic Fever
VRE	Vancomycin-Resistant Enterococci
WASH	Water, Sanitation, and Hygiene
WHO	World Health Organizatio

n

RATIONALE FOR THE MANUAL

Since the publication of the *Infection Prevention Guidelines for Health Care Facilities in Ethiopia* published in July 2004, and the first edition of the *National Infection Prevention and Patient Safety Guidelines* in 2011 and the second edition in 2012, considerable progress has been made in understanding and implementing evidence-based IPC practices in healthcare facilities. However, the recommended evidence-based global practices are continually modified in response to new scientific findings. As a result, the 2012 edition of the *National Infection Prevention and Patient Safety Guidelines* lacked updated information and were inadequate in some important areas. Moreover, the existing guidelines comprised two vast but interrelated programs (Infection Prevention and Patient Safety). This calls for separating infection prevention (IP) from patient safety (PS), updating the guidelines, and preparing a comprehensive Infection Prevention and Control Reference Manual for Healthcare Facilities in Ethiopia that will provide in-depth information on IPC. The revised manual will be used in conjunction with other guidelines, such as the Ethiopian Hospital Services Transformation Guidelines, National Healthcare Waste Management Guidelines, and other similar documents.

Significant efforts have been made to update information and practical interventions in IPC areas of serious concerns. All chapters in this manual have been revised. Additional topics, such as AMR, prevention of common healthcare-associated/acquired infections (HAIs), IPC in outbreak management, basic surveillance and biostatistics, basic microbiology, IPC in special settings, and other issues, have been included. This manual provides practitioners with the most appropriate recommendations for IPC activities, placing more emphasis on practices and procedures that are applicable to the country.

The manual is divided in two volumes: Volume I covers general IPC and Volume II addresses more advanced IPC and special settings. The document serves as a standardized IPC reference manual for healthcare providers and managers in all government, private, and nongovernmental healthcare delivery systems. It is also an important resource for health educators, trainers, and public health and medical officials. It is likewise relevant to preservice education, group-based training, and on-the-job learning.

The FMOH revitalized the national IPC Advisory Technical Working Group in 2019 under the Medical Services General Directorate. The Advisory Technical Working Group identified gaps in the IPC program and practices and took the initiative to review the existing IP- and PS-related documents to develop this IPC manual.

GLOSSARY

Alcohol-based hand rub (ABHR) is a fast-acting, antiseptic hand rub that does not require water to reduce resident flora, kills transient flora on the hands, and has the potential to protect the skin (depending on the ingredients).

Administrative controls, also known as "work practice controls," are changes in work procedures, such as written policies, rules, protocols, supervision, schedules, and training, with the goal of reducing the duration, frequency, and severity of exposure to hazardous situations and substances (e.g., blood, body fluids, and chemicals).

Airborne transmission is the spread of an infectious agent carried through the air by particles smaller than five micrometers (µm) in size.

Antibody is a microscopic structure, called an immunoglobulin, produced by the immune system, which is the system that defends the body from infection. Antibodies can be found in blood and other body fluids.

Antigens are foreign molecules, such as toxins, viruses, or bacteria that stimulate the body's immune system to produce antibodies.

Antimicrobial resistance occurs when microorganisms, such as bacteria, viruses, fungi, and parasites, develop ways to avoid the effects of medications used to treat infections (such as antibiotics, antivirals, and antifungals), and pass these changes on to their offspring, or in some cases to other bacteria via plasmids. Mechanisms can include the production of substances that inactivate the drug, an alteration in cell structure that prevents the drug from binding with the cell, or the ability to pump the drug out of the cell. Resistance develops by changes in existing genes or by acquisition of new genes (such as from plasmids).

Antimicrobial susceptibility testing (AST) measures the activity of one or more antimicrobial agents against a microorganism isolated from a sample to determine potential susceptibility or resistance to antimicrobials. It helps the prescriber determine which antimicrobial will be most successful in treating a patient with a specific infection. The type and extent of the AST conducted depends on the organism isolated, the source of the culture (body site), available antimicrobial agents, and typical susceptibility patterns.

Antiseptic agents or antimicrobial soap (terms used interchangeably) are chemicals applied to the skin or other living tissue to inhibit or kill microorganisms (both transient and resident). These agents, which include alcohol (ethyl or isopropyl), dilute iodine solutions, iodophors, chlorhexidine, and triclosan, are used to reduce the total bacterial count.

Antiseptic handwashing is washing hands with soap and water or with products containing an antiseptic agent.

At point of use: equipment, instruments, and supply items are at the place where needed (e.g., sharps containers are placed within arm's reach of where injections are being given).

Bioburden is the population of viable microorganisms on devices, instruments, equipment, or products. When measured, bioburden is expressed as the total count of bacterial and fungal colony-forming units per single item.

Biofilm is an accumulated, thin layer of bacteria and extracellular material that tightly adheres to surfaces (e.g., skin drains, urinary catheters) and cannot be easily removed. The presence of biofilm can increase the resistance of the bacteria to antimicrobial drugs, and reduce the effectiveness of disinfectants and sterilization because the products cannot penetrate the surface.

Bloodborne pathogens are infectious microorganisms (bacteria, viruses, and other microorganisms) contained in blood and other potentially infectious body fluids (including urine, respiratory secretions, cerebrospinal, peritoneal, pleural, pericardial, and synovial amniotic fluids, semen, vaginal secretions, breast milk, and saliva). The pathogens of primary concern are HBV, HCV, and HIV.

Clean water is natural or chemically treated or filtered water that is safe to drink and use for other purposes (e.g., handwashing and general medical use) because it meets national public health standards and WHO guidelines for drinking-water quality.

Cleaning is the removal of visible dirt (e.g., organic and inorganic material) from objects and surfaces, normally accomplished manually or mechanically, using water with detergents or enzymatic cleaners. Cleaning is required before high-level disinfection (HLD) or sterilization because tissue, blood, body fluids, dirt, and debris reduce the effectiveness of these processes.

Cleaning solution is any combination of soap (or detergent) and water, with or without a chemical disinfectant, used to wash or wipe down surfaces, such as floors, chairs, bench tops, walls, and ceilings (environmental surfaces).

Medical instruments cleaning: The first step required to physically remove contamination by a foreign material. It will also remove organic matter, such a blood and microorganisms, to prepare a surgical instrument or equipment for disinfection or sterilization.

Cohorting is the practice of placing patients with the same infectious disease (e.g., measles, influenza) or colonization (e.g., multidrug-resistant organisms) but no other infection, in proximity (e.g., the same room, the same ward, or the same area of a ward).

Colonization: The presence of pathogenic (illness or disease-causing) organisms in a person or animal in abundance (i.e., they can be detected by cultures or other tests) usually without causing symptoms or clinical findings (i.e., they do not invade tissues, cause cellular changes, or cause damage). In other words, it is the appearance or increased number of a particular invasive bacterial species in the resident microflora.

Colonized persons can be a major source of the transfer of pathogens to other people. For example, *Neisseria meningitides* colonize the nasal cavity and oropharynx with or without causing subsequent infections. *Entamoeba histolytica* can colonize the large bowel without any harm to the host but are often shed in the stool as infectious cysts, which may cause dysentery.

Colony (bacterial colony) is a cluster of identical microorganisms growing on the surface of or within a solid medium, presumably cultured from a single cell.

Combustible wastes are those that can be burned or will easily catch on fire. They include paper, cardboard, and used dressings, gauze, and some liquids and gases.

Contact time is the length of time a cleaning product must remain wet on the surface being cleaned for the disinfectant to kill the targeted microorganisms. Time of contact varies depending on the type of cleaning product and the targeted microorganism (e.g., bacteria, viruses, mycobacteria, spores). For use in healthcare facilities, the contact time for the organism that is most difficult to kill is routinely adopted.

Contact transmission occurs when infectious agents/pathogens (e.g., bacteria, viruses, fungi, parasites) are transmitted directly or indirectly from one infected or colonized individual to a susceptible host. This can occur through physical contact (e.g., touching) with the infected individual or with contaminated equipment/environmental surfaces. Infectious agents/pathogens can often survive on physical surfaces from several hours up to several months.

Cytotoxic waste contains by-products of drugs that kill dividing cells, used for treatment of certain cancers. It also includes waste materials that can damage human genes (e.g., DNA) and may cause cancers or congenital deformities in babies. This waste can include any items exposed to these drugs, including sharps, personal protective equipment (PPE), and body fluids.

Decontamination: Removes soil and pathogenic microorganisms from objects so that they are safe to handle, subject to further processing, use, or discard.

Detergent (term is used interchangeably with soap) is a cleaning product (e.g., bar, liquid, leaflet, or powder) that lowers surface tension of water, thereby helping to remove dirt and debris. Plain soaps do not claim to be antimicrobial on their label and require friction (i.e., scrubbing) to mechanically remove microorganisms. Antiseptic (antimicrobial) soaps do kill or inhibit the growth of some microorganisms, but not all.

Disease is any deviation from being healthy or the interruption of the normal structure or function of any body part, organ, or system manifested by a characteristic set of symptoms and signs whose etiology, pathology, and prognosis may be known or unknown.

Disinfectant cleaning solution is a product that is a combination of detergent (soap) and a chemical disinfectant. It is true that not all detergents and disinfectants are compatible. However, there is still a range of several combinations, such as alkaline detergents with chlorine compounds, alkaline detergents with quaternary ammonium compounds (QUATs) or other nonionic surfactants, and acid detergents with iodophors that are available commercially or can be prepared.

Disinfectant is a chemical that destroys or inactivates microorganisms on inanimate (non-living) objects. Disinfectants are classified as low-, intermediate-, or high-level depending on their ability to kill or inactivate *some* (low- or intermediate-level) or *all* (high-level) microorganisms. Although disinfectants may kill all microorganisms, they do not kill all spores. Commonly used disinfectants

for low-, intermediate-level cleaning include phenols, chlorine, or chlorine-containing compounds, and QUAT and H_2O_2. These classes of disinfectants are often used to clean frequently touched surfaces in healthcare facilities.

Disposal is the final step in healthcare waste management. It entails the intentional treatment of waste to render it harmless, followed by burial, deposit, discharge, dumping, placement, or release of waste material into the air or water or onto/into land. It is undertaken without the intention of retrieval/reuse.

DNA, deoxyribonucleic acid, is the hereditary material for all living organisms; it contains the instructions that make each type of living creature unique. DNA is the substance in the genes that is organized into the chromosomes in the cells, determines particular characteristics, and allows these characteristics to be passed from parents to offspring.

Droplet nuclei are small particles involved in airborne transmission of pathogen-containing respiratory secretions expelled into the air by coughing. They are reduced by evaporation to small, dry particles that can remain airborne for long periods of time and distance.

Droplet transmission occurs when infectious droplets larger than five μm in size are spread and land directly on or come in contact with a susceptible host's mucous membranes of the nose or mouth or conjunctivae of the eye. Droplets can be produced by coughing, sneezing, talking, or during procedures (e.g., bronchoscopy or suctioning). Due to their size, particles remain airborne briefly and can travel about one meter (three feet) or less. Droplet transmission requires close proximity or contact between the source and the susceptible host. Droplets may also land on surfaces and then be transferred by contact transmission.

Emollient is an organic agent (e.g., glycerol, propylene glycol, or sorbitol) that is added to ABHR to soften the skin and help prevent skin damage (e.g., cracking, drying, irritation, and dermatitis) that is often caused by frequent hand hygiene.

Empiric in the context of health services refers to an action, intervention, or practice being implemented on the basis of a clinical educated guess, based on experience and in the absence of laboratory test results for specific diagnosis. The empiric action, intervention, or practice is continued until the definitive diagnosis is made.

Empowerment: WHO defines empowerment as a process through which people gain greater control over decisions and actions affecting their health and should be seen both as an individual and a community process.

Encapsulation is a process used when other options for safe disposal are not available. It involves surrounding hazardous waste with an immobilizing agent in sealed, solid waste containers to reduce the likelihood of future environmental, scavenger, or human contact with waste.

Endogenous infection is caused by organisms normally present in an individual's body (normal flora or colonizing organisms).

Engineering controls are methods that are built into the design of the environment, equipment, or a process to minimize the hazards associated with use. An example is a medical device or piece

of equipment that limits exposure to bloodborne pathogens in the workplace, such as sharps disposal containers, self-sheathing needles (a barrel or cover that automatically slides over the needle and locks in place once the needle has been removed from the patient), sharps with injury protection, and needleless systems.

Environmental cleaning in healthcare facilities refers to the general cleaning of surfaces and equipment to reduce the number of microorganisms present, and providing a clean and pleasant atmosphere.

Environmental controls are activities of keeping **s**tandards specifying procedures to be followed for the routine care, cleaning, and disinfection of surfaces, beds, bedrails, bedside equipment, and other frequently touched surfaces.

Exogenous infection is caused by organisms from a source outside the individual's body.

Exposed person is the person who is potentially at risk of acquiring HIV infection (and or infection from other pathogens) through exposure to blood or body fluids in his or her occupation or in another non-occupational situation.

Foodborne or waterborne illness is any disease of an infectious or toxic nature caused by ingestion of food or water.

Frequently touched surfaces are surfaces in patient care areas in the healthcare facility with frequent hand contact. These surfaces include door handles, light switches, countertops, bedrails and ends of beds, patient charts, tap handles, handrails, toilet flushes, rounding and medical trolleys/carts, buttons on monitors, telephones, and call bells.

General waste does not pose any particular biological, chemical, radioactive, or physical hazard (e.g., paper boxes, newspapers, magazines, polyethylene bottles, polyester bags, wood, other papers, metals [e.g., aluminum cans and containers], high-density polyethylene [e.g., milk containers, saline bottles], glass, and construction/demolition materials).

HAI is an infection that occurs in a patient as a result of care at a healthcare facility and was not present at the time of arrival at the facility. To be considered an HAI, the infection must begin on or after the third day of admission to the healthcare facility (the day of admission is Day 1) or on the day of or the day after discharge from the facility. The term "healthcare associated/acquired infection" replaces the formerly used "nosocomial" or "hospital" infection because evidence has shown that these infections can affect patients in any setting where they receive healthcare.

Hand disinfection is a term that WHO does not recommend using because disinfection normally refers to the decontamination of non-living surfaces and objects.

Hand hygiene is the process of removing soil, debris, and microbes by cleansing the hands using soap and water, ABHR, antiseptic agents, or antimicrobial soap.

Handwashing is the process of mechanically removing soil, debris, and transient flora from the hands using soap and clean water.

Hazard: Anything (e.g., condition, situation, practice, behavior) that has the potential to cause harm, including injury, disease, death, environmental, property and equipment damage. A hazard can be a thing or a situation.

Hazardous waste is waste that can pose a health risk to HCWs, patients, and other people who are exposed to it. It includes both chemical/radioactive and infectious healthcare waste, for example, sharps, pathological waste, pharmaceutical waste, and cytotoxic, chemical, and radioactive waste.

Healthcare worker (HCW), in this manual, is someone who works in a healthcare facility, and provides healthcare and services to people, either directly or indirectly, such as a clinician, nurse, midwife, aide, helper, laboratory or x-ray technician, cleaner, or waste handler.

Healthcare textiles are made from woven textile materials, either natural or synthetic fibers, or a mix of fibers, and material prepared from non-woven fibers. These textiles can be either single-use or reusable items, and are used to make uniforms, PPE, surgical drapes, bed sheets, and other items. They are generally referred to as textiles in healthcare facilities.

Healthcare wastewater is any water that has been adversely affected in quality during the provision of healthcare services. It is mainly liquid waste containing some solids produced by staff and patients (i.e., human excrement) or during healthcare-related processes, or cooking, cleaning, and laundering at the healthcare facility. This type of wastewater poses risks similar to those of domestic wastewater, which is considered infectious. However, healthcare facilities (depending on the services offered) also generate wastewater that poses a higher risk, containing chemicals, pharmaceuticals, contagious microorganisms, and radioactive substances.

Healthcare-associated diarrhea is diarrhea that begins on or after the third calendar day of hospitalization (the day of hospital admission is Day 1).

Healthcare-associated infection is an infection that occurs in a patient as a result of care at a healthcare facility and that was not present at the time of arrival at the facility. To be considered an HAI, the infection must begin on or after the third day of admission to the healthcare facility (the day of admission is Day 1) or on the day of or the day after discharge from the facility. The term “healthcare-associated infection” replaces the formerly used “nosocomial” or “hospital” infection because evidence has shown that these infections can affect patients in any setting where they receive healthcare.

High-level disinfection is a process that kills all microorganisms but not necessarily high numbers of bacterial spores. HLD is achieved by soaking items in liquid chemicals classified as HLDs or by boiling or steaming for the appropriate time (20 minutes).

Incineration is one method of waste disposal and involves controlled burning of solid, liquid, or gaseous combustible wastes that result in inorganic, non-combustible residue.

Infection is an invasion and multiplication of microorganisms in body tissues that may be clinically apparent or result in local cellular injury due to competitive metabolism, toxins, intracellular replication, or antigen antibody response.

Infection prevention and control refers to scientifically sound practices aimed at preventing harm caused by infection to patients, health workers, and the community. It is a systematic effort or process of placing barriers between a susceptible host (a person lacking effective natural or acquired protection) and infectious agents. IPC is used interchangeably with IP in this manual.

Infectious microorganisms are microorganisms capable of producing disease in the appropriate hosts. They are also called infectious agents, pathogens, or pathogenic agents interchangeably in this manual.

Infectious waste is waste that is potentially contaminated with blood, body fluids, or pathogenic organisms, including, but not limited to, laboratory cultures, microbiological stocks, excreta, and items soiled with blood or body fluids.

Injection safety is a set of techniques used to perform injections in an optimally safe manner for patients and HCWs during patient care.

Instrument processing areas are places anywhere in the healthcare facility where soiled instruments, equipment, and other items are cleaned and processed by means of either HLD or sterilization.

Intermediate-level disinfection is a process that destroys all vegetative bacteria, including tuberculosis bacilli, all fungi, and most viruses (except some non-lipid viruses) but not bacterial spores. Intermediate-level disinfection is carried out using chemicals that have been approved as intermediate-level disinfectants or those that are approved as "tuberculocidal" in the national IPC guidelines.

Log10 reduction and kill rate is a quantitative (calculable) measurement describing the percentage of contaminants killed during instrument processing procedures. 1 log10 reduction means a 90% reduction in microbes on a given surface. For example, if there are 1 million microbes on a surface, 1 log10 reduction or kill rate will remove 90% of 1 million microbes, 2 log10 reduction or kill rate will remove 99% of microbes, and 5 log10 reduction or kill rate will remove 99.999%. Therefore, a 6 log10 reduction or kill rate will remove 99.9999% of microbes, which means that only 1 microbe will survive at the end of the procedure that has a kill rate of 6 log10 reductions.

Low-level disinfection is a process that destroys all vegetative bacteria (except tuberculosis bacilli), lipid viruses, some non-lipid viruses, and some fungi, but not bacterial spores. Low-level disinfection is carried out using chemicals that have been approved to achieve low-level disinfection.

Microorganisms are any living organisms, such as bacteria, protozoa, or fungi that cannot be seen with the naked eye. Microorganisms can only be viewed through a microscope.

Multi-dose vial is a vial of liquid medication intended for parenteral administration (injection or infusion) that the manufacturer has prepared to contain more than one dose of a medication. Multi-dose vials are labeled as such by the manufacturer and typically contain an antimicrobial

preservative to help prevent the growth of bacteria. The preservative has no effect on viruses and does not protect against contamination when HCWs fail to follow safe injection practices.

Municipal waste is general waste that is generated mainly by households, commercial activities, and street-sweeping. Ideally, it is collected by municipalities (e.g., local villages or cities) but in some locations this service is not available.

Non-critical items, for the purposes of cleaning and disinfection, are items that come into contact with intact skin but not with mucous membranes (e.g., blood pressure cuffs, stethoscopes, and crutches). Most can be cleaned and disinfected at the point of use using a low-level disinfectant.

Nonoccupational exposure is an exposure to HIV and other bloodborne pathogens outside the work setting. This term predominantly refers to potential exposure through sexual assault. Other forms of potential non-occupational exposure include those arising from needle-sharing among injecting drug users, consensual sex, needle sticks in the community, fights or playground incidents resulting in bleeding by an HIV-infected child, and mass causalities, such as road traffic accidents, etc.

Normal flora/commensal bacteria are microorganisms (usually bacteria and fungi) that are naturally present in and on healthy people (e.g., on the skin or in the gut, or reproductive or respiratory tract).

Occupational exposure is the exposure of an HCW to an infection while providing care and treatment services to patients in a healthcare facility.

Occupational health activities include all aspects of work-related health and safety activities, including prevention. The term refers in particular to activities that address infectious hazards at healthcare facilities.

Occupational health is the discipline that deals with all aspects of work-related health and safety and has a strong focus on prevention; it is also known as employee health.

Occupational health surveillance is the collection, analysis, and dissemination of data on hazards that have endangered or may endanger HCWs.

Occupational infection is an infection contracted as a result of an exposure to risk factors arising from work activity.

Occupational injury or infection is an injury or infection acquired by healthcare staff while performing their normal duties.

Operating room is an area or space where surgical procedures are performed.

Opportunistic infection is an infection caused by a microorganism that under normal circumstances does not cause disease but becomes pathogenic when the body’s immune system is impaired and unable to fight off infection, or antibiotic therapy allows for overgrowth of some microorganisms (such as yeast in the gastrointestinal and reproductive tracts).

Pasteurization is a disinfection process that uses hot water at temperatures of 65–77 °C (149–170.6 °F) for a contact time of at least 30 minutes to kill or markedly reduce the number of microorganisms other than bacterial spores.

Patient/client education is defined as a systematized process of transfer of knowledge, skills, and attitudes that empower the patient, family, caregiver, and community to actively participate in the promotion and maintenance of a safe healthcare facility environment.

Persistent activity is prolonged or extended protective activity that prevents the growth or survival of microorganisms after application of an antiseptic; it is also called "residual" activity.

Plasmids are genetic structures in a cell, typically a small, circular DNA strand in the cytoplasm of a bacterium or protozoan independent of the chromosomes. They are relevant for IPC because they enable AMR to pass from one genus of bacteria to another.

Point of care is the place where three elements come together: the patient, the HCW, and the care or treatment involving contact with the patient or the surrounding environment. The concept embraces the need to perform hand hygiene at recommended moments exactly where care delivery takes place. This requires that a hand hygiene product (e.g., ABHR) be easily accessible and as close as possible—within arm's reach—to where patient care or treatment is provided.

Point of use refers to a place and time where equipment, instruments, and supplies are used on patients (e.g., the patients' bedsides, procedure rooms, delivery rooms, operating theaters).

Polymerase chain reaction (PCR) is a type of molecular test in which genetic material (DNA/RNA) is extracted from the sample and through complex techniques is duplicated or amplified until there is a large enough amount to test the DNA, RNA, or protein sequences and identify specific microorganisms.

Post-exposure prophylaxis (PEP) is a preventive medical treatment for which a person may qualify following potential exposure to a disease-causing pathogen, such as HIV or HBV, to prevent becoming infected.

PPE items are the protective barriers and respirators used alone or in combination by a HCW to protect mucous membranes, airways, skin, and clothing from contact with harmful or infectious agents. PPE may also be used on an infectious patient to prevent the spread of infectious agents (e.g., surgical mask worn by a patient during transport to control the spread of illness).

Procedure areas are areas where patients are examined and patient care procedures (e.g., pelvic examinations, wound care management, blood drawing, immunizations, IUD insertions and removals, and normal childbirth) are performed.

Protective barriers are physical, mechanical, or chemical processes that help prevent the spread of infectious agents from person to person (patient, healthcare client, or health workers) and/or equipment, instruments, and environmental surfaces to people.

Residence time is the time that it takes between the entry of a waste substance into a furnace or incinerator and the exit of exhaust gases or burn-out residue from the furnace or incinerator.

Resident flora are microorganisms that live in the deeper layers of the skin and in hair follicles, and they cannot be completely removed, even by vigorous washing and rinsing with plain soap and clean water. In most cases, resident flora are not likely to be associated with infections; however, the hands or fingernails of some HCWs can become colonized by microorganisms that do cause infection (e.g., *Staphylococcus aureus,* gram-negative bacilli, or yeast), which can be transmitted to patients.

Respirator fit testing is a test protocol conducted to verify that a respirator is both comfortable and correctly fits the user without leakage. Fit testing uses a test agent, either qualitatively detected by the wearer's sense of taste, smell, or involuntary cough (irritant smoke), or quantitatively measured by an instrument to verify the respirator's fit. The benefits of this testing include better protection for the HCW/user and verification that the user is wearing a correctly fitting model and size of respirator.

Respiratory hygiene/cough etiquette are measures taken to prevent transmission of respiratory infections, including influenza, in healthcare facilities. They involve maintaining at least a one-meter (three-foot) distance from other individuals in common waiting areas, covering the mouth/nose when sneezing/coughing, performing hand hygiene after soiling hands with respiratory secretions, and placing visual alerts to remind HCWs, patients, and visitors to practice respiratory hygiene and cough etiquette.

Risk: The likelihood or possibility that harm (injury, illness, death, damage, etc.) may occur from exposure to a hazard.

RNA, ribonucleic acid, is present in all living cells and many viruses. RNA molecules are involved in protein synthesis and sometimes in the transmission of genetic information.

Safe injection is one that does not harm the recipient, does not expose the HCW to any avoidable risks, is provided by a skilled person using appropriate injection equipment, and does not result in waste that is dangerous for the community.

Sanitary landfill is an engineering method used for disposing of solid waste on land in a manner that protects the environment (e.g., by spreading the waste in thin layers, compacting it to the smallest practical volume, and then covering it with soil at the end of each workday).

Sanitizer is a chemical that reduces the number of bacterial contaminants on inanimate objects to safe levels based on public health requirements (i.e., a chemical that kills 99.999% of the specific test bacteria in 30 seconds under the conditions of the test). It is used in food service but not for cleaning surfaces in healthcare facilities.

Scrubbing (frictional cleaning) is the vigorous rubbing of a surface with a brush or other tool. This is the best way to physically remove dirt, debris, and microorganisms.

Seal check is a procedure conducted by the wearer of a particulate respirator to determine whether the respirator is properly sealed to the face. The user seal check can be either a positive pressure check (i.e., breathing out to check for leak on exhalation), or negative pressure check (i.e., breathing in to check for leak on inhalation), or both.

Sewerage is the system for the collection and transport of human excrement and accompanying water used in toilet systems (sewage). The system includes conduits (channels), pipes (sewers), and pumping stations.

Sharps are instruments, needles, and any other objects that can easily penetrate through the skin.

Sharps injuries are injuries from a "sharp" penetrating the skin. "Sharps" include syringe needles, scalpels, broken glass, and other objects that may be contaminated with blood or body fluids. These injuries potentially expose HCWs to infections from bloodborne pathogens.

Sharps injury prevention strategies are measures taken to prevent injuries when handling sharps. These measures include elimination of hazards, and the use of engineering controls, administrative controls, workspace practices, and PPE.

Sharps safety and needle safety are procedures used to handle needles and other sharp devices in a manner that will prevent injury and exposure from infectious agents during routine patient care.

Sharps waste includes used or unused sharps (e.g., hypodermic, intravenous, or other needles, auto-disable syringes, syringes with attached needles, infusion sets, scalpels, pipettes, knives, blades, and broken glass).

Single-use or single-dose vial is a vial of liquid medication intended for parenteral administration (injection or infusion) that is meant for use in a single patient for a single case/procedure/injection. Single-use or single-dose vials are labeled as such by the manufacturer and do not contain antimicrobial preservative.

Soap (term is used interchangeably with detergent) is a cleaning product (e.g., bar, liquid, leaflet, or powder) that lowers surface tension of water, thereby helping to remove dirt and debris. Plain soaps do not claim to be antimicrobial on their labels and require friction (i.e., scrubbing) to mechanically remove microorganisms. Antiseptic (antimicrobial) soaps kill or inhibits the growth of most microorganisms.

Soaps and **detergents (terms used interchangeably)** are cleaning products (bar, liquid, leaflet, or powder) that lower surface tension, thereby helping remove dirt, debris, and transient microorganisms from hands, utensils, equipment, etc.

Soiled or contaminated textile is a cloth item coming from multiple sources in a hospital or clinic that has been collected and brought to the laundry for processing.

Sorting is a process of inspecting and removing foreign and, in some cases, dangerous objects (e.g., sharps or broken glass) from soiled textiles before washing. This step is extremely important because soiled textiles from the operating room or clinic have occasionally been found to contain sharps (e.g., scalpels, sharp-tipped scissors, hypodermic and suture needles, and towel clips).

Source person is the person who is (either identified or not identified as) the possible source of contamination through potentially infectious blood or body fluid. If the serostatus of the source

person is unknown, he or she may be asked to provide informed consent to HIV testing. The source person may be a patient if an HCW is the one who is exposed (in occupational exposure).

Species refers to the taxonomic/biological classification system of microorganism; all species have a two-part name, called a binomial (e.g., *Staphylococcus aureus*). The first name is the generic name— genus—(e.g., *Staphylococcus*), the second name is the species (e.g., *aureus*), based on structural and biochemical characteristics. A species can have different strains and subgroups that can cause different diseases. Some organisms of medical interest are classified below the species level, based on their characteristics (e.g., *Escherichia coli* O157:H7, a strain that produces Shiga-like toxin).

Staining is a technique that uses dyes to color the cell wall of bacteria to quickly identify it in a broad group of bacteria. Staining methods involve fixing bacteria cells to a glass slide and then staining and washing them with a dye and alcohol. The differing characteristics of a microorganism's cell wall cause the stain to be retained in the cell or not, resulting in color changes. For example, Gram stain is used to differentiate bacteria into two groups, gram positive and gram negative; acid-fast stain is used to identify *Mycobacterium tuberculosis*.

Standard precautions are a set of infection control practices used for every patient encounter to reduce the risk of transmission of bloodborne and other pathogens from both recognized and unrecognized sources. They are the basic level of infection control practices to be used, at a minimum, in preventing the spread of infectious agents to all individuals in the healthcare facility.

Sterilants are chemicals used to destroy all forms of microorganisms, including endospores. Most sterilants are also HLDs when used for a shorter period of time. These chemicals are applied only on inanimate objects (e.g., surgical instruments) that are used in semi-critical and critical areas (e.g., surgery). It should be noted that they are not meant to be used for cleaning environmental surfaces.

Sterilization: A process that eliminates all microorganisms (bacteria, viruses, fungi, and parasites), including bacterial endospores, from inanimate objects by high-pressure steam (autoclave), dry heat (oven), chemical sterilization, or radiation.

Strain is a variation in members of the same bacterial species. For treatment and epidemiology, it may be helpful for clinical laboratories to distinguish between strains in the same species. For example, some strains of *E. coli* are harmless and play an important role in the human intestinal tract, but other strains can cause diarrhea. Tests, such as PCR, can identify strains.

Surfactant is an agent that reduces the surface tension of water, or the tension at the interface between water and another liquid, and a wetting agent found in many sterilants and disinfectants.

Surgical hand preparation refers to the protocol used preoperatively by surgical teams to eliminate transient flora and reduce resident skin flora. The process involves an antiseptic handwash or antiseptic hand rub and rubbing/scrubbing for specific amounts of time using specific techniques before putting on gloves. Antiseptics used for surgical hand preparation often have persistent antimicrobial activity.

Surgical hand scrub refers to surgical hand preparation with antimicrobial soap and water.

Surgical unit is a whole surgical area including lockers and dressing rooms; preoperative and recovery rooms; peripheral support areas, including storage space for sterile and high-level disinfected items; other consumable supplies and corridors leading to restricted areas; the operating room(s); scrub sink areas; and the nursing station.

Syndromic approach is an approach that bases preventive actions on a set of signs and symptoms that are suggestive of a clinical condition rather than a specific diagnosis. The symptoms could be related to multiple systems or organs.

Terminal or discharge cleaning is the process used to clean a patient's room after the patient has been discharged or transferred or to clean patient treatment areas, including operating theaters at the end of the day.

Textiles are cloth items used in healthcare facilities by housekeeping staff (bedding and towels), cleaning staff (cleaning cloths, gowns, and caps), and surgical personnel (caps, masks, scrub suits, surgical gowns, drapes, and wrappers) and staff of specialty units, such as intensive care units (ICUs) and other units, performing invasive medical procedures (e.g., anesthesiology, radiology, or cardiology).

Transient flora are microorganisms acquired through contact with individuals or contaminated surfaces during the course of normal, daily activities. They live in the upper layers of the skin and are more amenable to removal by hand hygiene. They are the microorganisms most likely to cause HAIs.

Transmission-based precautions are the second tier of basic infection control and are to be used in addition to standard precautions for patients who may be infected or colonized with certain infectious agents for which additional precautions are needed to prevent infection transmission.

Vaccine-preventable diseases are infectious diseases for which effective vaccines are available. They include but are not limited to HAV and HBV, influenza, measles, mumps, rubella, tetanus, diphtheria, pertussis, and varicella (chicken pox).

Waste management includes all activities—administrative and operational (including transportation activities)—involved in the handling of waste: generation, collection, transport, storage, and disposal of waste.

Waste segregation is the systematic separation of healthcare waste into designated categories according to the type of composition and hazards to enhance the safety and efficiency of waste handling and disposal.

Water-based diseases are those transmitted through aquatic vectors (such as schistosomiasis).

Waterborne diseases are those transmitted through drinking water contamination (such as typhoid, cholera, gastroenteritis, etc.).

Water-related diseases are those spread by insects that depend on water (malaria and yellow fever).

Water-washed diseases are those diseases caused by the shortage of adequate water for personal hygiene.

CHAPTER 1: INTRODUCTION TO INFECTION PREVENTION AND CONTROL

Key Topics

- Goal of IPC
- WHO core components of IPC
- The infection chain/cycle and breaking the chain of infection
- Introduction to HAIs
- Background on standard precautions and transmission-based precautions
- Background on clean and asepsis techniques

BACKGROUND

IPC is essential for the delivery of safe and quality healthcare services. Infections are a major health threat globally. They can affect anyone. HCWs have a critical role to play in the prevention and control of infections at all levels of care. The nature of their work increases their chances of acquiring or transmitting infectious agents. In healthcare settings, the risk for infection is usually high due to such factors as the presence of a wide range of infectious agents (including resistant strains) from various sources, the weakened immunity of patients, and invasive and other high-risk procedures. HAIs are the most frequent adverse events in healthcare delivery systems worldwide. They are a major cause of preventable diseases, deaths, and greater healthcare costs. The application of evidence-based IPC practices in all healthcare settings is key. The remainder of this chapter introduces readers to the basic principles of IPC, with the aim of laying the foundation for the chapters in the rest of the manual.

Goal of Infection Prevention and Control

The goal of IPC is to make healthcare facilities safe for all, including patients, clinical and non-clinical staff of healthcare facilities, and the community.

WHO Core Components of Infection Prevention and Control

The effective implementation of IPC practices in healthcare facilities requires that appropriate strategic interventions are put in place. WHO has provided guidance on core components for IPC interventions, which are summarized in table 1.1.

A comprehensive and effective approach to IPC consists of establishing IPC programs with strong links to other national programs, for example, those addressing quality and safety and AMR. The existence of an IPC program is a necessary, but not a sufficient, condition to achieve safe and high-quality healthcare. At the facility level, an adequately built environment (including the necessary infrastructure, materials and equipment, appropriate inpatient service, adequate human resources or staffing and workload) represents the foundation enabling the implementation of all other core components and the achievement of safe practices. These two prerequisites—a well-organized and

established IPC program and an adequately built environment and IP supplies—support the effective implementation of IPC guidelines, training and education, program monitoring, audit, feedback, and surveillance. Implementation success in each of these areas also depends on the adoption of a multimodal approach, that is, a strategy consisting of several elements implemented in an integrated way with the aim of improving an outcome and changing behavior.

WHO's core components of an IPC program at the healthcare facility level comprises the following eight core components. The first six are especially relevant for the national level, whereas all eight components apply to healthcare facilities.

Table 1.1. WHO core components of IPC

S. No.	Component	Recommendation
1	IPC programs	An IPC and PS program with a dedicated, trained team should be in place in each acute healthcare **facility** for the purpose of preventing HAIs and combating AMR through IPC good practices. Standalone, active **national** IPC programs with clearly defined objectives, functions, and activities for the purpose of preventing HAIs and combating AMR through IPC good practices should be established. National IPC programs should be linked to other relevant national programs and professional organizations.
2	Evidence-based guidelines	Evidence-based guidelines should be developed and implemented for the purpose of reducing HAIs and AMR. Education and training of the relevant HCWs on guideline recommendations and monitoring of adherence with guideline recommendations should be undertaken to achieve successful implementation.
3	Education and training	At the **facility** level, IPC education should be in place for all HCWs by using team and task-based strategies that are participatory and include bedside and simulation training to reduce the risk of HAIs and AMR. The **national** IPC program should support education and training of the health workforce as one of its core functions.
4	HAI surveillance	Facility-based HAI surveillance should be performed to guide IPC interventions and detect outbreaks, including AMR surveillance, with timely feedback of results to HCWs and stakeholders and through national networks. **National** HAI surveillance programs and networks that include mechanisms for timely data feedback and with the potential to be used for benchmarking purposes should be established to reduce HAIs and AMR.
5	Multimodal strategies	At the **facility** level, IPC activities should be implemented using multimodal strategies to improve practices and reduce HAIs and AMR. **National** IPC programs should coordinate and facilitate the implementation of IPC activities through multimodal strategies at the national or subnational level.

S. No.	Component	Recommendation
6	Monitoring and audit of IPC practices and feedback	Regular monitoring/audit and timely feedback of healthcare practices should be undertaken according to IPC standards to prevent and control HAIs and AMR at the healthcare facility level. Feedback should be provided to all audited persons and relevant staff. A **national** IPC monitoring and evaluation program should be established to assess the extent to which standards are being met and activities are being performed according to the program's goals and objectives. Hand hygiene monitoring with feedback should be considered as a key performance indicator at the national level.
7	Workload, staffing and bed occupancy (for facility level)	To reduce the risk of HAIs and the spread of AMR, the following should be addressed: (1) Bed occupancy should not exceed the standard capacity of the facility. (2) HCW staffing levels should be adequately assigned according to patient workload.
8	Built environment, materials, and equipment for IPC (for facility level)	At the **facility** level, patient care activities should be undertaken in a clean and/or hygienic environment that facilitates practices related to the prevention and control of HAIs and AMR, including all elements around the water, sanitation, and hygiene (WASH) infrastructure and services, and the availability of appropriate IPC materials and equipment. At the **facility** level, materials and equipment to perform appropriate hand hygiene should be readily available at the point of care.

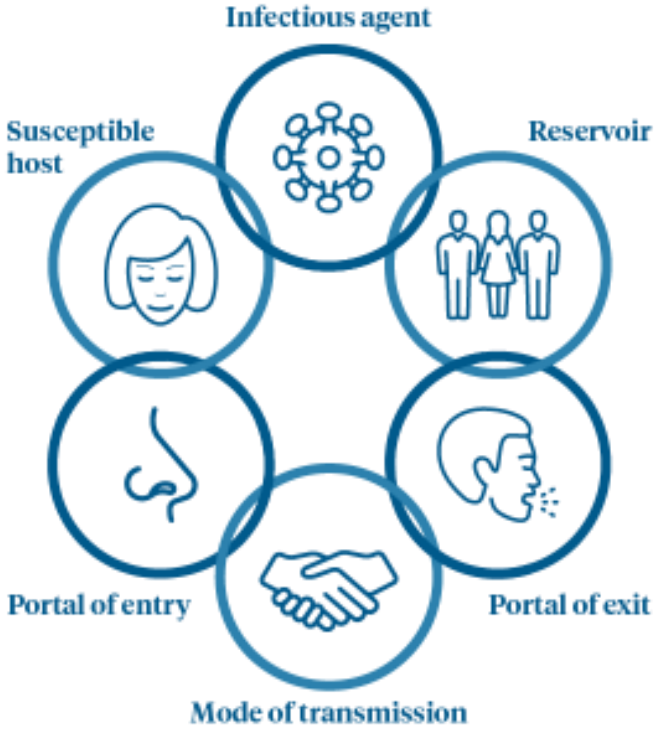
Source: WHO 2016

The Infection Chain/Cycle

All humans are susceptible to infections due to some bacteria and most of the viral agents and other infectious agents. These disease-causing organisms are also called pathogens. The number (dose) of organisms necessary to produce infection in a susceptible host varies with the location. All of us touch materials that contain some organisms every day but suffer from no infection because organisms coming into contact with the intact skin are unlikely to cause such risk. Nevertheless, when these organisms come into contact with mucous membranes or non-intact skin, the chance of the risk of infection increases. Infection risk increases greatly when organisms come into contact with normally sterile body sites. In such cases, the introduction of only few organisms may produce disease.

Health workers have a responsibility to prevent and control infections, including HAIs; however, it is essential to understand how the infections spread to apply appropriate preventive measures. For infectious agents to successfully survive and spread, certain factors or conditions must be present; these are illustrated as the components or elements of the chain of infection (figure 1.1). If any of the links or components of the chain are absent or removed, an infection cannot occur. This interruption of the "chain" is commonly referred to as "breaking the chain of infection." These concepts are illustrated in figure 1.1.

Figure 1.1 The infection chain



Source: "McKesson Medical-Surgical Inc.2021"

Key Elements of the Chain Infection

The following elements are required, in sequential order, for an infection to occur and spread, as shown in the infection chain illustration in figure 1.1:

1. **Infectious Agent:** These are disease-causing organisms, including bacteria, virus, fungus, parasites, etc.
2. **Reservoir:** The reservoir is the habitat in which an infectious agent normally lives, grows, and multiplies. Reservoirs include humans, animals, and the environment. The reservoir may or may not be the source from which an agent is transferred to a host. For example, the reservoir of *Clostridium botulinum* is soil, but the source of most botulism infections is improperly canned food containing *C. botulinum* spores. Many of the common infectious diseases have human reservoirs. Diseases that are transmitted from person to person without intermediaries include sexually transmitted diseases, measles, mumps, streptococcal infection, most respiratory pathogens, and many others. Smallpox was eradicated after the last human case was identified and isolated because humans were the only reservoir for the smallpox virus. Two types of human reservoirs exist:
    - **People with symptomatic illness**
    - **Carriers**: People who are not experiencing symptoms of an infection but can transmit the pathogen to others. The different types of carriers are:

- **Asymptomatic or passive carriers:** Those who have never been ill from the infection.
- **Incubatory carriers:** Those who are in the incubation period of the disease.
- **Convalescent carriers:** Those who have recovered from the infection.
- **Chronic carriers:** Those who remain as reservoirs for the disease causing agents for as long as years after they have had the infection.

3. **Portal of Exit:** This is a gateway through which the agent leaves the host or reservoir. However, the agent must have the right environment for its survival until it gets an entry to infect another person/animal. For example, the bacteria that cause tuberculosis (TB) can survive in sputum for weeks, but can be killed by sunlight within a few hours.
4. **Mode of Transmission:** An agent that exits and develops in its natural reservoir can be transmitted in numerous ways to a susceptible host and get portal of entry. The modes of transmission are classified as:

- **Direct transmission** refers to an immediate transfer of the agent from a reservoir to a susceptible host through direct contact or a droplet.
- **Direct contact** occurs through kissing, skin-to-skin contact, and sexual intercourse.
  - Direct contact also refers to contact with soil or vegetation harboring infectious organisms. Infections, such as mononucleosis ("kissing disease") and gonorrhea, are contracted from direct contact with an infected person. Likewise, hookworm infection is acquired through direct contact with contaminated soil.
- **Droplet spread** refers to a spray of relatively large, short-range germ laden aerosols produced by sneezing and/or coughing (or even talking) of infected people. Droplet spread is classified as direct because transmission is by direct spray over a few feet before the droplets fall to the ground.
- **Indirect transmission:** An agent is carried from a reservoir to the susceptible host by suspended air particles or by animate (vector) or inanimate (vehicle) intermediaries.
  - Airborne
  - Vehicle-borne
  - Vector borne
  - Mechanical
  - Biologic

  This manual deals primarily with preventing the spread of infectious diseases taking place in healthcare facilities from contacts with such sources as air (airborne and droplets), blood or body fluids, and contaminated foods or articles.

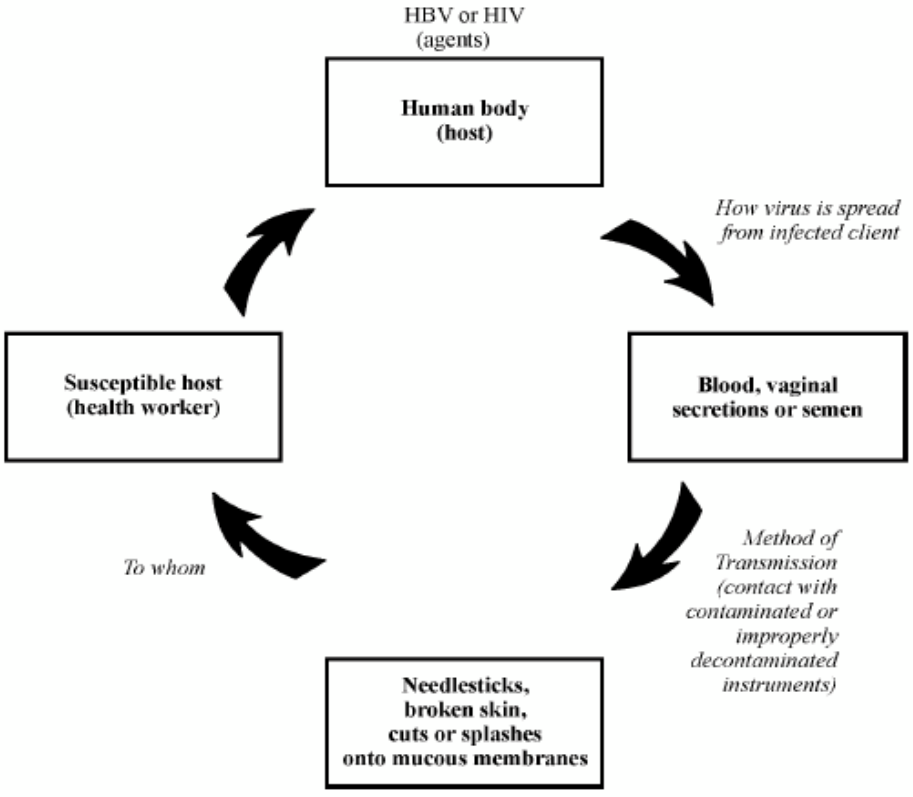
5. **Portal of entry** is the gateway through which an infectious agent enters in the susceptible host. The portals of entry could be the mouth, nose, skin, etc.

6. **New/susceptible host** is an organism (human or animal) that is liable to take up infectious agents/pathogens and harbor them. People are exposed to disease-causing agents every day but do not always get sick. An infectious agent/pathogen getting access to or inhabiting in the host does not necessarily lead to infection or initiate illness due to the body's natural defense mechanisms. The immune system is normally at work to fight against the invading agent. However, organisms that get access to a new host and reproduce there cause colonization, which may later increase the likelihood of the development of infections. The other reason why people do not get sick can be because of previous exposure through artificial or natural immunity (e.g., vaccinated against it or previously had the disease).

   For example:

   Figure 1.2 illustrates the steps in the transmission of HBV and HIV from infected people (e.g., a family planning client or pregnant woman attending an antenatal clinic) or patients getting treated at healthcare institutions. This spread of infection from viruses occurs when the staff (physician, nurse, or cleaning personnel) are exposed to the blood or body fluids of an infected person (e.g., needle stick injury).

Figure 1.2.Transmissions of HBV and HIV from patients to HCWs



Source: Tietjen, Bossemeyer, & McIntosh 2003

Breaking the Chain of Infection

An understanding of the chain of infection or the transmission cycle of specific infectious diseases is important if HCWs are to:

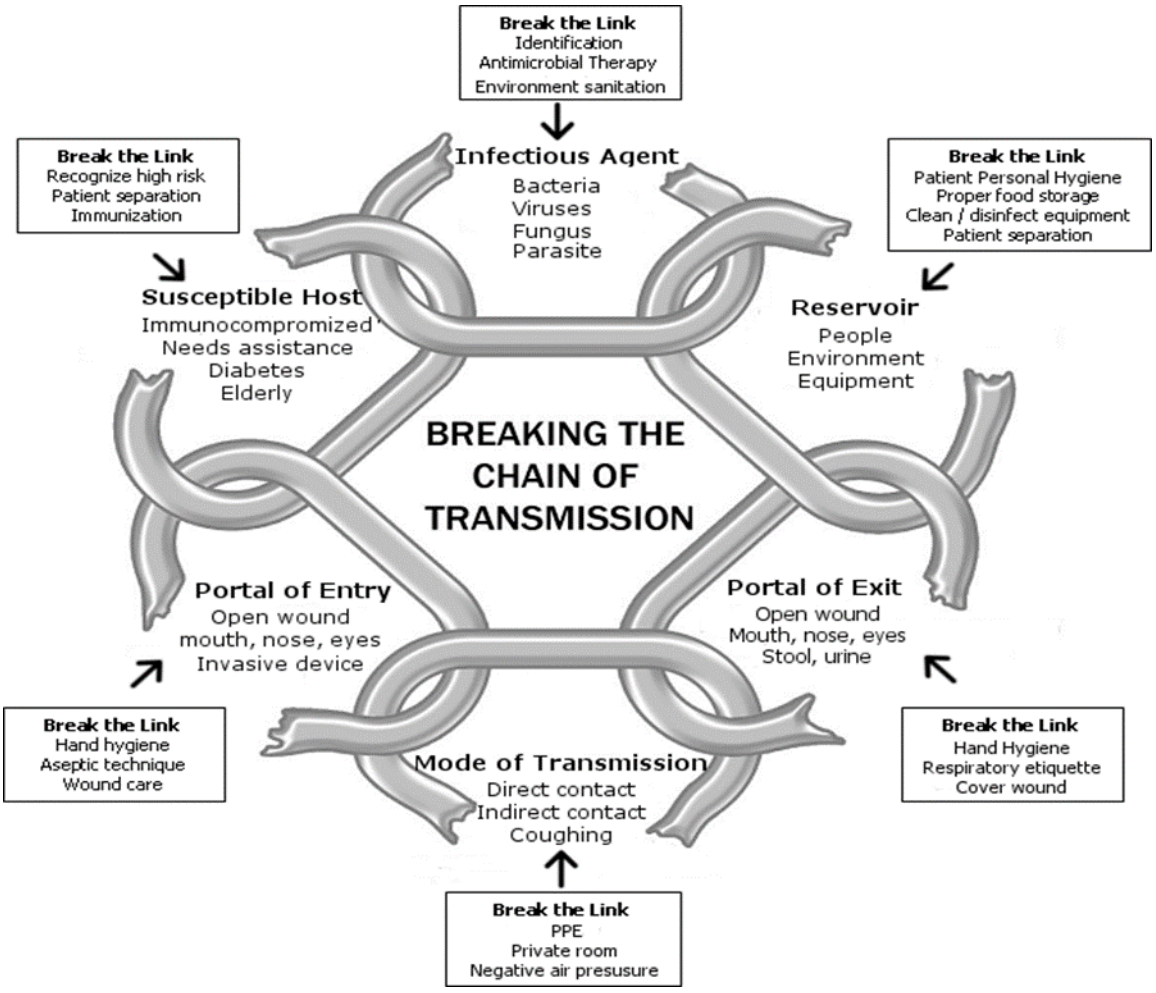
- Prevent transmission of microorganisms from patient to patient, from patient to the provider, or vice versa during medical and surgical procedures.
- Teach others about the factors required for transmission to occur.
- Teach others about how to break the disease transmission cycle.

Preventing the spread of infectious agents or proper IPC practices requires breaking the chain of infection by removing one or more of the conditions necessary for transmission of the diseases from the host reservoir to the susceptible host through practices that:

- Reduce the number of microorganisms present (e.g., handwashing, cleaning of instruments).
- Kill, inhibit, or inactivate microorganisms (e.g., handwashing with a waterless alcohol preparation, decontamination of patient care items).
- Create barriers to prevent infectious agents from spreading (e.g., wearing gloves or PPE).
- Reduce or eliminate risky practices (e.g., by using a hands-free technique in the operating room, using gloves and disposable syringes).
- Make sure that people, especially HCWs, are immune or vaccinated.

Figure 1.3 illustrates how to break or interrupt the chain of infection through IPC practices.

Figure 1.3. Breaking the chain of infection



Source: Adapted from Public Health Ontario n.d.

Failure to apply IPC measures in healthcare settings can increase the risk for HAIs.

Healthcare-Associated Infections

HAIs were previously known as hospital-acquired infections and nosocomial infections. An infection is called "healthcare-associated" if it is acquired during the course of a healthcare intervention for other conditions, regardless of where the interventions are provided, or infections acquired while a patient is under hospital care (or in any other health facility), which are not present or incubating at the time of admission. It is a time-related criterion that refers to infections occurring more than 48 hours after admission. This situation, therefore, is inclusive of infections acquired in the hospital but which appear after discharge, and also occupational infections among the staff of the facility.

HAIs may also occur

- Up to 48 hours after the episode of care
- Up to three days after discharge
- Up to 30 days after an operation
- Up to one year after an operation with an implant

Note that patients and HCWs are at risk of acquiring HAIs.

HAIs may be endogenous (from self) where the infectious agent is from the patient, such as the normal flora that causes disease as a result of gaining access to another part of the body where it is not normally found; for example, an organism from the colon entering the urinary tract and causing a urinary tract infection.

HAIs may also be exogenous (from others or cross infection). This involves acquiring infection from an external source; for example, a patient or health worker, through contaminated hands, or contaminated patient care items, or the environment.

Some of the most common HAIs are urinary tract infections, bloodstream infections, surgical site infections, and pneumonia.

IP practices are crucial for reducing the risk for any type of HAI with the application of an understanding of the chain of infection or transmission cycle. The two sets of practices for IP are standard precautions and transmission-based precautions.

Background on Standard Precautions and Transmission-Based Precautions

Standard precautions: These practices are designed for use in caring for all people, the clients and patients attending healthcare facilities (first-level precautions). They apply to blood; all body fluids, secretions, and excretions (except sweat); non-intact skin; and mucous membranes. Because no one really knows what organisms clients or patients have, it is necessary that standard precautions be used all the time.

Transmission-based precautions: The second-level precaution is intended for use in patients known or highly suspected of being infected or colonized with pathogens transmitted by:

- Air (TB, chicken pox, measles, etc.)
- Droplet (flu, mumps, and rubella)
- Contact (hepatitis A [HAV] or E and other enteric pathogens, herpes simplex, and skin or eye infections).

If there is any impending development of an infectious process in a patient without known diagnosis, implementing transmission-based precautions should be based on the patient's signs and symptoms (empirical basis) up until a definitive diagnosis is made.

In all cases (whether they are being used alone or in combination), transmission-based precautions must be used in conjunction with the standard precautions.

Background on Clean and Aseptic Techniques

Aseptic technique means using practices and procedures to prevent contamination from pathogens. It involves applying the strictest rules to minimize the risk of infection. HCWs use aseptic technique in surgery rooms, clinics, outpatient care centers, and other healthcare settings.

Antisepsis is the process of reducing the number of microorganisms on the skin, mucous membranes, or other body tissue by applying an antimicrobial (antiseptic) agent.

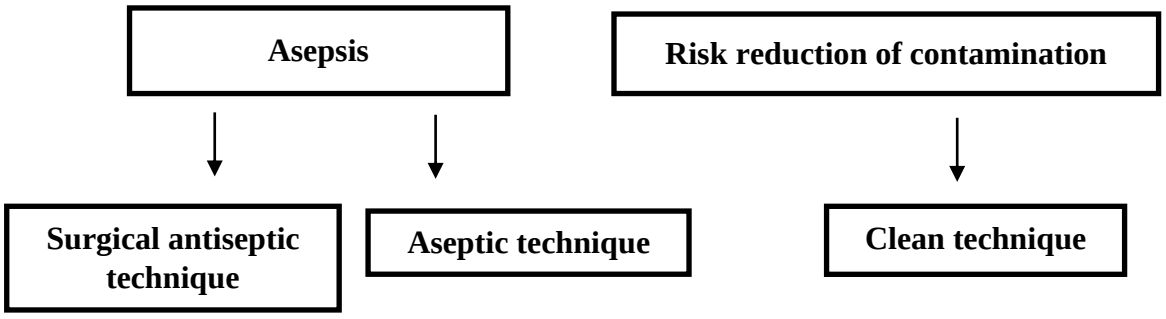
The goal of the aseptic technique is to eliminate germs entirely. The goal of the clean technique is to reduce the number of germs whenever possible.

Clean techniques are important for all healthcare providers and their patients because they prevent infections every day.

Examples of clean techniques include washing hands and putting on clean gloves when needed. Healthcare providers keep a patient's surroundings as clean as possible, but they are not using sterile items or aseptic techniques.

Asepsis and aseptic techniques are the combination of efforts made to prevent entry of microorganisms into any area of the body where they are likely to cause infection. The goal of asepsis is to reduce to a safe level, or eliminate, the number of microorganisms on both animate (living) surfaces (skin and mucous membranes) and inanimate objects (surgical instruments and other items).

Keeping the environment as clean as possible is always important in preventing infections. However, some situations call for aseptic technique, whereas others call for clean techniques.



SUMMARY

In summary, the goal of IPC is to make healthcare facilities a safer place. WHO's components of IPC are an integral part of these guidelines. Understanding each step of the chain of infection or transmission cycle is one step forward in the prevention and control of HAIs. Always apply standard precautions and transmission-based precautions, as appropriate. IP and PS activities are

everybody's responsibility. Each and every one of us have a responsibility to implement IPC and PS activities at our healthcare facilities.

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CHAPTER 2: BASIC MICROBIOLOGY FOR IPC

Key Topics

- Basic features of microorganisms
- Classifications and identification of microorganisms
- How microorganisms cause disease
- Common techniques for identifying microorganisms
- Characteristics of microorganisms of interest for IPC

BACKGROUND

A basic knowledge of the microscopic organisms that commonly cause infections and the methods used by the clinical laboratory to identify and examine them are important in the day-to-day work of the IPC team. Understanding the features and behavior of the microorganisms that are causing infections in a healthcare facility, in particular HAIs, can help the IPC team choose the most effective prevention strategy. It will also help IPC focal persons to more effectively convince HCWs of the need for basic IPC strategies, such as hand hygiene, standard precautions, transmission-based precautions, cleaning, and disinfection. Understanding the methods used in the clinical laboratory can also assist the IPC team in making sure that the best-quality samples are taken so that the microorganisms that are causing infection can be identified.

Basic Features of Microorganisms

The basic features that microorganisms of medical interest share can help hospital staff, patients, and families understand the importance of IPC. The features are given in table 2.1.

Table 2.1. Basic features of microorganisms and the implications for healthcare

Biological feature	Characteristic	Implications for healthcare
Microscopic size	Microorganisms can be seen only with a microscope.	Even a microscopic crack or space in equipment (such as an intravenous [IV] line or endoscope) can contain numerous microorganisms that can be passed to a patient.
Rapid rate of reproduction	If conditions are favorable, microorganisms can multiply quickly.	If even just a few microorganisms enter a vulnerable patient under the right conditions, they have the potential to cause serious infection in a short period of time.
Tendency to spread from one place to another	Microorganisms can spread through air currents, people's hands, or equipment.	Staff, patients, and families in healthcare facilities can spread microorganisms from one place to another and from one patient to another via their hands or equipment. Methods to remove microorganisms from the hands, medical equipment, and surfaces at facilities (through handwashing, cleaning, disinfection, and sterilization) must be performed carefully, consistently, and thoroughly.

Biological feature	Characteristic	Implications for healthcare
Ability to resist eradication	Some microorganisms can survive harsh conditions (heat, cold, dryness, and chemicals).	HCWs must carefully follow instructions for removing microorganisms from their hands, medical equipment, and surfaces at facilities (through handwashing, cleaning, disinfection, and sterilization).

Source: Association for Professionals in Infection Control and Epidemiology (APIC) 2014b

Classification and Identification of Microorganisms

Microorganisms that HCWs and IPC staff may encounter in healthcare settings include bacteria, fungi, parasites, and viruses.

The names of bacteria, viruses, fungi, and parasites follow the naming convention of the biological classification system. Their names contain two terms and are written in italic letters. The first term is the genus name; the second term is the species name. For example, for *Staphylococcus aureus*, the genus name is *Staphylococcus*, and the species is *aureus*.

After the first use of the full name in a text, the genus is abbreviated with the first letter; *Staphylococcus aureus* is written as *S. aureus.*

The genus name can be used alone (e.g., *Staphylococci*) but the species (e.g., *aureus*) cannot be used alone because a genus includes other species; *Staphylococcus* includes *Staphylococcus epidermidis* and *Staphylococcus haemolyticus.*

The singular form of "species" is abbreviated as "sp." and the plural as "spp." When used with a genus, spp. is a short way of saying that something applies to many species in a genus, but may not apply to all species in that genus.

Viruses are named by their family/subfamily, genera, and species. For example, influenza virus is from the family Orthomyxoviridae, in general *Influenza A, B,* and *C.* There are several subtypes of *Influenza A,* for example H1N1, H1N2, and H3N1.

It is common practice to name viruses based on the disease they cause. For example, the virus that causes acquired immunodeficiency syndrome (AIDS) was named human immunodeficiency virus (HIV).

Bacteria

Characteristics

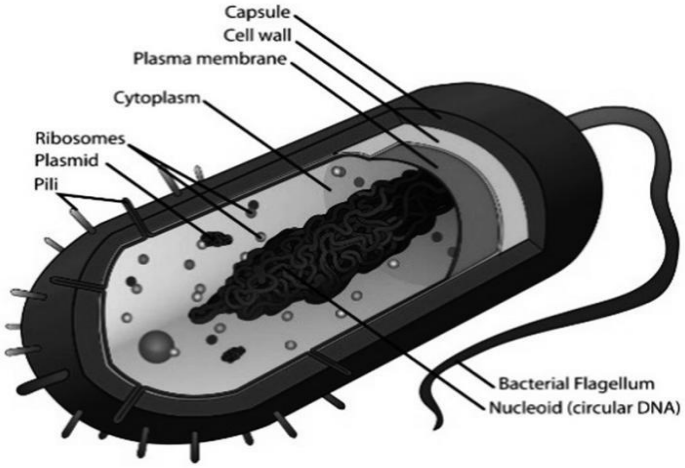
Bacteria are single-cell organisms (figure 2.1) with a well-defined cell wall that maintains the shape of the cell and protects an underlying structure called the plasma membrane, which surrounds and encloses the contents of the cell, including:

- Cytoplasm, which contains the other cell contents

- Ribosomes, which produce proteins for cell function
- Genetic material, which is composed of a bacterial chromosome made of double-stranded DNA that is essential for cell function and replication. Some bacteria also have plasmids, which contain other DNA molecules that are not necessary for cell replication and that carry genes for antibiotic resistance and production of toxins and enzymes.

Some bacteria also have appendages on the outside of the cell that help the cell move (flagella) or help the cell attach to surfaces or other cells (fimbriae and pili) (APIC 2014b).

Figure 2.1. Structure of a bacterial cell



Source: Villarreal 2008

Bacteria reproduce by cell division; a cell divides into two identical cells. When artificially grown on an appropriate culture medium, new cells form groups of the same species and strain of bacteria, called colonies, which may be seen with the naked eye.

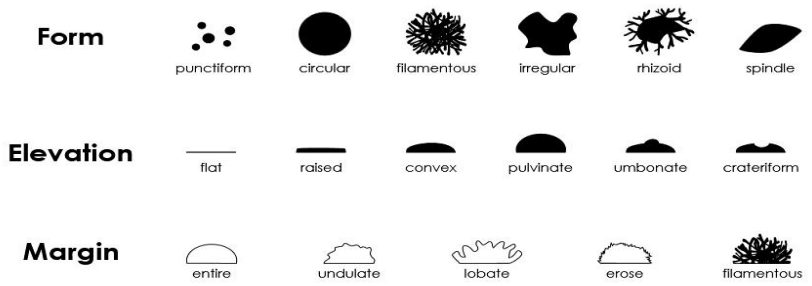
Significance for Healthcare

Bacteria are the most common causes of HAIs (WHO 2002) and thus it is helpful for HCWs and the IPC team to know the key characteristics of bacteria commonly seen in healthcare facilities**.**

Laboratory Methods of Identification

Colonies of bacteria can be identified without a microscope by their appearance (known as clonal morphology) on the nutrient gel used to grow them. Colonies of bacteria differ in color, size, form, elevation, texture, and margin (figure 2.2).

Figure 2.2. Colony morphology of bacteria

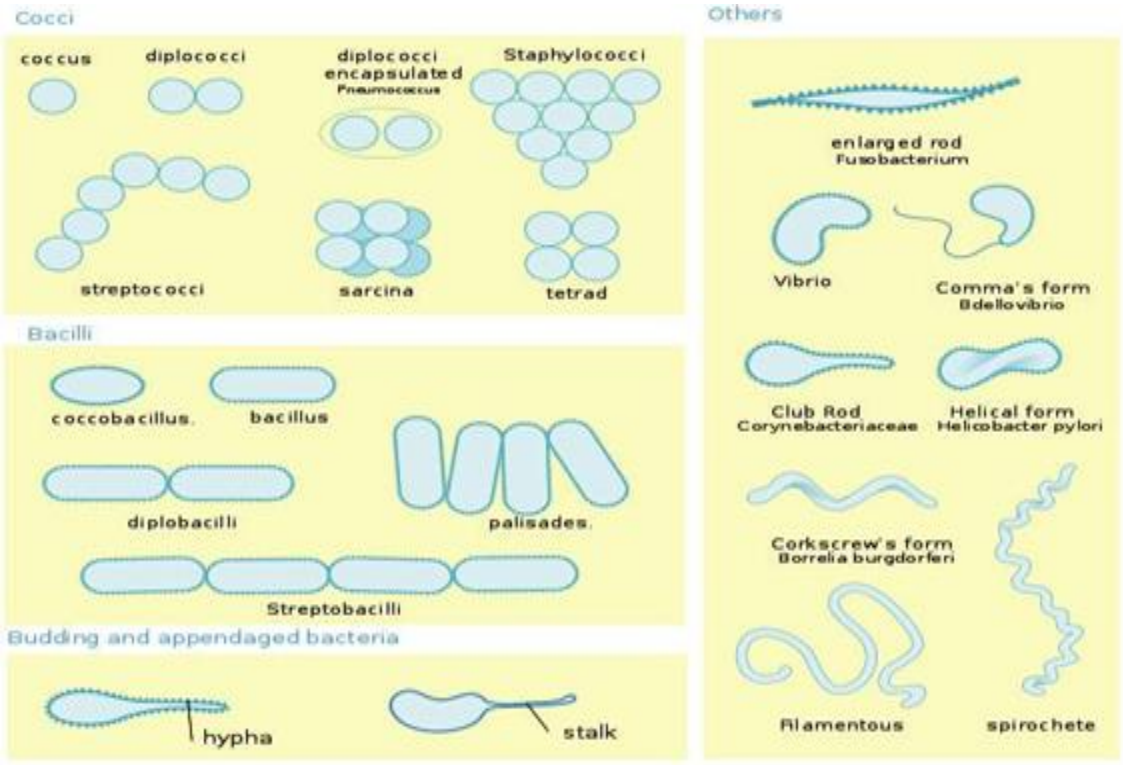


Source: Macedo 2016

Morphology (forms and structure) of bacteria cells is used to identify and classify different groups of bacteria. Given the small size of these microorganisms, they can be viewed and recognized only under a microscope, based on their size, shape, and how they are grouped together. Figure 2.3 shows some of the different shapes and groupings of bacteria that can be seen under the microscope.

Coccus: *Staphylococcus aureus*
Rods (bacilli): *E. coli*, *K. pneumoniae*
Spiral: *Treponema pallidum pertenue*

Figure 2.3. Shapes and groupings of bacteria

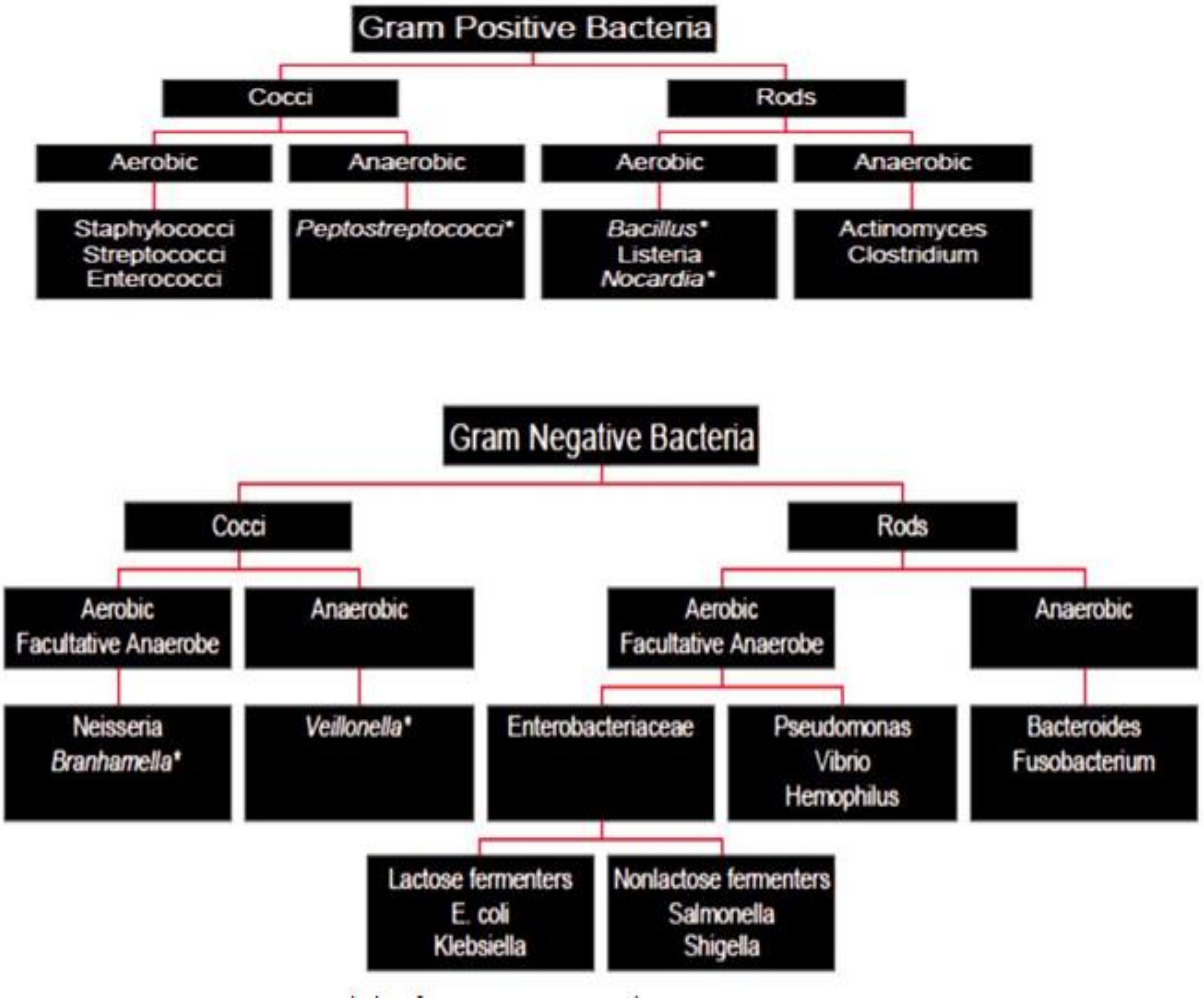


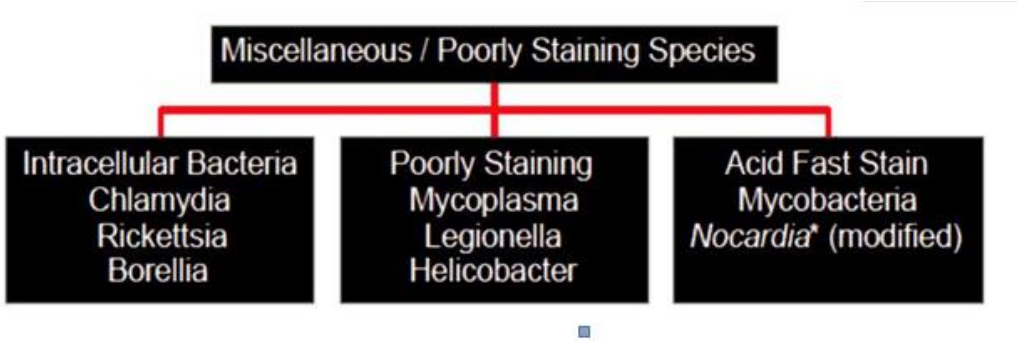
Source: Ruiz 2006

Staining of the cell walls with different dyes is also used to identify and classify bacteria (Figure 2.4). Gram stain is widely used in clinical laboratories to differentiate bacteria into two groups: gram positive and gram negative. Nearly all clinically relevant bacteria fall into one of these two groups based on whether their cell walls retain Gram stain. Another clinically relevant group of bacteria are acid-fast bacilli (AFB). Gram stain quickly determines a broad group of bacteria, which can be important for choosing the appropriate antibiotic to treat the infection and for determining the need for isolation of the patient. For example, gram-negative diplococci in cerebrospinal fluid suggest meningococcal meningitis, and gram-positive cocci suggest staphylococci as the cause of infection. AFB-positive rods suggest *Mycobacterium* spp., which may be TB (APIC 2014b).

Gram stain can also help the IPC team focus and guide IPC activities. For example, gram-positive bacteria include *S. aureus*, which commonly colonizes the skin and the nose of staff and patients. *S. aureus* is often resistant to antibiotics, can cause serious infections in the lungs, bones, and heart, and can also result in sepsis.

Figure 2.4. Bacterial classification by staining properties





Source: Lowy n.d.

Gram-negative bacteria include Enterobacteriaceae (e.g., *Escherichia coli*, *Klebsiella* spp., *Serratia* spp.) that commonly cause serious infections, especially when medical devices are used (such as urinary catheters and IV lines), are often resistant to antibiotics, and colonize patients in hospitals. Other gram-negative organisms (*Pseudomonas* spp. and *Acinetobacter* spp.) live in damp and wet areas of facilities, are difficult to eradicate from the environment, and cause HAIs.

Growth characteristics, including growth rate, composition of the air, nutrients, and temperature in which bacterial colonies grow, are used to identify bacteria. Bacteria can be divided into groups according to:

- **Oxygen requirements**: "Aerobic" bacteria require oxygen to grow; "anaerobic" bacteria grow in the absence of oxygen. Aerobic bacteria are more likely to be found on the surface of the body. The presence of anaerobic bacteria (e.g., *Bacteroides fragilis* and *Clostridium perfringens*) can indicate a source from a deep wound, the gut, or vagina. Bacteria can be strict (obligate) anaerobes, which die in the presence of oxygen, or facultative anaerobes, which can survive with or without oxygen (APIC 2014b).
- **Fermentation of carbohydrates**: Lactose fermenting bacteria are typically gram negative. For example, *Enterobacter* spp. are lactose fermenting and *Pseudomonas* spp. and *Proteus* spp. are non-lactose fermenting.
- **Presence of specific enzymes:**
    - **Catalase test** differentiates streptococci (negative) from staphylococci (positive).
    - **Coagulase test** differentiates S. aureus (positive) from other staphylococci such as S. epidermidis (negative) (APIC 2012; APIC 2014b).

Viruses

Characteristics

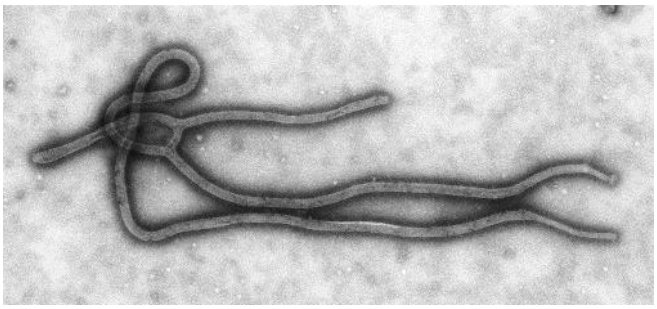
Viruses are microorganisms that are smaller than bacteria and consist of genetic material, which can be either DNA or RNA, surrounded by a protein coat and, in some viruses, by a membranous envelope. Viruses do not have many of the cell structures found in bacteria and fungi, and are able to multiply only in the living cells of a host (figure 2.5.) They attach to receptors on the host cell

(such as a respiratory tract cell), enter the cell, and use the cell to replicate. The offspring are then released from the host cell.

Viruses are classified based on:

- The type of substance that makes up their central core—DNA (e.g., herpesvirus, cytomegalovirus) or RNA (e.g., HIV, measles, Ebola Virus Disease [EVD], severe acute respiratory syndrome-associated coronavirus [SARS-CoV], HCV, and polio).
- The number of strands in the core—double-stranded (e.g., rotavirus) or single-stranded.
- The presence or absence of a membrane-like envelope surrounding them—enveloped (coronaviruses [CoVs], herpesvirus, chicken pox virus, influenza viruses, and EVD) and non-enveloped viruses (adenovirus, poliovirus) (APIC 2014b).

Figure 2.5. Transmission electron micrograph of EVD



Source: Centers for Disease Control and Prevention (CDC) 2019b

Implications for Healthcare

Many viruses can be transmitted in the healthcare environment and often cause HAIs and outbreaks. Bloodborne viruses, such as HIV and HBV and HCV, can be spread from patient to patient during transfusions, dialysis, injections, and endoscopy. Viruses, such as influenza and respiratory syncytial virus (RSV), can be spread from patient to patient by respiratory fluid droplets during crowding or sharing of respiratory equipment, or on contaminated hands. Other viruses, such as measles and varicella, quickly spread to patients on air currents. Rotaviruses and enteroviruses infect the gastrointestinal tract and are transmitted by hand-to-mouth contact due to poor hand hygiene and inadequate cleaning (WHO 2002).

The presence or absence of a virus envelope has significance for cleaning and disinfection. Enveloped viruses (e.g., herpes, HIV, Ebola) are easier to kill with disinfectants than non-enveloped viruses (e.g., norovirus, rotavirus, adenovirus, and poliovirus). Cleaning products should be evaluated for their ability to kill both enveloped and non-enveloped viruses (Rutala, Weber, Healthcare Infection Control Practices Advisory Committee 2008).

Laboratory Methods of Identification

Most virus identification methods are out of the scope of many clinical laboratories in limited-resource settings but may be available in reference laboratories. Examples of some tests commonly used to detect the presence of virus are:

- Enzyme-linked immunosorbent assay (ELISA) for detecting antibodies against HIV, RSV, rotavirus, and HBV
- PCR for DNA and RNA detection of HIV, human papillomavirus, and many other viruses
- Papanicolaou (Pap) smears for the effect of human papillomavirus on squamous cells lining the cervix (APIC 2014b).

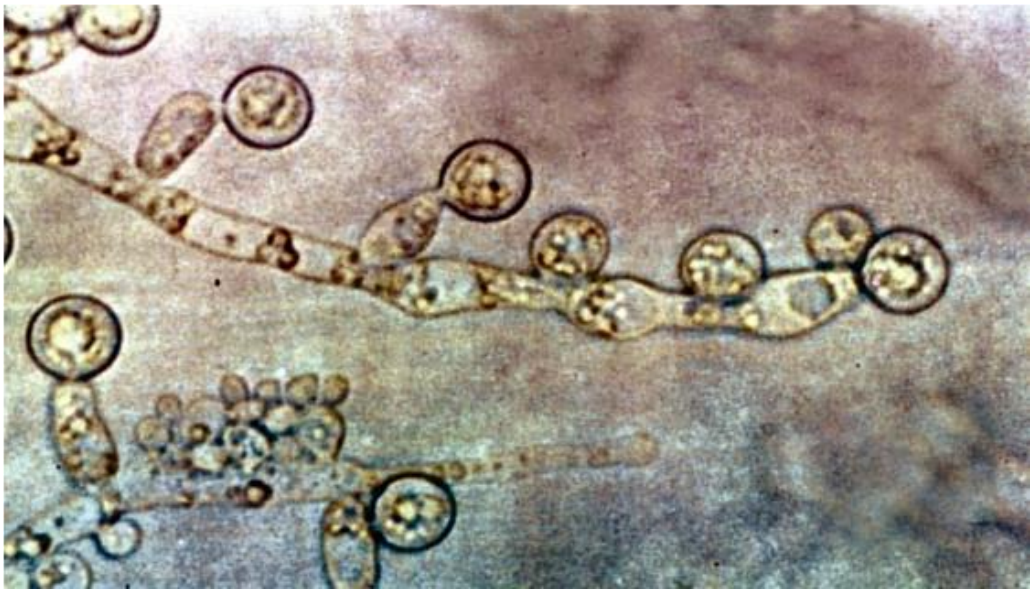
Fungi

Characteristics

Fungi are typically slightly larger than bacteria and can be divided into yeasts and molds based on their appearance.

- Yeasts are single-celled, microscopic, and form smooth, creamy colonies in culture (figure 2.6).
- Molds consist of long, branching filaments of cells called hyphae. A tangled mass of hyphae visible to the naked eye is a mycelium and can be various colors (black, white, or green) (APIC 2014b).

Figure 2.6. Candida albicans



Source: Colm 2010

Significance for Healthcare

Although fungi can cause infection in humans (e.g., *Candida albicans*), most are opportunistic pathogens that cause infections (which can be severe) in those who are on extended antibiotic treatment or are immunosuppressed (*C. albicans*, *Aspergillus* spp., *Cryptococcus neoformans*, *Cryptosporidium*). A species of yeast, *Candida auris*, with a propensity to spread in hospitals and that is resistant to multiple antifungals, is emerging globally. Molds, such as *Aspergillus* spp., which originate in dust and soil can become airborne and infect vulnerable patients during hospital renovation or construction if precautions are not taken (APIC 2014b; WHO 2002).

Laboratory Methods of Identification

Like bacteria, fungi can also form colonies. Fungi are mainly identified using direct examination under the microscope of the physical characteristics of the mold, such as shape, color, staining, and the root-like structures. They are also identified through culture and non-culture tests (APIC 2014b).

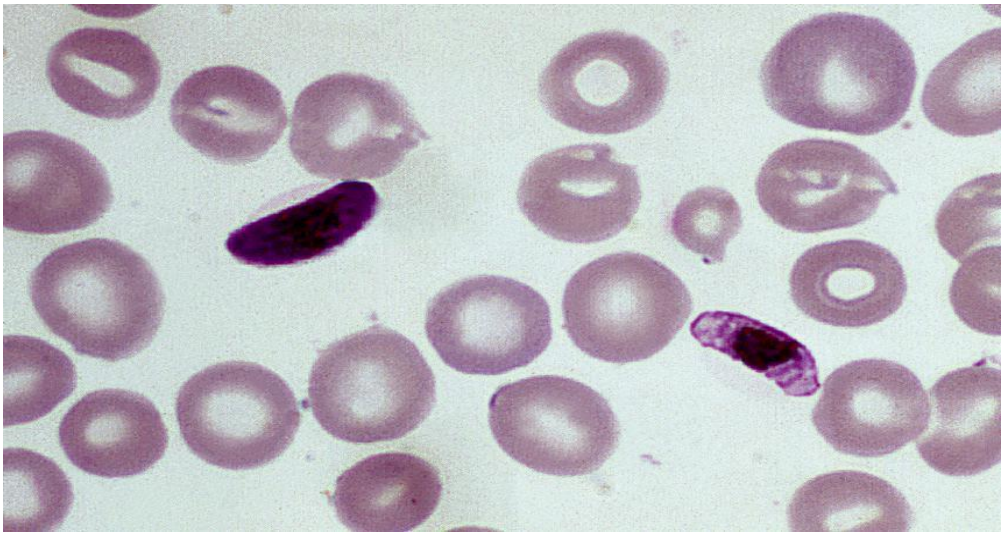
Parasites

Characteristics

Parasites range from single-cell protozoan parasites (*Giardia* spp. and *Plasmodium* spp.) to large worms (e.g., hookworm) and insects (*Sarcoptes scabiei*, the scabies parasite). Some parasites can live inside the cell (intracellular), such as the parasite that causes malaria (*Plasmodium* spp.) (figure 2.7). Others (such as scabies, mites, and lice) live on the outside the body, on the skin. Most protozoan parasites exist in two different forms:

- The trophozoite stage—the feeding stage during which the parasite produces effects in the host.
- The cyst stage—the dormant stage, when most protozoan parasites are transmitted.

Figure 2.7. Plasmodium falciparum, malaria parasite



Source: CDC/Dr. Mae Melvin 1971

Common Parasitic Infections

Healthcare-associated parasitic infestations include scabies, lice, and myiasis (maggots). Water- or foodborne parasite infestations—such as amoebiasis (caused by *Entamoeba histolytica*) or cryptosporidiosis (caused by *Cryptosporidium parvum*)—mainly occur in community settings but can also spread in hospitals.

Significance for Healthcare

Some parasites can spread from person to person in healthcare facilities. *Giardia lamblia* is easily transmitted from person to person through poor hand hygiene and unclean surfaces. The mite that causes scabies can cause outbreaks in healthcare facilities. Others, such as malaria, are spread via mosquitoes (vectors) and, therefore, can spread in healthcare facilities if patients are not protected from mosquitos and other insect bites (WHO 2002).

Laboratory Methods of Identification

Several laboratory methods for the identification of parasite infestation are available. They include microscopy, serology-based assays, and molecular-based essays. Direct examination of stool or urine for blood or ova from intracellular parasites is the primary method of diagnosis for parasites in some laboratories (APIC 2014b).

Microbial Pathogenesis (How Microbes Cause Disease)

Normal Flora/Commensal Microbiota

Normal flora/commensal microbiota vary by body site. For example, coagulase-negative staphylococci are common on the skin and *E. coli* in the gut (APIC 2014b; WHO 2002).

Implications for healthcare: Commensal bacteria can cause opportunistic infections when the immune system is compromised (e.g., in infants, the elderly, or those with acute or chronic disease) or the other body defenses are interrupted (e.g., a surgical wound disrupting the protective barrier of the skin; a medical device, like an IV or urinary catheter, entering the body; or prolonged use of antimicrobial agents leading to an imbalance in the commensal gut microbiota). Examples include coagulase-negative staphylococci from the skin, which can cause an IV line infection, and *E. coli* from the gut, which can cause a urinary tract infection (WHO 2002).

Colonization

Examples of colonization include *Neisseria meningitidis* in the throat, *Salmonella* species in the gut, methicillin-resistant *S. aureus* (MRSA) in the nose, or yeast in the genital tract.

Implications for Healthcare: Colonization may result in infection of the colonized person when the immune or other body defenses are interrupted (e.g., a person colonized with MRSA has surgery, which interrupts the natural barrier of the skin, and develops a MRSA surgical site

infection [SSI]). Transmission to others (e.g., a person with *Salmonella* colonization is involved with food preparation at the healthcare facility and does not wash his/her hands and transmits *Salmonella* to patients).

Organisms that are resistant to antibiotics often colonize hospitalized patients, which can then lead to infections that are difficult to treat. Surveillance cultures (such as nose swabs for MRSA and rectal swabs for vancomycin-resistant enterococci [VRE] or carbapenem-resistant Enterobacteriaceae [CRE]) may be used in some settings to identify patients with colonization. If colonization with MRSA, which can cause serious SSIs, is identified before surgery from surveillance cultures of the nose (or other sites), medications to decolonize can be prescribed to decrease the risk of an SSI from MRSA.

Infection

An infection usually causes clinically apparent symptoms, or sometimes may cause no symptoms and be subclinical. Symptoms vary according to the type of microorganism and the location of the infection. Symptoms are a result of the actions of the microorganisms on the body (e.g., diarrhea, necrotic tissue) and the immune response to them (e.g., fever, purulence). The characteristics and location of the microorganism, and the immune status of the person determine if and how an infection progresses (APIC 2014b).

Implications for Healthcare: People seeking care at healthcare facilities may be more vulnerable and prone to infections, especially infants, pregnant women, the elderly, people with acute or chronic diseases, and those with a condition that suppresses the immune system and/or disrupts body defenses (wounds, invasive medical devices). It is important to protect patients from exposure to pathogenic microorganisms in the facility and identify any patients with infections that may spread to others.

Sources of Microorganisms

HAIs can be categorized according to the source of the microorganisms that cause them. Bacteria can come from:

- **The patient (endogenous):** Organisms from the individual's own body (normal flora or colonization) can cause infection when the immune system is compromised, other body defenses are interrupted (via a wound or medical device), or antibiotic therapy causes overgrowth of some microorganisms (such as yeast in the gastrointestinal and reproductive tracts) (APIC 2014b; WHO 2002).

  Implications for healthcare: IPC includes surgical asepsis; preoperative skin antisepsis; preventive care when inserting and maintaining invasive medical devices; removal of invasive medical devices as soon as possible; decolonization of colonized patients using an appropriate antimicrobial agent; patient education on hand hygiene and cleanliness; and rational use of antibiotics.

- **Another person (exogenous infection)**: Organisms that cause infection can come from a source outside the individual, such as:

- Other patients (direct contact with blood or other body fluids, respiratory droplets, unwashed hands)
- Airborne (aerosols/air droplets carrying TB, varicella, or measles)
- Staff (contaminated or colonized hands, clothing, skin)
- Objects contaminated by an infected person (equipment, environmental surfaces) or contaminated sources (water, fluids, food) (APIC 2014b; WHO 2002).

Implications for Healthcare: IPC includes standard precautions, including hand hygiene and use of PPE, and isolation using transmission-based precautions. Administrative and environmental controls should also be considered.

- **The healthcare environment:** Organisms causing infection can come from the hospital environment where they live permanently or transiently, including such places as:

  - Water, damp areas, fluids, and even disinfectants (e.g., Pseudomonas spp., Acinetobacter spp., Mycobacterium spp., Legionella spp.).
  - Surfaces, equipment, supplies, and patient care items if reused and/or not well-cleaned.
  - Food prepared or stored by the hospital or the patients' families.
  - Dust/soil, such as during construction or renovation of the facility (e.g., Aspergillus spp.) (APIC 2014b; WHO 2002).

  Implications for healthcare: IPC includes proper handling of fluids, correct handling and dilution of disinfectants, elimination of damp areas when possible, use of the cleanest water available, monitoring of the food service, regular and thorough environmental cleaning, hand hygiene, proper cleaning of multi-use items, and isolation/careful control in areas undergoing construction/renovation.

Background of Microorganisms of Interest for IPC

Characteristics of Organisms Commonly Associated with HAIs

Microorganisms have characteristics that enable them to survive and/or easily spread in healthcare environments. These characteristics include:

- **Are able to survive on the hands of HCWs**, environmental surfaces, and medical equipment when IPC practices, such as hand hygiene, cleaning, disinfection, and sterilization, are suboptimal. Examples include influenza virus, RSV, and *S. aureus*, which can live for hours or days on hands and surfaces if not cleaned.

- **Can survive dryness, heat, and disinfectants** and so can cause infections in patients and HCWs in healthcare facilities despite IPC methods, such as hand hygiene, cleaning, disinfection, and sterilization. Examples include norovirus, *C. difficile*, some molds that survive by forming spores, *Pseudomonas* spp., and microorganisms that have been known to survive in disinfectants.

- **Live in blood and body fluids** even though they cannot survive for long in the healthcare environment. These microorganisms can be passed from person to person

via items contaminated with blood or body fluids—even minute amounts. Examples include HBV, HCV, and HIV on or in dialysis machines, multi-dose vials, multi-use lancets, or insulin pens; and EVD on the hands, equipment, and surfaces that are not adequately cleaned.

- **Thrive in damp areas**, and thus the drains, sinks, and equipment that use water (such as humidifiers, patient warmers, and respiratory equipment) can harbor these organisms. Fluids used in healthcare, such as IV fluids and disinfectants, can also grow microorganisms. Examples include *Mycobacterium* spp. and gram-negative bacteria such as *Acinetobacter* spp., *Pseudomonas* spp., *Burkholderia* spp., and Enterobacteriaceae.
- **Colonize patients and staff**, allowing the microorganisms to survive in the healthcare environment and pass from person to person, causing an infection if the immune defenses become suboptimal, such as after surgery or when medical devices are in place. Examples include *S. aureus*, Enterobacteriaceae, and *Enterococcus* spp.
- **Are small in size and able to remain suspended in the air and be transmitted short distances** through the air in respiratory droplets, especially when propelled by coughing or sneezing, and therefore can cause transmission if PPE to protect the nose, mouth, and eyes—as described for standard precautions and transmission-based precautions—are inadequate. Examples include influenza and *N. meningitidis*.
- **Are very small in size and so are able to float long distances on air currents** if the ventilation at the facility is not protective of staff and patients. Examples include the viruses causing varicella, measles, and SARS.
- **Are resistant to antimicrobials**; examples include MRSA, VRE, and CRE (CDC 2019a).

These characteristics help determine which microorganisms commonly cause HAIs. The causes of HAIs are generally similar, no matter the country or region (table 2.2), although gram-negative organisms are more likely to be the most common cause of bloodstream infection in middle- and low-resource settings than in high-income settings. A knowledge of the specific microbes and the microbial patterns of infection in the specific facility (from surveillance), country (from the health department or published articles), or region (from combined data) can be helpful in guiding IPC efforts at a facility (Mahon, Lehman, Manuselis 2014; WHO 2011).

Table 2.2. Microorganisms that cause the four HAIs of global public health interest

HAI	Microorganisms that cause HAIs
Central line-associated bloodstream infection	Coagulase-negative staphylococci, *S. aureus*, *Enterococcus* spp., *Candida* species, MRSA, *Klebsiella pneumonia, Escherichia coli, Pseudomonas aeruginosa*
Surgical site infection	*S. aureus,* coagulase-negative staphylococci, *Enterococcus* spp., *E. coli, P. aeruginosa, Enterobacter* species, *K. pneumoniae and oxytoca, Candida* spp., *Acinetobacter Baumannii*
Catheter-associated urinary tract infection	*E. coli, Enterococcus* spp., *P. aeruginosa, Candida* spp., *K. pneumoniae, Enterobacter* spp.

Pneumonia	*E. coli, Klebsiella* spp.*, Proteus* spp.*, S. pneumoniae, H. influenzae, S. auerus, Acinetobacter* spp.*, P. aeruginosa*

Adapted from American Thoracic Society Documents 2005; Carr 1998; CDC 2011; Hidron, Edwards, Patel, et al. 2008

Gram-Negative Bacteria

HAIs caused by gram-negative bacteria include pneumonia, bloodstream infections, wound or SSIs, and meningitis. Gram-negative bacteria are often resistant to antibiotics. This group, which includes *Klebsiella* spp., *Acinetobacter* spp., *Pseudomonas aeruginosa,* and *E. coli*, among many others, is found in damp areas and is transmitted via the unwashed hands of HCWs, water sources, and inadequately cleaned medical equipment. Careful attention to IPC practices, such as standard precautions, including hand hygiene and proper environmental cleaning, reduces the risk of patients acquiring infections.

- **Enterobacteriaceae** are a group consisting of several families of gram-negative bacteria, many of which are normally present in the gut, including *E. coli,* and species of *Proteus, Enterobacter, Klebsiella*, *Citrobacter*, and *Serratia.* However, patients whose care requires medical devices (endotracheal tubes, urinary catheters, or IV catheters) and those who are on long courses of antibiotics are at risk of developing localized or bloodstream infections with these organisms. Members of this group can cause gastrointestinal illness (e.g., *Shigella*, *Salmonella,* and *Yersinia*).

  Enterobacteriaceae in healthcare settings are of particular concern because they have become resistant to most or all available antibiotics and pass this resistance along to other bacteria. Similar to other gram-negative organisms, prevention includes cleaning, preventing damp areas, and paying careful attention to IPC measures, such as standard precautions and hand hygiene. The rational use of antimicrobials is also a critical component. Contact precautions may be warranted for known cases of multidrug-resistant colonization or infection (CDC 2019a; WHO 2002).

- ***Acinetobacter* species** are commonly found in water and soil but infections with this organism rarely occur in the community. Outbreaks of pneumonia and blood and wound infections in hospitals, including ICUs, are usually caused by *Acinetobacter baumannii. Acinetobacter* spp. can also colonize patients (such as those on a ventilator, with wounds, or with a long hospital stay) and spread to other patients. Prevention includes cleaning, preventing damp areas, and paying careful attention to IPC practices, such as standard precautions, including hand hygiene and environmental cleaning (CDC 2019a; WHO 2002).

- ***Pseudomonas*** infection is caused by strains of bacteria found in the healthcare environment, especially *Pseudomonas aeruginosa.* Although *P. aeruginosa* can cause infections in the community (such as ear and eye infections), serious infections usually occur in healthcare settings. Patients with weak immune systems, those with medical devices (endotracheal tubes, urinary catheters, or IV catheters), and those with wounds from surgery or from burns are at risk for life-threatening infections. Prevention includes cleaning, preventing damp areas, and paying careful attention to IPC

practices, such as standard precautions, including hand hygiene and environmental cleaning (CDC 2019a; WHO 2002).

Gram-Positive Bacteria

Gram-positive bacteria often cause infections in healthcare settings. These bacteria have sturdy cell walls and are therefore capable of surviving for longer periods on surfaces in the healthcare environment and on the skin (WHO 2002).

- ***Staphylococcus aureus*** is found on the skin and in the nasal passages of about 30% of people. It causes skin infections in the community; however, in healthcare settings, *S. aureus* can cause serious and life-threatening infections, such as pneumonia, sepsis, endocarditis, osteomyelitis, and SSI. Patients with weak immune systems, those with medical devices (endotracheal tubes, urinary catheters, or IV catheters), and those with chronic conditions, such as diabetes or cancer, are at risk. *S. aureus* can become resistant to antibiotics, making the infections more difficult to treat (specifically the group of beta-lactam antibiotics that include methicillin, oxacillin, penicillin, and amoxicillin). These are known as MRSA. Prevention includes careful attention to IPC practices, such as standard precautions, including hand hygiene and environmental cleaning, and excellent asepsis of the skin before procedures. Contact precautions may be warranted for known cases of MRSA (CDC 2019a; WHO 2002).

Organisms Specific to Particular Body Systems

It can be helpful for the IPC team to be aware of the microorganisms that typically cause infections to various body systems (Table 2.3). Those infections occurring in the community may be caused by different organisms than those acquired in the healthcare facility. An occurrence of one of these infections should alert the IPC team to investigate a possible HAI. In addition, infections with certain organisms warrant transmission-based precautions to prevent their spread in the facility.

Table 2.3. Background of the common organisms that cause infection of body systems

Infection/site	Common organisms
Bone and joint infections	Osteomyelitis: *S. aureus, Salmonella* sp., *Pseudomonas* sp., *Streptococcus agalactiae,* Septic arthritis: *S. aureus, Neisseria gonorrhoeae, S. pneumoniae, S. pyogenes*
Endocarditis/ heart valve	*St. viridans, S. aureus*, *Enterococcus* spp*., Haemophilus* spp., *S. epidermidis, Candida* spp.
Gastroenteritis/ intestines	*Salmonella* sp., *Shigella* spp., *Campylobacter* spp., *E. coli O157:H7*, viruses*, G. lamblia*, *Entamoeba histolytica*, *Yersinia* spp., *Vibrio* spp., *C. difficile*

Infection/site	Common organisms
Meningitis/brain membrane	Neonates: Gram-negative bacilli, *St. agalactiae* (group B)*, Listeria monocytogenes* Infants: *St. agalactiae* (group B)*, E. coli, H. influenzae, S. pneumoniae, N. meningitides* Children: *S. pneumoniae, N. meningitides* Older adults: *S. pneumoniae, N. meningitides, L. monocytogenes,* aerobic gram-negative Bacilli Others: *C. neoformans, M. tuberculosis,* viruses
Peritonitis/ abdomen	*Bacteroides* spp., anaerobic cocci, *Enterococcus* spp., Enterobacteriaceae, *S. aureus, Candida* spp.
Respiratory tract infections, upper	Pharyngitis*: S. pyogenes*, respiratory viruses, *C. albicans, N. gonorrhoeae, Corynebacterium Diphtheria* Sinusitis*: S. pneumoniae, H. influenzae, S. pyogenes*, *S. aureus,* gram-negative bacilli
Respiratory tract infections, lower	Bronchitis: *S. pneumoniae*, *H. influenzae*, respiratory viruses, *Bordetella pertussis*, RSV Pneumonia: *S. pneumoniae, H. influenzae, Mycoplasma pneumoniae, Chlamydophila pneumoniae, Mycobacterium tuberculosis, S. aureus*, gram-negative bacilli, anaerobes, *Legionella pneumophila, Pneumocystis jiroveci (carinii)* Empyema: *S. aureus*, *Streptococcus* spp., anaerobes, *S. pyogenes*, *H. influenza*
Sexually transmitted diseases Skin infections	*Chlamydia trachomatis, N. gonorrhoeae, Bacteroides* spp., Enterobacteriaceae, *Gardnerella* *vaginalis*, *Mobiluncus* sp., *Trichomonas vaginalis*, *Treponema pallidum*, HIV, cytomegalovirus, human papillomavirus, pubic lice, scabies *S. aureus, S. pyogenes, Candida* spp., dermatophytes, gram-negative bacilli, *Clostridium* spp. Burns: *S. aureus*, *Candida* spp., *P. aeruginosa*
Urinary tract infections	*E. coli* and other Enterobacteriaceae*, Enterococcus* spp., *Candida* spp., *Klebsiella* spp., *Proteus* spp., *Pseudomonas* spp., *S. saprophyticus*

Sources: APIC 2014b; Brooks 2012; Mahon, Lehman, Manuselis 201

SUMMARY

Microorganisms that IPC staff may encounter in healthcare facilities include bacteria, fungi, parasites, and viruses. Collaboration with the clinical laboratory can increase the IPC team's capacity to identify, investigate, and contain infectious diseases.

Knowledge of the microorganisms that cause HAIs, and the methods used to identify them, are important in the day-to-day work of an IPC team and will help improve PS at the facility. The IPC team needs to aware of, and knowledgeable about, the basic characteristics of microorganisms that cause HAIs, and should be familiar with the characteristics of those organisms that are significant in their setting and patient population.

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CHAPTER 3: STANDARD AND TRANSMISSION-BASED PRECAUTIONS

Key Topics

- Key components of standard precautions
- Key components of transmission-based precautions
- Empiric/syndromic use of transmission-based precautions
- Recommended precautions for each route of infection transmission

BACKGROUND

Standard precautions for infection control guidelines issued by the CDC in 1996 involves two levels of approaches: standard precautions and transmission-based precautions. Standard precautions combine the major features of universal precaution and body substance isolation. The basic concept in the implementation of standard precautions is the maintenance of a physical, mechanical, or chemical barrier among microorganisms, the environment, and an individual, thus breaking the disease transmission cycle. The rationale is that, for transmission to occur in the healthcare setting, all elements in the disease transmission cycle must be present (as discussed in Chapter 1: Introduction to IPC). Whether it is a woman coming for antenatal care, a hospitalized patient, or a HCW caring for patients, standard precautions help prevent the spread of bloodborne pathogens, respiratory viruses (e.g., HBV, HCV, HIV, and influenza), and other infectious diseases in healthcare facilities.

Standard Precautions

Standard precautions are a set of guidelines designed to create a physical, chemical, and mechanical protective barrier between a microorganism and a person to prevent the spread of infection (the barrier serves to break the diseases transmission cycle).

Examples of barriers are:

- Physical barrier – PPE
- Mechanical barrier – HLD and sterilization
- Chemical barrier – antiseptic and disinfectant

Standard precautions are first-level precautions. The aim of standard precautions is to reduce the risk of transmitting microorganisms from known or unknown sources of infection (e.g., respiratory droplet, contaminated object) in healthcare settings. Applying standard precautions while providing patient care is based on the expected interaction a HCW will have with blood, body fluids, or potential pathogen exposure from patients. They provide a rationale for the appropriate use of limited IPC resources.

Key Principles of Standard Precautions

- Consider every client and patient as potentially infectious or susceptible to infection.

- Apply to all patients and clients attending a healthcare facility.
- Apply to all blood, body fluid, secretion, execration (except sweat), mucous membrane, and non-intact skin.

Key Components of Standard Precautions

The components of standard precautions create protective barriers for preventing infections in visitors, patients, and HCWs, and are based on the premise that every person (patient, visitor, or HCW) is potentially infectious and susceptible to infection.

The key components of standard precautions are:

- **Hand hygiene** involves HCWs cleaning their hands before, after, and at specific moments during patient care and when performing healthcare tasks. Hand hygiene is the single most important intervention for preventing transmission of infections (e.g., person to person or contaminated object to person). It must be performed consistently at the recommended moment during patient care using soap and water or ABHR, and with a technique that effectively removes microorganisms from the hands. (For detailed information, see Volume 1, Chapter 4: Hand Hygiene).
- **Use of PPE** relies on an HCW's assessment of the likely risk of contact with potentially infectious materials during each task. The appropriate PPE should be chosen by the HCW according to the assessed risk. The risk is not based on the appearance, characteristics, or diagnosis of the patient, but rather on the potential for the HCW coming into contact with blood, body fluids, non-intact skin, mucous membranes, or items that have been in contact with them. The risk may be reassessed during the task (e.g., if the patient starts vomiting) and PPE added, as needed. PPE is used depending on the assessed risk of transmission. (For detailed information, see Volume 1, Chapter 5: Personal Protective Equipment.)
- **Safe injection practices** are those that do not harm the patient, do not expose the HCW to any risks, are provided by skilled personnel using appropriate injection equipment, and do not result in waste that is dangerous to the community. (For detailed information, see Volume 1, Chapter 6: Sharps and Injection Safety.)
- **Environmental cleaning** is the cleansing of noncritical care equipment, instruments, devices, and environmental surfaces. Patient care equipment is cleaned between each use on patients to prevent cross-contamination between patients. (For detailed information, see Volume 1, Chapter 9: Environmental Cleaning.)
- **Instrument processing** is managing instruments and other items before their reuse to reduce the transmission of infection during clinical procedures and patient care through cleaning and sterilization or HLD. (For detailed information, see Volume 1, Chapter 7: Decontamination and Reprocessing of Medical Devices.)
- **Processing textiles and laundry** in a manner that:
    - Removes pathogens from the textiles and protects cleaned textiles from the reintroduction of pathogens.

- Reduces the risk for transfer of pathogens to HCWs, other patients, and the environment. (For detailed information, see Volume 1, Chapter 8: Processing Reusable Textiles and Laundry Services.)

- **Healthcare waste management:** Healthcare waste is a key issue to control to reduce HAIs at healthcare facilities and to ensure that the environment is well protected. Healthcare waste management (HCWM) should be a part of the overall management system of a healthcare facility and should reflect the quality of the services provided by the facility**.**

Transmission-Based Precautions

Although the spread of infectious disease in hospitals has been recognized for many years, understanding about how to prevent infections and implementing successful remedial policies and practices have not been easy to date.

Isolation guidelines involve a two-level approach: (1) Standard precautions, which apply to all clients and patients attending healthcare facilities, on the one hand, and (2) transmission-based precautions, which apply primarily to hospitalized patients (Garner 1996). Actually, both approaches are too interlinked to be used separately. Therefore, the relatively specific transmission-based precautions should always be used in conjunction with the standard precautions.

Transmission-based precautions are for patients who are known or suspected to be infected or colonized with infectious agents, including epidemiologically important pathogens that require additional control measures to effectively prevent transmission. Because the infectious agent is often not known at the time of admission to a healthcare facility, transmission-based precautions are used empirically according to the clinical syndrome and the likely etiologic agents at the time. Later, the course of management should be modified as soon as the pathogen is identified or a transmissible infectious etiology is ruled out.

There are three main types of transmission-based precautions:

- Airborne precaution
- Droplet precaution
- Contact precaution

Note: For some diseases that have multiple routes of transmission, more than one transmission-based precaution category can be used (e.g., influenza, Middle East Respiratory Syndrome-coronavirus [MERS-CoV], varicella).

When used either individually or in combination, each route of transmission-based precautions are always used in addition to the standard precautions. When transmission-based precautions are indicated, efforts should be made to counteract possible adverse effects on patients (i.e., anxiety, depression, and other mood disturbances, perceptions of stigma, reduced contact with clinical staff, and increases in preventable adverse events to improve acceptance by patients and adherence by HCWs).

Airborne Precautions

Airborne precautions prevent the transmission of infectious agents that remain infectious over long distances (particles that are five μm or less in size, can remain in the air for several hours, and can be widely dispersed). This transmission can occur either through airborne droplet nuclei or dust particles containing the infectious microorganisms, which can be produced by coughing, sneezing, talking, or by procedures (e.g., bronchoscopy or suctioning). Special air handling and ventilation are needed to ensure the prevention of airborne transmission of infectious agents. Airborne particles do not land on and contaminate surfaces. These precautions are effective in preventing such infections as *Mycobacterium tuberculosis*, Chicken pox, and measles. They are recommended for patients with either known or suspected infections that could be transmitted by airborne route. The precautions include:

Patient Placement

Patients should be placed in airborne infection isolation room. An airborne infection isolation room is a single-patient room that is equipped with special air handling and ventilation capacity (i.e., a facility that could create negative pressure relative to the surrounding area, 12 air exchanges per hour for new construction and renovation, and six air exchanges per hour for existing facilities, air exhausted directly to the outside). In a setting where resources are limited, the air in the room should be exhausted to the outside using a fan or other filtration system keeping the door closed at all times.

- If a private room is not available, place patients in a room with patients having active infection with the same disease, but with no other infection (cohorting).
- The staff on duty should check all visitors for susceptibility before allowing them to visit.
- Limit movements in and out of the room to HCWs caring for the patient.
- In areas where TB is prevalent, it is important to devise a mechanism to quickly assess patients with suspected TB and put them under airborne precautions.
- Respiratory hygiene and cough etiquette to prevent the spread of respiratory secretions via droplets expelled from the respiratory tract onto the hands and surfaces. This includes:
    - Cover the mouth and nose when coughing and sneezing, and dispose of used tissues in the nearest waste container.
    - Perform hand hygiene after contact with respiratory secretions and contaminated objects.
- Maintain an appropriate distance from and between symptomatic patients, at least one meter (three feet).
- Identify persons with symptoms suggestive of acute respiratory illness and teach them to use a surgical mask and practice cough etiquette.

During seasons of high transmission of respiratory diseases, screen patients for symptoms of respiratory infections and provide a separate space in the waiting area distant from other patients (at

least one meter/three feet). Apply additional disease- or syndrome-specific transmission-based precautions, as needed.

The transmission of SARS-CoV in emergency departments by patients and their family members during the widespread SARS outbreaks in 2003, and subsequently Ebola in 2014, highlighted the need for vigilance and prompt implementation of infection control measures in key healthcare setting areas (e.g., reception and triage areas in emergency departments, outpatient clinics, and physician offices).

The strategy targets patients, accompanying family members, and friends with undiagnosed transmissible respiratory infections, and applies the procedure to any person with signs of illness, such as cough, congestion, rhinorrhea, or increased production of respiratory secretions on arrival at the health facilities and afterwards. The term, cough etiquette, is derived from recommended source control measures for *M. tuberculosis.*

Elements of Respiratory Hygiene/Cough Etiquette

- Education of healthcare facility staff, patients, and visitors.
- Posted signs, in language(s) appropriate to the population served, with instructions to patients and accompanying family members or friends. Visual alerts are posted at the entrance to and inside the outpatient facilities (e.g., emergency departments, physician offices, outpatient clinics) with instructions to patients and persons accompanying them to practice respiratory hygiene/cough etiquette, and inform a staff member of their symptoms as soon as possible. Generally, a person having a cough should be provided with a mask.
- Source control measures (e.g., covering the mouth/nose with a tissue when coughing and prompt disposal of used tissues, using surgical masks on the coughing person when tolerated and appropriate).
- Hygiene of the hand after contact with respiratory secretions.
- Spatial separation, ideally more than three feet (one meter), of persons with respiratory infections in common waiting areas, when possible. When possible, encourage people in common waiting areas who are coughing to sit at least one meter/three feet away from others.
- Covering sneezes and coughs and placing masks on coughing patients are proven means of source containment that prevent infected persons from dispersing respiratory secretions into the air.
- Restrict susceptible HCWs from entering the room of patients known or suspected to have measles, chicken pox, disseminated zoster, or smallpox, if other immune HCWs are available.

Use of PPE

- Wear a particulate respirator, such as a fit-tested N95 mask, and conduct a seal check before entering the patient's room (or use at least a surgical mask if particulate respirator is not available). A seal check should be performed every time the N95 is used.

- In the case of chickenpox or measles, no mask is needed for immune persons, but susceptible persons should not be allowed to enter the room.
- Remove the respirator or surgical mask after leaving the room and place it in a plastic bag or waste container with a tight-fitting lid.
- Gown, gloves, and eye protection are not needed for many organisms transmitted exclusively by the airborne route (such as *M. Tuberculosis*, measles) but may be needed when an infectious microorganism is transmitted by multiple routes (e.g., varicella virus).

Patient Transport

Limit the transport of patients to essential reasons only, for example, diagnostic tests or therapeutic procedures that cannot be performed in the room. If the patient needs to leave the room for a test or procedure:

- Alert the department or facility where the patient is being transported so that they can prepare to receive a patient on transmission-based precautions.
- Use PPE appropriately.
- Ensure that a patient on droplet or airborne precautions wears a surgical mask when outside the patient's room.
- Cover wounds with appropriate dressings.
- Clean and disinfect the wheelchair or coach after transportation.
- Remove PPE and perform hand hygiene once the patient has been transported.

Droplet Precautions

These precautions reduce the risks of transmission of pathogens spread wholly or partly by droplets larger than five μm in size (e.g., *Bordatella pertussis, H. influenza* & *N. Meningitides*, *M. pneumonia*, flu, mumps, and rubella viruses). Other conditions include diphtheria, pertussis, pneumonic plague, and *S. pharyngitis*.

These pathogens remain in the air briefly and can travel about one meter (three feet) or less. Droplet transmission requires close proximity or contact between the source and the susceptible host. Droplets may also land on surfaces and then be transferred by contact transmission.

Patient Placement

- Private room, door can be left open. Patients should wear a surgical mask in waiting rooms and when outside the patient's room.
- If a private room is not available, place the patient in a room with a patient having active infection with the same disease, not with another infection.
- If neither option is available, maintain over one meter (three feet) of spatial separation between patient beds. Use of a physical barrier, such as a curtain or divider, is especially important to prevent transmission by droplets.

- Limit the transport of patients to essential purposes only and notify in advance the area of the receiving patients.

Use of PPE

- Wear eye protection and a face mask or face shield, which covers the eyes, nose, and mouth completely, before entry into the patient care area.
- Remove PPE after leaving the patient care area. If PPE is to be reused, it must be cleaned and disinfected before each reuse.
- Always perform hand hygiene before and immediately after patient care.

Cleaning

- Ensure that rooms of patients on droplet precautions are frequently cleaned and disinfected (at least daily and before use by another patient). Focus cleaning on surfaces, frequently touched items, and equipment in the immediate patient area.
- Use gloves, gown, and face/eye protection when cleaning patient care equipment and the environment of a patient who has been on contact precautions.

Contact Precautions

Patients are placed on contact precautions when they have suspected or known infections that are spread directly or indirectly from an infected or colonized individual by touch or contact with the patient or the patient's environment (surfaces and equipment). Contact is a common way that germs spread in healthcare facilities. Organisms that require contact precautions include cholera; varicella-zoster virus (shingles); neonatal or mucocutaneous herpes simplex virus; enterovirus meningitis; patients infected or colonized with enteric pathogens; hemorrhagic fever viruses; multidrug-resistant organisms, such as CRE; and *C. difficile*. Chicken pox is spread by both airborne and contact routes at different stages of illness. Contact precautions should be implemented for patients with wet or draining infection that may be contagious (e.g., draining abscesses, herpes zoster, impetigo, conjunctivitis, scabies, lice, and wound infection).

Patient Placement

Isolate patients who require contact precautions in a single room, if possible. The door can be left open in this case. If a private room is not available, place the patient in a room with a patient having active infection with the same microorganism, not with another infection (cohorting). In multi-patient rooms, more than one meter (three feet) spatial separation between patient beds is advised to reduce the opportunities for inadvertent sharing of items between the infected/colonized patient and other patients.

Use of PPE

- Put on a clean, non-sterile gown and gloves on entering the patient care area; remove and properly discard before exiting the patient room.
- Perform hand hygiene immediately after removing PPE.
- For semi-private or multi-patient rooms, do not use the same PPE between patients.

- Remove PPE, perform hand hygiene, and put on new PPE before coming in contact with another patient or patient environment (e.g., bed, patient locker, over-bed table, IV stand).

Handwashing

- Involves HCWs cleaning their hands before, after, and at specific moments during patient care and when performing healthcare tasks.
- Wash hands with antimicrobial agent or use alcohol hand rub before entering a room and after removing gloves (if patient has *C. difficile* diarrhea, need to wash hands with soap and water after removing gloves).
- Do not touch potentially contaminated surfaces or items before leaving the room.

Patient Transport

- Limit the transport of patients to essential purposes only.
- During transport, ensure that precautions are maintained to minimize the risk of transmission of organisms (i.e., cover patient with a clean linen, not the linen that was used on the patient's bed).

Patient Care Equipment

- Use disposable or dedicated patient care equipment (e.g., blood pressure cuffs) and clean and disinfect equipment before reuse on other patients.

Cleaning

- Ensure that the rooms of patients on contact precautions are frequently cleaned and disinfected (at least daily and before use by another patient).
- Focus cleaning on toilets, frequently touched surfaces, and equipment in the immediate patient area.
- Use gloves and a gown when cleaning patient care equipment and the environment of a patient who has been on contact precautions.
- Organisms that form spores (such as norovirus and *C. difficile*) require cleaning products, such as bleach, that inactivate spores, which are more difficult to destroy than vegetative microorganisms.

Empiric/Syndromic Use of Transmission-Based Precautions

Every effort should be made to diagnose the microorganism responsible for infection; however, laboratory diagnosis is not immediately available and not always available. In these circumstances, precautions must be based on empiric/syndromic findings. If there is any question about whether a patient without a known diagnosis has a specific infection, implement transmission-based precautions informed by the patient's signs and symptoms until a definitive diagnosis (i.e., laboratory test results) can be made.

A complete listing of clinical syndromes or conditions warranting the empirical use of transmission-based precautions is presented in table 3.1.

Table 3.1. Empiric use of transmission-based precautions (based on signs and symptoms) for isolation of a patient in the hospital

Contact	Droplet	Airborne
Acute diarrhea in an incontinent or diapered patient Diarrhea in an adult with a history of recent antibiotic use or hospitalization (in settings with *C. difficile*) Upper respiratory infections in infants and young children (wear a mask, as per standard precautions) History of infection/colonization with multidrug-resistant organisms (use airborne precautions for TB) Abscess or infected draining wound that cannot be covered with bandages Skin or wound infection with excessive drainage in a patient with a recent hospitalization (in settings where multidrug-resistant microorganisms are prevalent)	Symptoms of upper respiratory infection; cough, runny nose, sore throat, congestion Severe during periods when pertussis is present in the community Suspected meningitis: fever, vomiting, and stiff neck, persistent cough. Hemorrhagic rash with fever Generalized rash of unknown cause	Chronic cough/fever/weight loss/night sweats and upper lobe chest findings Cough or fever and chest findings in a person who is infected with HIV or at high risk for HIV Rashes (vesicles or pustules) suggestive of varicella Acute respiratory distress syndrome when new respiratory organisms are a risk in the community Vesicular rash (suspected varicella) (wear gown, gloves, and eye protection also)

Adapted from: Siegel, Rhinehart, Jackson, et al. 2007.

In all situations, transmission-based precautions must be used in conjunction with standard precautions (Siegel, Rhinehart, Jackson, et al. 2007).

SUMMARY

To protect HCWs, patients, and visitors from acquiring infections during healthcare facility visits, ensure compliance with standard precautions for all patients at all times, and apply transmission-based precautions to all patients with potential or confirmed infections that are transmitted via contact, droplet, and airborne routes.

Standard precautions, including hand hygiene, are the cornerstone of IPC. They provide the first line of defense in the prevention of transmission of pathogens in healthcare facilities. Transmission-based precautions, including their empiric use, are designed to provide additional protection, and reduce the risk of transmission via airborne, droplet, and contact routes among hospitalized patients and HCWs.

These guidelines serve as the minimum requirements that should be enforced in all healthcare settings to protect patients, visitors, and HCWs.

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CHAPTER 4: HAND HYGIENE

Key Topics

- When to perform hand hygiene (WHO's "5 Moments for Hand Hygiene")
- Proper technique for washing hands with soap and water
- Proper technique for use of ABHR
- Issues and considerations related to hand hygiene
- Monitoring hand hygiene
- WHO's strategy for improving hand hygiene programs

BACKGROUND

Hand hygiene is the single most important measure to prevent the transmission of infection and is the cornerstone of IPC. The original study in this field was conducted at a maternity hospital in Vienna, Austria in 1847. This study demonstrated that the mortality rate among mothers was significantly lower when the HCWs cleaned their hands with an antiseptic agent (Semmelweiss 1861). Numerous other studies since then have demonstrated that HCWs' hands become contaminated during routine care of patients and can transmit infectious diseases from patient to patient (Association of periOperative Registered Nurses [AORN] Recommended Practices Committee 2004; Duckro, Blom, Lyle, et al. 2005; Ojajarvi 1980; Pittet, Dharan, Touveneau, et al. 1999; Riggs, Sethi, Zabarsky, et al. 2007; Sanderson and Weissler 1992). Proper hand hygiene can prevent the transmission of microorganisms and decrease the frequency of HAIs. Despite evidence that hand hygiene prevents the transmission of infections, compliance with hand hygiene recommendations during patient care continues to present ongoing challenges in all settings. Methods used to improve compliance with hand hygiene are addressed later in this chapter.

The goal of hand hygiene is to remove soil, dirt, and debris, and reduce both transient and resident flora. Hand hygiene can be performed using ABHR or by washing the hands with water and plain or antimicrobial soap (bar or liquid) that contains an antiseptic agent, such as chlorhexidine, iodophors, or triclosan (WHO 2009a).

Traditionally, handwashing with soap and water has been the primary method of hand hygiene; however, ABHR has been shown to be more effective for standard hand hygiene than plain or antimicrobial soaps (CDC 2002). However, ABHR effectiveness is best achieved when hands are not visibly soiled. Recommendations for when and how to perform hand hygiene are described in this chapter.

"Failure to perform appropriate hand hygiene is considered to be the leading cause of healthcare associated infections (HAIs) and the spread of multidrug resistant microorganisms, and has been recognized as a significant contributor to outbreaks."

Boyce, Pittet, the Healthcare Infection Control Practices Advisory Committee 2002

When to Perform Hand Hygiene (Hand Hygiene Opportunities)

WHO has five recommended points in time when hand hygiene should occur to prevent transmission of HAIs. These recommendations are called the "My 5 Moments for Hand Hygiene" and focus on the following times:

- Before making contact with a patient
- Before performing a clean/aseptic task, including touching invasive devices
- After performing a task involving the risk of exposure to a body fluid, including touching invasive devices
- After patient contact
- After touching equipment in the patient's surrounding areas (WHO 2006a)

The "5 Moments" are numbered according to healthcare workflow in an attempt to ease recall for HCWs (table 4.1).

Table 4.1. WHO's five recommended moments for hand hygiene

1	BEFORE PATIENT CONTACT	WHEN?	Clean your hands before touching a patient when approaching him or her.
		WHY?	To protect the patient against harmful germs carried on your hands.
2	BEFORE ASEPTIC TASK	WHEN?	Clean your hands before any aseptic task.
		WHY?	To protect the patient against harmful germs, including the patient's own germs entering his or her body.
3	AFTER BODY FLUID EXPOSURE RISK	WHEN?	Clean your hands immediately after exposure risk to body fluids (and after glove removal).
		WHY?	To protect yourself and the healthcare environment from the patient's harmful germs.
4	AFTER PATIENT CONTACT	WHEN?	Clean your hands after touching the patient and his or her immediate surrounding and leaving the room.
		WHY?	To protect yourself and the healthcare environment from the patient's harmful germs.
5	AFTER CONTACT WITH PATIENT SURROUNDING	WHEN?	Clean your hands after touching any object in the patient's immediate surroundings, when leaving. Even without touching the patient.
		WHY?	To protect yourself and the healthcare environment from the patient's harmful germs.

Source: WHO 2020

- Other Opportunities for Hand Hygiene
- Immediately on arrival and before departure from work (the health facility)
- Immediately after touching contaminated instruments or articles
- Before putting on gloves and after removing them

- Whenever the hands become visibly soiled after nasal blowing or following a covered sneeze
- Before touching the face (eyes, nose, or mouth)
- Before and after cleaning the environment
- Before and after preparing food
- Before eating and drinking or serving food
- After visiting the toilet

Hand Hygiene for Patients and Patient Caretakers and Visitors

- Patients, their caretakers, and visitors should also be instructed on proper hand hygiene with alcohol rub or soap and water, as indicated.
- Opportunities for hand hygiene by patients, caretakers, and visitors include:
    - Before eating
    - After using the toilet
    - Before and after handling their babies
    - Before and after helping to care for patients
    - When hands are soiled

Hand Hygiene Methods

Handwashing with Soap and Water

The purpose of routine handwashing in healthcare is to remove dirt and organic material, and microbial contaminants from the hands. Clean water must be used to prevent microorganisms in the water from contaminating the hands. However, water alone is not effective at removing substances containing fats and oils, which are often present on soiled hands. Proper handwashing also requires soap, which is rubbed on all hand surfaces, followed by thorough rinsing and drying.

The cleansing activity of handwashing is achieved by both friction and the detergent properties of the soap. Plain soap has minimal antimicrobial properties, but assists with the mechanical removal of debris and loosely adherent microbes, while the mechanical action removes some bacteria from the hands. Time is also an important factor—handwashing for 30 seconds has been shown to remove 10 times the amount of bacteria as handwashing for 15 seconds. The entire handwashing procedure, if completed properly, as described step by step in figure 4.1, should take 40–60 seconds (CDC 2002; WHO 2009a).

Figure 4.1. The steps for routine handwashing (How to properly wash your hands)

Source: WHO 2009c

Handwashing with soap and water is recommended (rather than using ABHR) in the following situations:

- If the hands are visibly soiled or contaminated with blood or body fluids
- After using the toilet
- Before eating

- To remove the buildup of emollients (e.g., glycerol) on the hands after repeated use of ABHR
- In outbreaks of *C. difficile*, but not in healthcare settings with only a few cases of *C. difficile* (Cohen, Gerding, Johnson, et al. 2010; Siegel, Rhinehart, Jackson, et al. 2007). *C. difficile* is a bacterial infection that causes severe diarrhea and is common in some settings.

Avoiding Contamination of the Hands During Handwashing

Because microorganisms grow and multiply in moisture and in standing water, the following are recommended to prevent contamination of the hands during handwashing:

- Avoid bar soaps, when possible, because they can become contaminated, leading to colonization of microorganisms on the hands. There is some evidence, however, that the actual hazard of transmitting microorganisms through handwashing with previously used bar soaps is negligible. If bar soap is used, provide small bars and use soap racks that drain the water after use (WHO 2009a).
- Do not add liquid soap to a partially empty liquid soap dispenser. This is known as "topping off." The practice of topping off dispensers may lead to bacterial contamination of the soap. Using refill packets avoids this problem, but if they are not available, dispensers should be thoroughly cleaned and dried before refilling (WHO 2009a).
- Filter and/or treat water if a healthcare facility's water is suspected of being contaminated; this will make the water microbiologically safer (WHO 2009a). (See Volume 1, Chapter 11: Food and Water Safety, and Volume 2, Section 2, Chapter 5: Preventing Healthcare-Associated Infectious Diarrhea.)
- Use running water for hand hygiene. In settings where no running water is available, water "flowing" from a prefilled container with a tap is preferable to still-standing water in a basin. Use a container with a tap that can be turned off, preferably with the back of the elbow (when hands are lathered) and turned on again with the back of the elbow for rinsing. As a last resort, use a bucket with a lid or a pitcher and a mug to draw water from the bucket, with the help of an assistant, if available (WHO 2009a).
- Avoid dipping the hands into basins of standing water. Even with the addition of an antiseptic agent (e.g., Dettol or Savlon), microorganisms can survive and multiply in these solutions (Rutala 1996).
- If a drain is not available where hands are washed, collect water used from hand hygiene in a bucket that is deep enough to prevent the dirty water from splashing out, and discard it in a drain or in a latrine.
- Dry hands properly because wet hands can more readily acquire and spread microorganisms. Dry hands thoroughly with a method that does not recontaminate the hands. Paper towels or single-use clean cloths/towels are an option. Make sure that towels are not used multiple times or by multiple individuals because shared towels quickly become contaminated (WHO 2009a). Air-dry hands if disposable or single use towels are not available. Do not dry hands on personal clothing.

Alcohol-Based Hand Rub

The antimicrobial activity of alcohol results from its ability to denature proteins (i.e., the ability to dissolve some microbe components) and kill microbes. Alcohol solutions containing 60%–80% alcohol are most effective, with higher concentrations being **less** effective. This paradox results from the fact that proteins are not denatured easily in the absence of water; as a result, microorganisms are not killed as easily with higher alcohol-based solutions (> 80% alcohol) (WHO 2009a).

The use of an ABHR is more effective in killing transient and resident flora than handwashing with antimicrobial agents or plain soap and water. It also has persistent (long-lasting) activity. ABHR is quick and convenient to use and can easily be made available at the point of care. ABHR usually contains a small amount of an emollient (e.g., glycerol, propylene glycol, or sorbitol) that protects and softens the skin. ABHR should be used at any of the "5 Moments" described earlier in this chapter, unless hands are visibly soiled (CDC 2002; Girou, Loyeau, Legrand, et al. 2002; WHO 2009a).

To be effective, approximately 3–5 mL (i.e., one teaspoon) of ABHR should be used. The ideal volume of ABHR to apply to the hands varies according to different formulations of the product and hand size (refer to the manufacturer's instructions for use). ABHR should be used following the steps shown in figure 4.2 for approximately 20–30 seconds or until the solution has fully dried. Because ABHR does not remove soil or organic matter, if the hands are visibly soiled or contaminated with blood or body fluids, wash the hands with soap and water. To reduce the buildup of emollients on the hands after repeated use of ABHR, washing the hands with soap and water after every 5–10 applications of ABHR is recommended.

In *C. difficile* outbreak settings, handwashing with soap and water is recommended over ABHR because it is more effective than ABHR in removing endospores. If there are only a few cases of *C. difficile*, normal use of ABHR is recommended (Cohen, Gerding, Johnson, et al. 2010; Siegel, Rhinehart, Jackson, et al. 2007; WHO 2009a). The need for using soap and water over ABHR during outbreaks of norovirus is an unresolved issue (Siegel, Rhinehart, Jackson, et al. 2007; WHO 2009a).

Figure 4.2. WHO recommendation on how to perform hand hygiene with ABHR

Source: WHO n.d.

Producing Alcohol-Based Hand Rub

An effective ABHR solution is inexpensive and simple to make, even in resource-limited settings. WHO provides procedures for making ABHR in healthcare facility pharmacies (box 4.1).

Box 4.1. Alcohol-based hand rub formulation

Formulation 1: To produce final concentrations of ethanol 80% v/v, glycerol 1.45% v/v, hydrogen peroxide (H_2O_2) 0.125% v/v:

Pour into a 1,000-mL graduated flask:

1. Ethanol 96% v/v, 833.0 mL
2. H_2O_2 3%, 41.7 mL
3. Glycerol 98%, 14.5 mL

Top up the flask to 1,000 mL with distilled water or water that has been boiled and cooled; shake the flask gently to mix the contents.

Formulation 2: To produce final concentrations of isopropyl alcohol 75% v/v, glycerol 1.45 v/v, hydrogen peroxide 0.125% v/v:

Pour into a 1,000-mL graduated flask:

1. Isopropyl alcohol (with a purity of 99.8%), 751.5 mL
2. H_2O_2 3%, 41.7 mL
3. Glycerol 98%, 14.5 mL

Top up the flask to 1,000 mL with distilled water or water that has been boiled and cooled; shake the flask gently to mix the contents.

v/v=volume percent, meaning 80 parts absolute alcohol in volume and 20 parts water measured as volume, not as weight

Source: WHO 2009a

Do not add ABHR to a partially empty dispenser. This practice of "topping off" dispensers may lead to bacterial contamination. The use of refill packets avoids this problem, but if they are not available, the dispensers should first be thoroughly cleaned and dried before refilling (WHO 2009a).

Antiseptic Soaps

Antiseptic soaps can be used in place of plain soap during the "My 5 Moments for Hand Hygiene" described above, but are not recommended for most settings. Handwashing with antiseptic soap is more irritating to the skin and more expensive than using ABHR. Therefore, if available, ABHR should be used under normal circumstances (WHO 2009a).

Use of antiseptic soaps is recommended for surgical hand scrub and before entry into special areas of healthcare facilities (e.g., neonatal ICUs).

Surgical Hand Scrub

The purpose of the surgical hand scrub is to mechanically remove soil, dirt, debris, and transient flora microorganisms, and to reduce resident flora before and for the duration of surgery. The goal is to prevent wound contamination by microorganisms from the hands and arms of the surgical team members.

Issues and Considerations Related to Hand Hygiene

Glove Use

Although the effectiveness of gloves in preventing contamination of HCWs' hands has been confirmed, gloves do not provide complete protection against hand contamination. Contamination may occur as a result of small, undetected holes in gloves and during glove removal. Therefore, wearing gloves does not replace the need for proper hand hygiene. Hand hygiene should always be performed before putting on and after removing gloves. (See Volume 1, Chapter 5: Personal Protective Equipment, for details on correct glove use) (CDC 2002; WHO 2002).

Wearing the same pair of gloves and cleaning gloved hands between patients or between dirty and clean body sites is not a safe hand hygiene practice (Siegel, Rhinehart, Jackson, et al. 2007; WHO 2009a; WHO 2009c; WHO 2009d). Not changing gloves between patients has been associated with the transmission of microorganisms, such as MRSA and gram-negative bacilli. Reprocessing gloves is not recommended.

Every effort must be made to reinforce the message that gloves do not replace the use of hand hygiene and that when gloves are required, they should be used in addition to hand hygiene. (See Volume 1, Chapter 5: Personal Protective Equipment, for more information on glove use.)

Hand Lotions and Hand Creams

In an effort to minimize hand hygiene-related contact dermatitis (a skin rash caused by irritation from a substance, such as soap, due to frequent hand hygiene), hand lotions, creams, barrier creams, and moisturizing skin care products are recommended. Hand lotions and creams often contain humectants (substances that help retain moisture) and various fats and oils. The humectants can increase hydration and replace altered or depleted skin lipids that can serve as a barrier to microorganisms on normal skin. Several studies have shown that regular use (i.e., at least twice per day) of such products can help prevent and treat contact dermatitis. There is also biologic evidence that emollients (e.g., glycerol and sorbitol) contained in ABHR, with or without antiseptics, may decrease cross-contamination because they reduce shedding of bacteria from the skin for up to four hours. These products are absorbed into the superficial layers of the epidermis and are designed to form a protective layer that is not removed by standard handwashing (Boyce, Pittet, the Healthcare Infection Control Practices Advisory Committee 2002; McCormick, Buchman, Maki 2000; WHO 2009a).

Therefore, although the use of hand lotions, creams, and moisturizers by HCWs should be encouraged, there are some considerations. First, to reduce the possibility of the products becoming contaminated, provide small, individual-use containers or pump dispensers, which are completely emptied and cleaned before being refilled. Refilling or topping off lotion containers may lead to contamination and proliferation of bacteria in the lotion. Second, to avoid confusion, hand lotion dispensers should not be located near dispensers of antiseptic solutions. Moreover, oil-based barrier products, such as those containing petroleum jelly (e.g., Vaseline® or lanolin), should not be used because they damage latex rubber gloves.

Resistance to Topical Antiseptic Agents

With the increasing use of topical antiseptics, especially in home settings, concern has been raised about the development of resistance to these antiseptics by microorganisms. Although low-level bacterial tolerance to commonly used antiseptic agents has been observed, studies have shown no clinical evidence to date that supports the development of resistant microorganisms following use of any topical antiseptic agents (WHO 2009a).

Lesions and Skin Breaks

Cuticles, hands, and forearms should be free of lesions (e.g., ulcers, abscesses, and tumors), dermatitis, eczema, and skin breaks (e.g., cuts, abrasions, and cracking). Broken skin should be covered with waterproof dressings. If covering is not possible, HCWs with active lesions should not perform clinical duties until the lesions are healed. In particular, surgical HCWs with skin lesions should not operate until the lesions are healed.

Religious and Cultural Considerations

It is clear that cultural and religious factors strongly influence attitudes toward handwashing. During efforts to enhance hand hygiene compliance, it is advisable to consider possible religious and cultural factors that may act as barriers to practice, and tailor promotional activities to address these issues. WHO's *Guidelines on Hand Hygiene in Health Care* provide information outlining these considerations (WHO 2009a).

Fingernails

Research has shown that the area beneath the fingernails harbors the highest concentrations of bacteria on the hands. This area most frequently harbors coagulase-negative staphylococci (a bacterium normally found on the skin), gram-negative rods (bacteria known to cause infection), *Corynebacteria* (bacteria), and yeasts. Fingernails longer than 0.2 cm (0.08 inches) have been shown to increase carriage rates of *S. aureus*. Moreover, long nails, either natural or artificial, tend to puncture gloves more easily than short nails. Therefore, nails should be kept moderately short —not extend more than 0.5 cm (0.2 inches) beyond the fingertip. (CDC 2002; Fagernes and Lingaas 2011; McGinley, Larson, Leydon 1988; Olsen, Lynch, Coyle, et al. 1993; WHO 2009a).

Artificial Nails

Individuals with artificial nails have been shown to harbor more pathogenic organisms (i.e., disease-causing microorganisms), especially gram-negative bacilli and yeast, on the nails and in the area beneath the fingernails. Studies have demonstrated that the longer the artificial nail is, the more likely that a pathogen can be isolated. Therefore, artificial nails (e.g., nail wraps, nail tips, acrylic lengtheners) should not be worn in clinical areas because they constitute an infection risk in high-risk areas (Hedderwick, McNeil, Lyons, et al. 2000; Jumaa 2005; Siegel, Rhinehart, Jackson, et al. 2007).

Nail polish

There is concern that individuals wearing nail polish may be hesitant to perform rigorous hand hygiene in an effort to protect their nails, although no studies have demonstrated a relationship between freshly applied nail polish and infection. However, compromises in hand hygiene technique may lead to transmission of infection. Chipped nail polish supports the growth of a larger number of organisms on fingernails compared with freshly polished or natural nails. Also, dark-colored nail polish may prevent dirt and debris under fingernails from being seen and removed (Baumgardner, Sallese Marago, Walz, et al. 1993; CDC 2002; Rothrock 2006). The recommendation is that health workers avoid using dark-colored nail polish when providing patient care.

Jewelry

Current evidence demonstrates that wearing rings increases hand contamination. Research has also shown that HCWs wearing wristwatches had a higher total bacterial count on their hands compared with HCWs without wristwatches. Surgical team members should not wear rings because it may be more difficult for them to put on surgical gloves without tearing them (Fagernes and Lingaas 2011; Siegel, Rhinehart, Jackson, et al. 2007; Trick, Vernon, Hayes, et al. 2003). Rings with ridges or stones should be avoided because of the greater difficulty in cleaning effectively, and the increased likelihood of damage to gloves and injury to patients. If plain wedding rings are worn, they should be moved up and down during hand hygiene for more effective cleaning.

In summary, HCWs should adhere to the following to ensure effective hand hygiene practices:

- Keep nails short, clean, and without polish or artificial nail extensions.
- Do not wear wrist watches and jewelry, including wearing rings with ridges or stones.
- Cover any cuts or abrasions with waterproof dressings.
- Keep sleeves short or rolled up.

Hand Care

Hand care is important to protect the skin from drying and cracking. Cracked skin may encourage microbial colonization and broken areas can present a site of entry for pathogens. Hand creams can be applied to care for the skin on hands.

Communal tubs of hand cream must be avoided because they may contain bacteria over time, and lead to contamination of the hands.

Note: The following are recommendations for hand care to prevent irritation due to frequent hand hygiene (based on WHO hand care recommendations [WHO 2009a]).

- Develop a regular routine of using a protective hand cream or lotion, at least daily.
- Do not routinely wash hands with soap and water immediately before or after using an ABHR.
- After hand rubbing or handwashing, let your hands dry completely before putting on gloves.

- Use ABHRs with emollients rather than detergent-based soaps.
- Select efficacious products with the least potential for irritation.
- Avoid unnecessary prolonged glove use.
- Dry hands completely after washing and before gloving.
- Avoid rough paper towels; pat rather than rub dry.
- Don't use soaps, detergents, or aqueous creams or lotions containing sodium lauryl sulfate.
- When skin is damaged or frequent handwashing is required, a mild soap (without antiseptic agent) should be used to remove soil and debris.
- In high-risk areas, such as the operating room, neonatal ICU, or transplant units, hand scrub protocols that use soft brushes or sponges for a shorter time (at least two minutes) should replace harsh scrubbing by hard brushes for six to ten minutes.

Monitoring Hand Hygiene

WHO's *Guidelines on Hand Hygiene in Health Care* encourage providers in all healthcare settings to evaluate, improve, and monitor the reliability of hand hygiene practices with the aim of changing the behavior of HCWs. Optimizing hand hygiene compliance at the five recommended moments for hand hygiene increases PS (WHO 2009a; WHO 2009e).

Hand hygiene compliance can be monitored both directly and indirectly (table 4.2) (WHO 2009a). Each method of monitoring hand hygiene has its own advantages and disadvantages (table 4.3). However, the direct observation of hand hygiene compliance by a validated observer is considered the "gold standard" in hand hygiene monitoring. It is often valuable to use more than one method of monitoring at the same time (The Joint Commission 2009; WHO 2009a).

Validity and reliability are important aspects of direct hand hygiene monitoring. The validity of a new observer should be confirmed by either joint observations with another confirmed observer or by being tested through the WHO Training Film: A Tool to Help Convey the Concept of the "5 Moments for Hand Hygiene" to Health-Care Workers (http://www.who.int/gpsc/media/training_film/en/), which is available online. Results should be compared and any discrepancies should be discussed. This process should be repeated until the HCW is fully competent (WHO 2009a).

Validity: Doing a procedure technically correctly following the "gold standard" for that procedure. Reliability: Completing a procedure technically correctly at all times following the "gold standard" for that procedure.

Table 4.2. Hand hygiene observation methods

Direct methods of hand hygiene observation	Indirect methods of hand hygiene observation
Direct observation	Monitoring consumption of products (soap or ABHR)
Patient assessment	Automated monitoring of the use of sinks or ABHR dispensers

Source: WHO 2009a

In the implementation of a hand hygiene monitoring program, expectations for performing hand hygiene should be clearly defined and made known in the healthcare facility. Policies detailing these expectations should also be in place. Monitoring should occur on a regular, routine basis, and a set minimum number of observations should be collected in a given monitoring period.

Table 4.3. Advantages and disadvantages of various hand hygiene monitoring approaches

Monitoring approach	Advantages	Disadvantages
Direct observations by expert observers	Only way to reliably capture all hand hygiene opportunities Details can be observed Unforeseen qualitative issues can be detected while observing hand hygiene	Time-consuming Skilled and validated observers required Prone to observation, observer, and selection bias
Self-reports by HCWs	Inexpensive	Overestimate of true compliance Not reliable
Direct observations by patients	Inexpensive	Potential negative impact on patient-HCW relationship Reliability and validity required and remain to be demonstrated
Consumption of hygiene products (e.g., towels, soap, and ABHR)	Inexpensive Reflects overall hand hygiene activity (selection biased) Validity may be improved by using indirect denominators (e.g., patient-days or workload that is converted into total hand hygiene opportunities)	Does not reliably measure the need for hand hygiene (denominator) No information about the appropriate timing of hand hygiene actions Prolonged stocking of products at ward level complicates and might jeopardize the validity Validity threatened by increased patient and visitor usage Not able to discriminate between individual or professional group usage

Source: WHO 2009a

Direct Monitoring

The goal of the direct hand hygiene observation is to observe HCWs during their usual patient care activities. The observers should assess the HCWs' compliance with indications for hand hygiene and with facility policies on hand hygiene practices. It is preferable that observers have training and experience as patient care professionals but this is not essential.

Hand hygiene observations should focus on the two essential parameters for determining hand hygiene compliance:

1. The indication for hand hygiene
2. The observed hand hygiene action related to the indication

When the HCW is observed, the action is considered to have been either "performed" or "not performed" (WHO 2009).

WHO recommends that the "5 Moments" be used as a framework for observing opportunities for hand hygiene. It is possible, however, to simplify which moments are observed, based on the objectives of the period of observation and/or the resources available. Observation can be limited to certain professional role categories or disciplines or certain indications in the "5 Moments" (e.g., in some settings it may be appropriate to observe the action of hand hygiene only before and after contact with the patient or the patient environment) (WHO 2009; WHO 2009a).

Observations should be collected in a standard way, such as on a form (Appendix 4A) with each hand hygiene observation session on a separate form. A standard form should have three main sections:

- A header containing information about the healthcare facility and the location in the facility where the session was completed.
- A second header containing information on the session observed.
- Columns below the headers representing the sequence of actions for different HCWs observed during the same session, with each column representing one HCW. (See Appendix 4A for the WHO Observation Form.) (WHO 2009a; WHO 2009e)

Content can be adapted to suit the needs of the facility. Appendix 4B is a sample observation form for hand hygiene data collection. This form reflects a modified approach that looks at hand hygiene compliance at room entry and room exit only (useful for areas with single-patient rooms).

Hand hygiene compliance (%) is the simplest way to analyze the hand hygiene data collected. Hand hygiene compliance is the ratio of the number of actions to the number of opportunities:

Compliance (%) = (# of hand hygiene actions/Total # of opportunities) x 100

Compliance data can be summarized based on total compliance by a HCW, by role or discipline (e.g., doctors, nurses), or by location (e.g., ward A, ward B), depending on the objectives of the monitoring program. It is important to provide feedback and disseminate compliance data to the HCWs and leaders after the observation session/assessments are completed. Minimizing the delay between observation and reporting of results may help increase the effects of the monitoring (WHO 2009a).

There are some limitations with direct monitoring of hand hygiene. For example, HCWs may improve or modify their behavior in response to being observed or studied, resulting in an overestimate of compliance. Therefore, it is important to be aware of this effect when evaluating compliance rates.

Indirect Monitoring

Indirect hand hygiene monitoring, such as monitoring the consumption of hand hygiene products (e.g., soap, ABHR, paper towels) to estimate the number of hand hygiene actions is a less expensive monitoring approach and can be useful in settings where resources for direct monitoring are limited.

However, this methodology requires validation to be most effective. One of the major limitations of this type of indirect monitoring is that it is impossible to determine if the hand hygiene actions were performed at the proper moment (WHO 2009a).

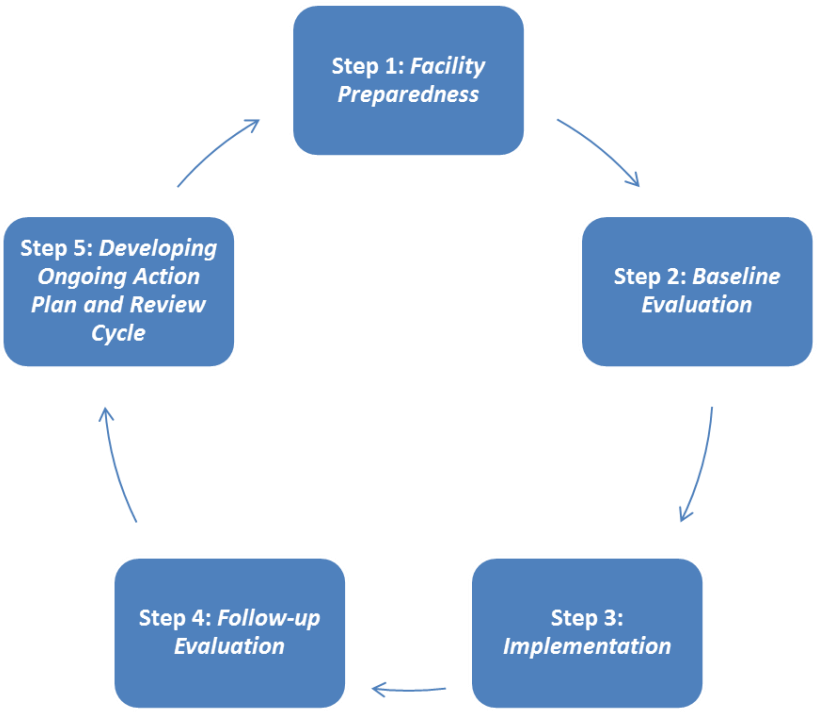
Implementation of a Multimodal Hand Hygiene Improvement Strategy

The WHO *Multimodal Hand Hygiene Improvement Strategy* identifies the key components to address during the implementation of a hand hygiene improvement strategy (WHO 2009a; WHO 2009e). (See Appendix 4C.) The components are:

- System change to ensure that infrastructure is in place, including the availability of ABHR and access to a safe and continuous supply of water, soap, and towels to allow HCWs to practice hand hygiene.
- Training and education of HCWs
- Monitoring of hand hygiene practices and provision of feedback
- Reminders in the workplace
- Creation of a safety culture

To implement these components, the guidelines detail five sequential steps, listed below, with each step building on the activities and actions in the previous steps (figure 4.3). Rather than a linear process, the five steps should be considered a cyclical process, with each cycle being repeated, refined, and enhanced at least every five years. It is imperative to evaluate success factors and areas of weakness in the program to achieve long-term sustainability and process improvement (WHO 2009a).

Figure 4.3. Five steps of the hand hygiene improvement strategy



Adapted from: WHO 2009a

Although complex, the hand hygiene improvement strategy lays the groundwork for the implementation of a sustainable hand hygiene monitoring program. It is aimed at improving hand hygiene compliance and increasing PS in the healthcare facility. The basic elements of each step follow (WHO 2009a; WHO 2009e).

Step 1: Facility Preparedness

Assess and ensure the preparedness of the healthcare facility. Consider the following:

- Identify a person or team to coordinate the program.
- Identify HCWs and facility leadership who will play a major role in program implementation.
- Obtain raw materials to produce ABHR at the healthcare facility's pharmacy (if necessary).
- Train observers on how to monitor hand hygiene practices.
- Train identified persons on how to calculate hand hygiene compliance.

Step 2: Baseline Evaluation

Include a baseline evaluation of hand hygiene practices, facility infrastructure, HCW knowledge, and current beliefs about hand hygiene. Consider the following:

- Survey HCWs on their perceptions of hand hygiene (e.g., do they think that hand hygiene is important, and/or effective, and/or necessary?).
- Survey HCWs on their knowledge of hand hygiene (e.g., do they know how and when to perform proper hand hygiene?).
- Look for details in the healthcare facility's structure that may help explain current hand hygiene compliance (e.g., is there easy access to running water, sinks, and/or ABHR?).
- Monitor the use of soap and ABHR, if applicable.
- Collect baseline data on hand hygiene compliance.
- Make sure that ABHR and dispensers are available in time for the start of Step 3.
- Compile data on hand hygiene practices.

Step 3: Implementation

Implement the planned program. Consider the following:

- Share baseline data with HCWs.
- Distribute educational materials, hand hygiene guidelines, and/or policies to HCWs.
- Distribute ABHR to HCWs.
- Measure how much ABHR is used each month.

- Hold education and training sessions.
- Survey HCWs on their opinion of the ABHR (e.g., do they find it acceptable?).
- Continue to monitor hand hygiene compliance observations, if possible.
- Meet monthly with key HCWs involved with the hand hygiene program.

Step 4: Follow-Up Evaluation

Evaluate the short-term impact of the implemented hand hygiene program. Considered the following:

- Survey HCWs and healthcare facility leadership on their perceptions of hand hygiene (e.g., Do they think that hand hygiene is important and/or effective and/or necessary?).
- Survey HCWs on their knowledge of hand hygiene (e.g., Do they know how and when to perform proper hand hygiene?).
- Inspect the healthcare facility structure to determine whether there are any barriers to hand hygiene compliance related to structural issues.
- Collect data on soap and ABHR use.
- Collect data on hand hygiene compliance.
- Complete data entry.

Step 5: Developing an Ongoing Action Plan and Review Cycle

Develop an ongoing action plan and review cycle. Consider the following:

- Review collected data and results carefully.
- Prepare a report on the findings of the entire program.
- Share information about the findings of the program with leadership and HCWs.
- Create a five-year plan of action to continue to improve and promote hand hygiene compliance.

Modifying a Hand Hygiene Program

In situations where the complete implementation of the WHO hand hygiene improvement strategy is not possible, due to either limited resources or time, a hand hygiene improvement team should focus on the minimum criteria listed in table 4.4. These criteria ensure the achievement of each component of the multimodal strategy and include the most pertinent steps of the program (WHO 2009a).

Table 4.4. Minimum criteria for implementation

Multimodal component	Minimum criteria for implementation
1a. System change: ABHR	Bottles of ABHR are positioned at the point of care in each ward or given to HCWs.
1b. System change: Access to safe, continuous water supply and towels	There is one sink for at least every 10 beds; soap; running water; and clean, dry towels available at every sink.
2. Training and education	A program to update training over the short, medium, and long term is established.
3. Observation and feedback	Two periods of observational monitoring are undertaken: the baseline evaluation and the follow-up evaluation.
4. Reminders in the workplace	"How to" and "5 Moments" posters are displayed in all wards (e.g., patient rooms, health facility staff areas, outpatient areas, ambulatory departments).
5. Institutional safety climate	The Chief Executive, Chief Medical Officer/Medical Superintendent, and Chief Nurse all make a visible commitment to support hand hygiene improvement during program implementation (e.g., verbal announcements and/or formal letters to health facility staff).

Source: WHO 2009f

Key Message

The hands of HCWs are a major source of transmission of nosocomial pathogens.

SUMMARY

Hand hygiene is the single most important measure to prevent the transmission of infection and is the cornerstone of IPC. The goal of hand hygiene in healthcare is to prevent the transmission of infections by removing bacteria from the hands at strategic "moments" during the care of patients. Hand hygiene can be performed using ABHR or by washing the hands with water and soap. ABHR has been shown to be more effective for standard hand hygiene than plain or antimicrobial soaps, and is more easily available at the point of care. Despite evidence proving that hand hygiene prevents the transmission of infections, compliance with hand hygiene recommendations during patient care continues to be challenging in all settings and requires constant and ongoing efforts from IPC staff. WHO's *Multimodal Hand Hygiene Improvement Strategy* provides a guide for the implementation of a sustainable hand hygiene program at healthcare facilities.

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CHAPTER 4: HAND HYGIENE

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CHAPTER 5: PERSONAL PROTECTIVE EQUIPMENT

Key Topics

- Types and uses of PPE
- Instructions for putting on and removing PPE
- Types of PPE to prevent transmission of infection during an outbreak

BACKGROUND

HCWs are confronted each day with the difficult question of how to work safely in the potentially hazardous environment of healthcare facilities. Today, the most common occupational risk the healthcare personnel face is due to contact with blood and body fluids during routine work, such as cleaning, instrument processing, and patient care. This exposure to pathogens increases the risk of getting HAIs and possible death. HCWs in some occupational settings, such as surgery and delivery rooms, have a higher risk of exposure to pathogens than those in all other departments combined (Gershon & Vlahov 1992; Gershon & Zirkin 1995). However, there is no area of clinical care practice without risk of exposure to infectious substances. The use of risk-appropriate PPE is one of the components of standard precautions, which refers to the wearing of protective barriers or clothing.

The use of PPE is ages old and has been reasonably helpful to protect patients or clients from microorganisms that could be transmitted by medical staff and others working in the healthcare setting. Lately, with the emergence of COVID-19, HIV/AIDS, HBV, HCV, and resurgence of TB in many countries, including in Ethiopia, there is increased awareness of the importance of PPE for protecting HCWs. Hospital administrators, supervisors, and HCWs need to be aware not only of the benefits and limitations of specific PPE, but also of the actual role that PPE play in preventing infection so that they can use them effectively and efficiently.

The basic principle behind wearing PPE is to get physical barrier/protection from pathogenic microorganisms. PPE include gloves, masks/respirators, eyewear (face shields, goggles, or glasses), caps, gowns, aprons, boots, and other items. The most effective barriers are made of treated fabrics or synthetic materials that do not allow water or other liquids (blood or body fluids) to penetrate them. However, these fluid-resistant materials are not widely available because they are expensive. Lightweight cotton clothes (with a thread count of 140/inch) are materials most commonly used for surgical clothing (masks, caps, and gowns) and drapes in many countries. Unfortunately, lightweight cotton does not provide an effective barrier because moisture can pass through it easily, allowing contamination.

On the other hand, denim, canvas, and heavy twill are too dense to allow steam penetration (i.e., they cannot be sterilized), are hard to wash, and take too long to dry. When fabric is used, it should be white or light-colored showing dirt and contamination more easily. To be effective, PPE must be selected, worn, and removed correctly. The state of the PPE is also important for it to effectively provide protection. For example, surgical gowns and drapes have proven to be effective for impending wound infection only when dry. When wet, however, clothes act as a wick or sponge to draw bacteria from the skin or equipment up through the fabric that can then contaminate a surgical wound.

Types and Uses of PPE

As a rule, PPE selection should be based on risk assessment. If there is risk of exposure to patients or health workers, then the PPE or combination of PPEs appropriate for the identified risk should be used. Effectiveness in protection is also dependent on the practice of correct procedures and adherence to rules for wearing (putting-on) and removing (putting-off) the PPE. Table 5.1 shows the use/application and effectiveness of PPEs to block transmission of microorganisms.

Table 5.1. How PPE blocks the spread of microorganisms

Where microorganisms are found (risk assessment)	How microorganisms are spread	Barriers to stop the spread of microorganisms	Must be used for (examples of indications)	Who the barriers protect
Healthcare staff				
Hair and scalp	Shedding skin or hair	Cap	Invasive procedures where tissue beneath the skin is exposed Situation where splashing or exposure of blood, body fluids, secretions, or excretions is likely	Service provider and patient
Nose and mouth	Coughing, talking	Mask (water resistant),		
Face (eyes nose or mouth)	Splashing	Masks, face shields, goggles		
Body, arm, and skin	Shedding skin or hair	Scrub suit, cover gowns		
Nose and mouth	Coughing, talking	Masks	Situation that calls for droplet transmission	
		Special masks (N95)	When airborne transmission is expected	
Hands	Touching	Gloves with handwashing or alcohol hand rubbing	When there is a reasonable chance of the hands coming into contact with blood and other body fluids	Patient
Feet and lower legs	Splashes, spills and sharp material	Closed boots or closed-toe shoes (open sandals are not acceptable)	Situation where splashing or blood, body fluids, secretions, or excretions is likely	Service provider
Patient				
Mucous membrane and non-intact skin	Touching	Gloves	Situation where there is direct contact with a mucous membrane and non-intact skin	Service provider and patient
Blood and body fluids	Splashing or spraying	Gloves, eyewear, mask, drapes, and apron	Invasive procedures where tissue beneath the skin is exposed Situation where splashing or exposure of blood, body	Service provider and patient
	Touching (contact)	Instrument processing		

Where microorganisms are found (risk assessment)	How microorganisms are spread	Barriers to stop the spread of microorganisms	Must be used for (examples of indications)	Who the barriers protect
	Accidental exposure to contaminated needles and scalpel blades	Protective footwear, decontamination and disposal; use of a safe or neutral zone during surgery	fluids, secretions, or excretions is likely	
Contaminated items or waste	Infectious waste	Utility gloves, plastic bags, and proper disposal	Collection, transportation, and disposal of waste	Staff
Unprepared skin	Touching	Skin preparation, drapes, gloves	Invasive procedures where tissue beneath the skin is exposed	Patient
Clinic or hospital environment	Touching	Gloves handwashing, Appropriate dressing	Environmental cleaning and disinfection	Staff and their families

Source: Siegel, Rhinehart, Jackson, et al. 2007

PPE should be:

- Made available close to the point of use for easy accessibility.
- Stored neatly in a clean/dry area to prevent contamination until required for use.
- Preferably for single use; if reusable, there must be a clear policy and standard operating procedure (SOP) for placement in bins after use, and removal for laundering and recycling.
- Have an SOP for stock ordering and rotation to ensure that there is always an adequate supply based on usage and that older items are always used first. Do not wait for stocks to run out before ordering more.

Caps

Head covers are most commonly used as part of surgical attire in surgical and procedure areas. When used, head covers or caps should be large enough to cover the entire scalp and hair (figure 5.1). Facial hair is also required to be covered for surgical procedures in sterile areas (e.g., in the operating theater) using a facial hair covering. They can be disposable or made of reusable cloth that can be laundered. In the surgical and procedure areas, a new clean head covering should be worn each day and changed sooner when soiled with blood or body fluids. The same standard and regularity of cleaning expected for surgical scrubs should be applied when cleaning head/facial coverings (e.g., laundered at the hospital and changed at least daily).

Caps are used to keep the hair and scalp covered so that flakes of the skin and hair are not shed on the wound during surgery. Caps meant to be reliably protective should be large enough to cover all

the hair on the scalp. Head covers or caps are most often worn during surgery and in procedure areas where a sterile field is required. They are not necessary for most other areas in the healthcare facility. Head covers are not part of routine PPE for contact, droplet, or airborne precautions, but are used during outbreaks for viral hemorrhagic fever (VHF). (See the section on use of PPE during outbreaks of VHF at the end of this chapter.)

Figure 5.1 Surgical head coverings

A. Head covering

Adopted from: Blue Sky Scrubs 201

Figure B. Surgical Cap: Adopted from halyard health

Figure C. Adopted from MUDGUARD professional healthcare supplies

Healthcare Workers Wear Caps

- To protect the patient from infection coming from the hair and scalp.
- To protect the staff from splashes and exposure to blood.

Patients Wear Caps

- To keep the sterile field during invasive procedures.

Protective Eye Wear

There are four different types of eye protection that are effective in preventing infection in healthcare facilities (figure 5.2):

1. Goggles
2. Safety glasses
3. Mask with shield
4. Face shield

Eye protection should be comfortable, allow for sufficient peripheral vision (i.e., the area that is visible outside the central area of focus), and must be adjustable to ensure a secure fit. Compared with older styles of goggles, newer styles may provide better indirect airflow properties to reduce fogging, provide better peripheral vision, and offer more size options for fitting goggles to different HCWs.

Eye wear protects staff during an accidental splash of blood or other body fluid by covering the eyes. Masks and eyewear should be worn when performing any task where an accidental splash into the face could occur (e.g., performing cesarean sections, vaginal delivery, or cleaning instruments) when

giving care to patients with droplet precautions. If face shields are not available, goggles or glasses and a mask can be used together.

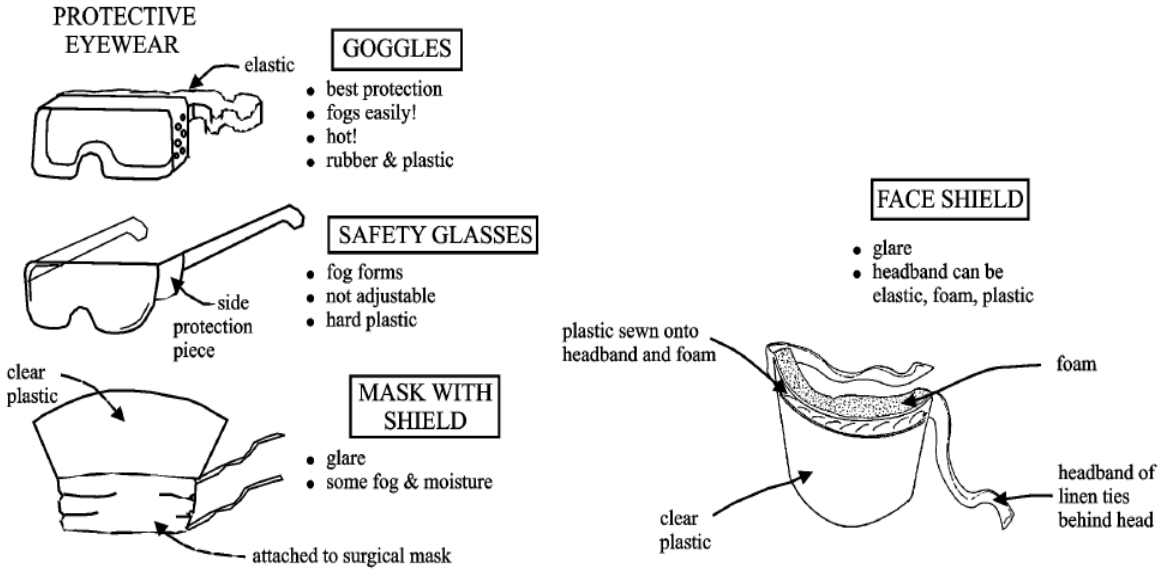
Eye and face protection must be worn when there is risk of splashing body fluids into mucous membranes (e.g., eyes/nose). Eyes can be protected by wearing either goggles or a visor. If reusable eye/face protection is used, it should be decontaminated in accordance with the manufacturer's guidelines. Hands should always be decontaminated after removing the equipment.

Note: Personal eyeglasses and contact lenses are NOT considered adequate eye protection (Siegel, Rhinehart, Jackson, et al. 2007)

Suitable protective eye/face equipment should:

- Be part of standard precautions.
- Be part of droplet precautions to protect from respiratory secretions.
- Be used during procedures and surgery when splashing is likely to happen.
- Be used during specimen collection or aerosol-generating procedures on patients with specific respiratory tract pathogens (e.g., TB or novel respiratory viruses) (WHO 2008b).
- Cover the entire face area (e.g., face shield) if protection of the mouth and nose area is also required.
- Be changed if visibly soiled.
- Be removed using the earpieces/headband to avoid touching potentially contaminated surfaces.
- Be disposed of after use if single-use or placed in a receptacle for reprocessing.
- Fit over personal glasses; antifog properties should be considered.

Figure 5.2. Different types of eye protection equipment



Source: Tietjen, Bossemeyer, & McIntosh 2003

How to Wear Protective Eyewear

Put on eye protection after putting on the isolation gown and mask (if used) but before putting on gloves (figure 5.3).

Figure 5.3. Putting on eye protection

Source: Siegel, Rhinehart, Jackson, et al. 2007

Removal of face shields, goggles, and masks can be performed safely after gloves have been removed (figure 5.4). The ties, earpieces, and/or headband used to secure the equipment to the head are considered "clean" and safe to touch with bare hands. If the ties, earpieces, and/or headband are found to be contaminated, they should be removed using gloved hands, and the skin/face should be rinsed using ample running water and soap. The front of a mask, goggles, and face shield is considered contaminated.

Figure 5.4. Taking off eye protection

Source: Siegel, Rhinehart, Jackson, et al. 2007

Masks

There are many different types of masks used to cover the mouth and nose. Masks made from cotton or paper are comfortable but are not fluid-resistant (do not protect from splashes) and are not an effective filter to prevent inhalation of microorganisms transmitted via droplet nuclei (≤ 5 μm). Masks made from synthetic materials provide protection from large droplets (> 5 μm) spread by coughs or sneezes. They may be more difficult to breathe through than cotton or paper masks. The use of masks during patient care is part of standard precautions when there is a potential for splashes or droplet transmission, and is part of droplet precautions (Siegel, Rhinehart, Jackson, et al. 2007).

There are two types of masks (figure 5.5):

- **Surgical masks:** Regulating bodies (such as United States Food and Drug Administration [FDA], the European Union, and WHO) require surgical masks to have fluid-resistant properties.
- **Procedure/isolation masks:** These are not regulated, and they do not have any specifications for their manufacture.

Surgical Masks

Masks should be large enough to cover the nose, the lower part of the face, the jaw, and all facial hair. They are worn in an attempt to retain/confine moist droplets expelled as health workers or surgical staff speak, cough, or sneeze. Equally important is their protective function against accidental splashes of blood or other contaminated body fluids on the health workers' nose or mouth. This preventive function is only effective if the masks are made of fluid-resistant materials.

When removing, one should handle the masks by the strings; remove it with great care because the center of the mask is the most contaminated part (Rothrock, Mcowen, Smith 2003).

Respirators

These are special types of masks called particulate respirators worn by healthcare personnel for protection against inhalation exposure to airborne infectious agents that are < 5μm. They include infectious droplet nuclei from patients with *Micobacterium tuberculosis*, *Variola virus* (smallpox), SARS-CoV, and dust particles containing infectious particles, such as spores of environmental fungi (e.g., *Aspergillus* sp.). Respirators should be worn when filtering inhaled air is deemed important. These articles contain multiple layers of filter material and fit tightly onto the face allowing no air leaks around the mask when breathing. The N95 disposable particulate and air purifying respirator

is the type used most commonly by healthcare personnel. Other respirators used include N-99 and N-100 particulate respirators; powered air-purifying respirators with high-efficiency filters; and non-powered full-face piece electrometric negative pressure respirators (Siegel, Rhinehart, Jackson, et al. 2007).

Figure 5.5. Types of masks

Surgical Mask | Respirator (N95)

Gowns

Gowns should fully cover the torso of the HCW, fit comfortably over the body, and have long sleeves that fit snuggly at the wrists.

There are three types of protective gowns used in healthcare facilities:

1. Isolation gowns
2. Surgical gowns
3. Coverall suits (See the section on use of PPE during outbreaks of VHF at the end of this chapter.)

Isolation gowns should be long-sleeved, fluid-resistant, single-use, and preferably disposable. Isolation gowns are designed to prevent contamination of the HCW's arms, exposed areas of the body, and clothing from blood, body fluids, and other potentially infectious material.

Note: Isolation gowns should be worn in combination with gloves and other PPE, as recommended.

Surgical gowns are sterile and preferably fluid-resistant, with sleeves that either taper gently toward the wrists or end with elastic or ties around the wrists. Large, droopy sleeves are not recommended because they can cause accidental contamination. Surgical gowns are used during surgery or procedures to protect patients and the sterile field from microorganisms and from blood and other body fluids (e.g., amniotic fluid) present on the HCW's clothing, the front of the HCW's body, and the HCW's arms.

When the surgical gowns are put on, the cuffs of sterile surgical gloves should completely cover the end of the sleeves of the gowns.

Lightweight cloth or paper gowns are not recommended because they offer little protection against moisture, which can easily pass through, allowing the passage of microorganisms. If a cloth or paper gown is used, always wear a plastic apron under/over it.

If a protective covering fails (e.g., during a large spill) and skin/clothing becomes contaminated with blood or body fluids, clothing should be removed and laundered immediately. The HCW should bathe as soon as possible after completing the operation or procedure.

Coveralls are full-body suits made from materials that are lightweight, breathable, and impermeable to liquids (figure 5.6). They should be worn by all HCWs who work in isolation areas for treating highly infectious diseases (e.g., VHF). They are designed to go over a scrub suit and create a barrier to eliminate or reduce contact exposure to blood, body fluids, and highly infectious microorganisms (CDC 2016). Coveralls without an attached hood and with thumbholes are recommended.

Steps for putting on coverall suits

- Assess the garment for any visible tears or compromise to integrity.
- Make sure that a trained observer is watching and monitoring the steps.
- Perform hand hygiene.
- Put on the scrub suit, rubber boots, or shoe covers, and a pair of sterile or non-sterile gloves.
- Unfold the coverall suit and unzip.
- Slide legs, one by one, into the suit.
- Slide arms, one by one, into the suit.
- Tuck the cuffs of the first pair of gloves under the sleeves of the coverall suit.
- Insert thumbs into thumb hole (if provided).
- Close the zipper by pulling it up to the neck.
- Cover the zipper with the additional flap, if available .

Steps for removing coverall suits

- Make sure that a trained observer is watching and monitoring the removal process and is ready to assist, if needed.
- Disinfect inner gloves using ABHR or 0.5% chlorine solution covering all surfaces of the gloved hands.
- Lift the chin.
- Find the zipper at the level of the belly and carefully trace fingers of one hand up to find the zipper tab.
- Hold the outside of the top of suit with the other hand (do not let it go).
- Unzip or unfasten the suit completely (still holding the top near the zipper).

- Gently pull the side of the suit being held partially over the shoulder.
- Perform a rotating movement of the shoulder inside out (one by one) to remove the coverall and carefully move the coverall down the body, turning inside out.
- Do a “moon walk” to remove the legs of the suit over the boots.
- Carefully place it in the waste bag, touching only the inside.
- Avoid contact of the scrub suit with the outer surface of the gown.
- Disinfect gloved hands using ABHR or 0.5% chlorine solution, covering all surfaces of the gloved hands.
- See the step-by-step PPE removal checklist for essential next steps in removal of PPE.

Figure 5.6. Coverall suit

When to Wear Gowns

The type of gown to use is based on the type of patient interaction, including the expected degree of contact with infectious material, the potential for blood and body fluid penetration of the barrier, and the type of task to be carried out by the HCW.

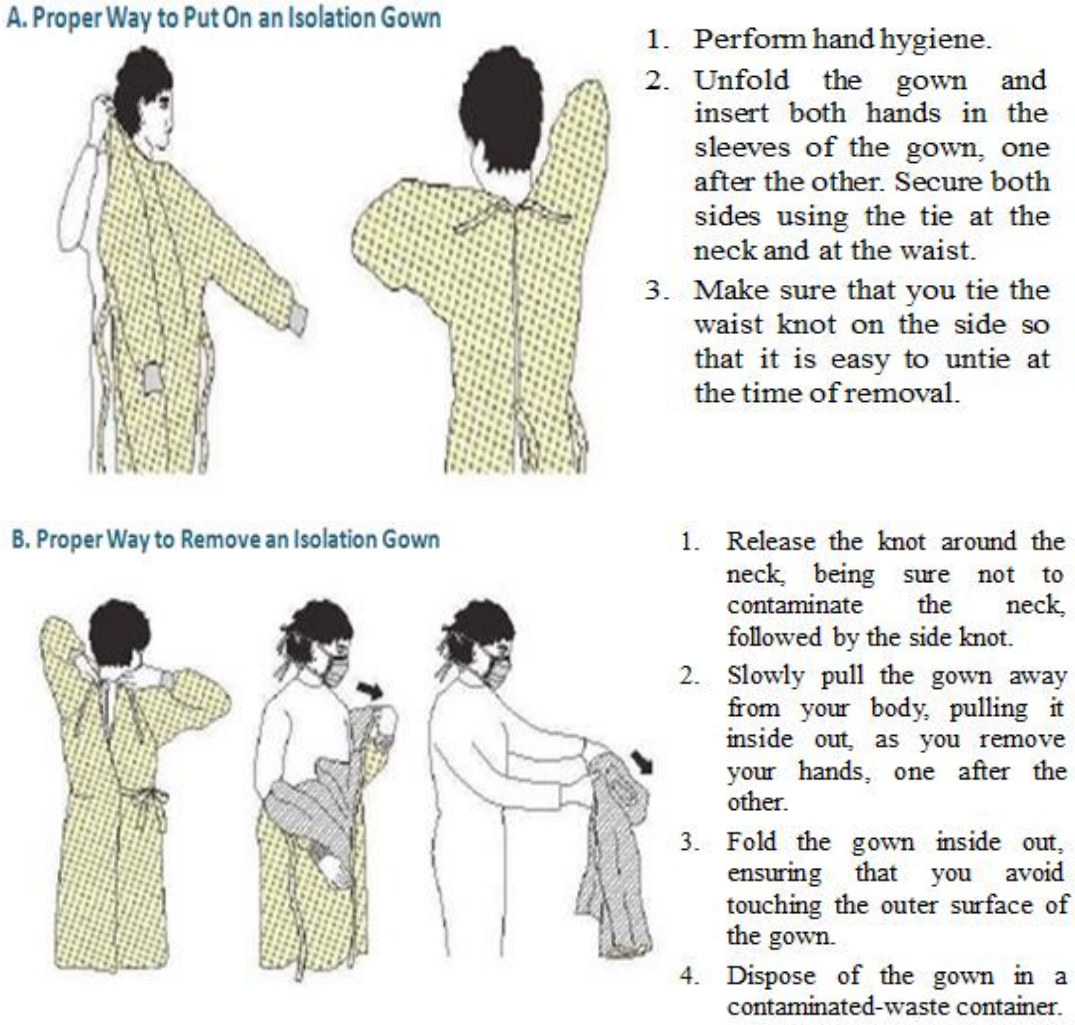
- During standard precautions, an isolation gown (with gloves) is worn if blood or body fluid contact, spills, or splashes on clothing is expected.
- During contact and droplet precautions, an isolation gown (with gloves) is used to prevent transmission of an infectious agent that cannot be prevented by standard precautions alone.
- During surgical procedures, deliveries, or other aseptic procedures, a sterile surgical gown is worn to protect the sterile field and the clothes of the scrub team or those performing the procedure.

How to Wear and Remove Gowns

Full coverage of the arms and body front, from the neck to the mid-thigh or below, will ensure that clothing and exposed areas of the upper body are protected. Isolation gowns are always worn in combination with gloves and other PPE (e.g., masks, eye protection) according to the type of transmission being prevented (contact, droplet, etc.).

Isolation gowns are usually the first piece of PPE to be put on (figure 5.7A). HCWs should remove isolation gowns before leaving the patient care area to prevent possible contamination of the environment outside the patient care area (figure 5.7B) (Siegel, Rhinehart, Jackson, et al. 2007).

Figure 5.7. A and B. Putting on and removing an isolation gown



Adapted from: Siegel, Rhinehart, Jackson, et al. 2007

Plastic Apron

It is used to protect clothing or surfaces from contamination. Reusable aprons, which are made of rubber or plastic, provide a waterproof barrier along the front of a person's body. Therefore, it should also be worn during cleaning and procedures with the likelihood of splashes or spillage of blood, body

fluids, secretions, or excretions (e.g., when conducting deliveries). Disposable water-proof aprons are also available for clinical use.

Aprons keep contaminated fluids off the HCW's clothing and skin. For example, during invasive procedures, wearing a water resistant apron (disposable or reusable) will not only help guard the healthcare provider against exposure to blood or body fluids (e.g., amniotic fluid), but also prevents the HCW's abdominal skin from being a source of contamination to the patient.

Gloves

HCWs wear gloves for three reasons:

1. To reduce the risk of staff acquiring infections from patients.
2. To reduce the risk of transmitting microorganisms, including skin flora from provider to clients/patients.
3. To reduce contamination of staff's hands by microorganisms that are transmissible from one patient to another (cross-contamination).

Types of Gloves

Surgical glove should be used when performing invasive medical or surgical procedures.

Clean examination gloves provide protection to HCWs when performing many of their routine duties. These gloves can be used when contact with mucous membranes and non-intact skin are expected (e.g., during medical examinations and procedures, such as pelvic examination).

Utility or heavy-duty household gloves should be worn when processing instruments, equipment, and other items; for handling and disposing of contaminated waste; and when cleaning contaminated surfaces. Double gloving of either new examination gloves or reprocessed surgical gloves provide some protection if utility gloves are not available.

Note:

A clear understanding of the parameters to opt for sterile or high-level disinfected gloves is important. Judicious use of these options can reduce costs and at times maintain safety for both patients and staff.

The use of high-level disinfected surgical gloves when performing surgical or invasive procedures is the only acceptable alternative on condition that sterile surgical gloves are not available.

Table 5.2 shows the advantages and disadvantages of different types of non-sterile gloves .

Table 5.2. Advantages and disadvantages of different types of non-sterile gloves

Material	Advantages	Disadvantages
Latex	• Offers the best fit, natural feel, and dexterity • Approved by regulatory authorities • Provides protection against most chemicals, including acids and bases, chlorine, iodine, and formaldehyde • Offers better puncture resistance than other gloves (e.g., vinyl gloves)	• Long contact with fatty substances (e.g., fatty tissue and vegetable oils) will disintegrate latex gloves • Not recommended for HCWs with known allergies to latex
Vinyl	• First synthetic material gloves available on the market • Least expensive of the three types and generally available in low- and middle-income countries • Recommended if they are the only type of non-sterile glove available and the risk of exposure to blood and body fluids is high • Acceptable for short procedures/tasks (e.g., suctioning endotracheal secretions, removing IV lines) that involve minimum risk of glove tears, have low risk of exposure to contaminants, and involve minimal stress on the gloves	• Loose-fitting (i.e., baggy), have limited elasticity, and tear easily • Have higher failure rates than latex or nitrile gloves because they tear more easily and they are loose-fitting around the wrist, which can allow fluids to contaminate an HCW's hands
Nitrile	• Allergy-free • Preferred choice for HCWs with latex allergies • Made from synthetic materials and are very elastic • Can be used with petroleum-based substances, including hand moisturizers • 3–5 times more puncture-resistant than latex gloves • Fit well on hands like latex gloves • More elastic than vinyl gloves • Available in various thicknesses and colors	• Not recommended for HCWs with known allergies to nitrile compounds

Source: Jhpiego, 2018

The best surgical gloves are made of latex rubber because of the rubber's natural elasticity, sensitivity, durability, and a comfortable fit. An increasing problem of allergies to latex these days created a demand for another material. A new synthetic, rubber-like material called "nitrile," which has properties similar to latex, has been developed to make better gloves. This new glove material is less likely to cause allergic reactions. In many countries, the only type of examination gloves available is made of vinyl, a synthetic material that is less expensive than latex rubber. Although vinyl is cheaper, it is inelastic (does not stretch like latex), making these gloves loose-fitting and easy to tear. To conclude, the better quality examination gloves are made from latex or nitrile. They can be found in medical supply stores in most countries. Utility gloves, which are made of thick rubber, are more intractable and are meant for maximal protection during heavy duty activities.

Deciding which type of examination glove is best for a task (if a choice is available) largely depends on the degree of risk from the exposure (low or high risk) to a potentially pathogen-laden blood or body fluids; the length of the procedure to be carried out; and the possibility of the development of an allergy to latex or, rarely, to nitrile.

Vinyl examination gloves should only be used for short tasks involving minimal stress on the glove and low risk of exposure. If they are the only type of examination glove available and the risk of exposure to blood and body fluids is high, frequent changing or double gloving should be considered.

Natural rubber latex examination gloves provide the best protection. They are the most appropriate for surgical procedures and tasks involving moderate to high risk, such as exposure to blood or body fluids. These gloves should be avoided if staff have a known or suspected allergy to latex or for prolonged contact (>1 hour) with HLDs, such as glutaraldehyde (because it may cause loss of effectiveness due to the breakdown of latex).

Nitrile examination gloves are best for staff with a latex allergy and can be used for activities involving moderate to high risk. Nitrile gloves have many of the characteristics of latex but have a better resistance to oil-based products. Staff with a known allergy to nitrile or latex compounds should not use these gloves.

Note: When using latex rubber gloves, avoid the use of hand creams or lotions that contain mineral oil, petroleum jelly (Vaseline), or lanolin to protect your hands because they may cause the gloves to break down within a few minutes.

When to Wear Gloves

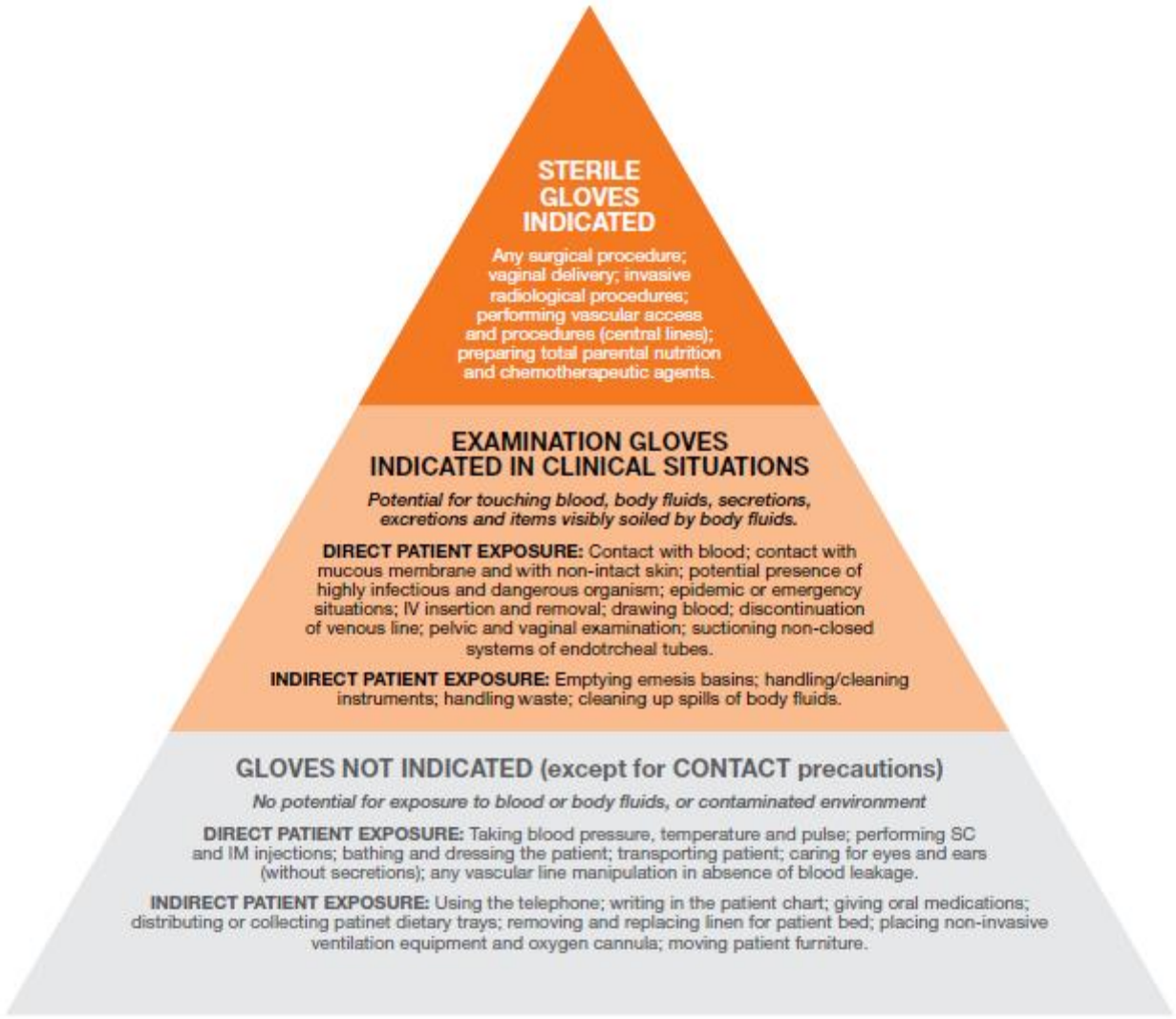
Depending on the situation, surgical gloves, clean examination gloves, or utility gloves should be worn by all staff when:

- There is a chance of the hands coming into contact with blood or other body fluids, mucous membranes, or non-intact skin.
- They perform invasive medical procedures (e.g., inserting vascular devices, such as peripheral venous lines).
- They handle contaminated waste items or touch contaminated surfaces.

The Glove Pyramid: an aid to decision making on when to wear (and not wear) gloves

Gloves must be worn according to **STANDARD** and **CONTACT PRECAUTIONS**. The pyramid details some clinical examples in which gloves are not indicated, and others in which clean or sterile gloves are indicated. Hand hygiene should be performed when appropriate regardless of the indications for glove use (figure 5.8).

Figure 5.8. The glove pyramid



Source: WHO 2009b

When to Use Double Gloves

The transmission of HBV and HCV from surgeon to patient and vice versa is known to have occurred even in the absence of incorrect application of the technique and apparent problems of intactness of the gloves (Davis 2001). Even the best quality, new latex rubber surgical gloves may leak up to 4% of the time. Moreover, it was found that latex gloves gradually become weaker and lose their intactness, especially when exposed to fat on the surfaces of wounds.

Surgical teams rely on surgical gloves as a barrier to protect themselves against blood-borne pathogenic infections during surgery. Double gloving is adopted by surgeons to tackle the problem of glove perforation. Glove perforations were detected in 10 of 112 sets of single gloves (8.9%) and 12 of 106 sets of outer gloves in the double-gloved group (11.3%). There was no inner double-glove perforation (0%). Accordingly, the study concluded that double-gloving is effective in protecting

operating room nurses against blood-borne pathogen exposure. It should be introduced as a routine practice (Guo et al. 2012).

When double gloving, the first glove should be a half size larger than normally worn gloves. The second pair, however, should be the correct size because this will help prevent the hand from cramping. Whether the surgeon, assistant, or nurse should double glove should be considered carefully, especially in setups where gloves are reused and the risk of contracting bloodborne pathogens, such as HIV, is high (>5% prevalence).

In general, for short duration surgical procedures (30 minutes or less) and those involving minimal exposure to blood or mucous secretions (e.g., laparoscopy or minilaparotomy), double gloving is probably not necessary.

When to Use Elbow Length Gloves

Elbow length gloves should be used during vaginal deliveries and cesarean sections when the chance of coming in contact with blood is 25% and 35%, respectively. Elbow length gloves are also recommended for use during such procedures as the manual removal of the placenta and any other procedure where contact with a large volume of blood or body fluids is likely. This kind of glove is generally meant to give protection to the hands, including the forearms.

How to Use Gloves

Although the effectiveness of gloves in preventing contamination of a HCW's hands has been repeatedly confirmed, wearing gloves does not replace the need for handwashing. The truth is that even the best quality latex surgical gloves may have small and unnoticeable defects; they may be torn during use; and the hands can become contaminated during removal (Davis 2001).

Note: The practice of hand hygiene, coupled with the use of protective gloves, is a key component in minimizing the spread of disease.

The purpose of donning and removing sterile gloves, as shown in figure 5.9, is to ensure maximum asepsis for patients and to protect the HCW from the patient's body fluids. In the correct use of gloves—a means to achieve this double goal—the skin of the HCW remains exclusively in contact with the inner surface of the glove and has no contact with the outer surface. Any error in the performance of this technique leads to a lack of asepsis, requiring a change of gloves.

Procedure for Wearing Sterile Gloves

1. Perform hand hygiene before an "aseptic procedure'' by surgical hand scrub.
2. Check the package for intactness. Open the first non-sterile packaging by peeling it completely off the heat seal (cover) to expose the second sterile wrapper, but without touching it.
3. Place the second sterile package on a clean and dry surface without touching the surface. Open the package and fold it toward the bottom so as to unfold the paper and keep it open.
4. Using the thumb and index finger of one hand, carefully grasp the folded cuff edge of the glove.

5. Slip the other hand into the glove in a single movement, keeping the folded cuff at the wrist level.

6-7. Pick up the second glove by sliding the fingers of the gloved hand underneath the cuff of the glove.

8-10. In a single movement, slip the second glove on the ungloved hand while avoiding any contact/resting of the gloved hand on a surface other than the glove to be donned (contact/resting constitutes a lack of asepsis and requires a change of gloves).

11. If necessary, after donning both gloves, adjust the fingers and inter-digital spaces until the gloves fit comfortably.

12-13. Unfold the cuff of the first gloved hand by gently slipping the fingers of the other hand inside the fold, making sure that any contact with the outer surface of the glove is avoided (lack of asepsis requiring a change of gloves).

14. The hands are gloved and must touch exclusively sterile devices or the previously- disinfected patient's body area.

15-17. Remove the first glove by peeling it back with the fingers of the opposite hand. Remove the glove by rolling it inside out to the second finger joint (do not remove completely).

18. Remove the other glove by turning its outer edge on the fingers of the partially ungloved hand.

19. Remove the glove by turning it inside out entirely (ball forming) to ensure that the skin of the HCW is always and exclusively in contact with the inner surface of the glove.

20. Discard the gloves.

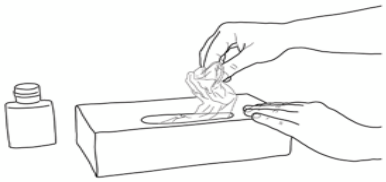
21. Perform hand hygiene after glove removal according to the recommended indication.

(See also figures 5.9, 5.10, and 5.11.)

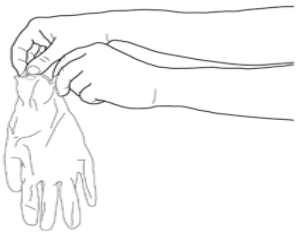
Figure 5.9. How to don and remove examination gloves

When the hand hygiene indication occurs before a contact requiring glove use, perform hand hygiene by rubbing with an alcohol-based handrub or by washing with soap and water.

I. HOW TO DON GLOVES:



1. Take out a glove from its original box



2. Touch only a restricted surface of the glove corresponding to the wrist (at the top edge of the cuff)

3. Don the first glove

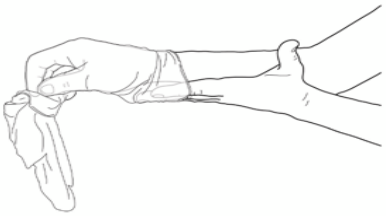
4. Take the second glove with the bare hand and touch only a restricted surface of glove corresponding to the wrist

5. To avoid touching the skin of the forearm with the gloved hand, turn the external surface of the glove to be donned on the folded fingers of the gloved hand, thus permitting to glove the second hand

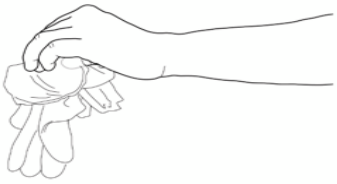
6. Once gloved, hands should not touch anything else that is not defined by indications and conditions for glove use

II. HOW TO REMOVE GLOVES:

1. Pinch one glove at the wrist level to remove it, without touching the skin of the forearm, and peel away from the hand, thus allowing the glove to turn inside out



2. Hold the removed glove in the gloved hand and slide the fingers of the ungloved hand inside between the glove and the wrist. Remove the second glove by rolling it down the hand and fold into the first glove



3. Discard the removed gloves

4. Then, perform hand hygiene by rubbing with an alcohol-based handrub or by washing with soap and water

Source: WHO 2009b

Donning surgical sterile gloves at the time of a surgical intervention follows the same sequence except that:

- It is preceded by a surgical hand preparation.
- Donning of the gloves is performed after putting on a sterile surgical gown.
- The opening of the first packaging (non-sterile) is done by an assistant.
- The second packaging (sterile) is placed on a sterile surface and is then used for the intervention.
- Gloves should cover the wrists of the sterile gown.

Figure 5.10. How to wear (don) sterile gloves

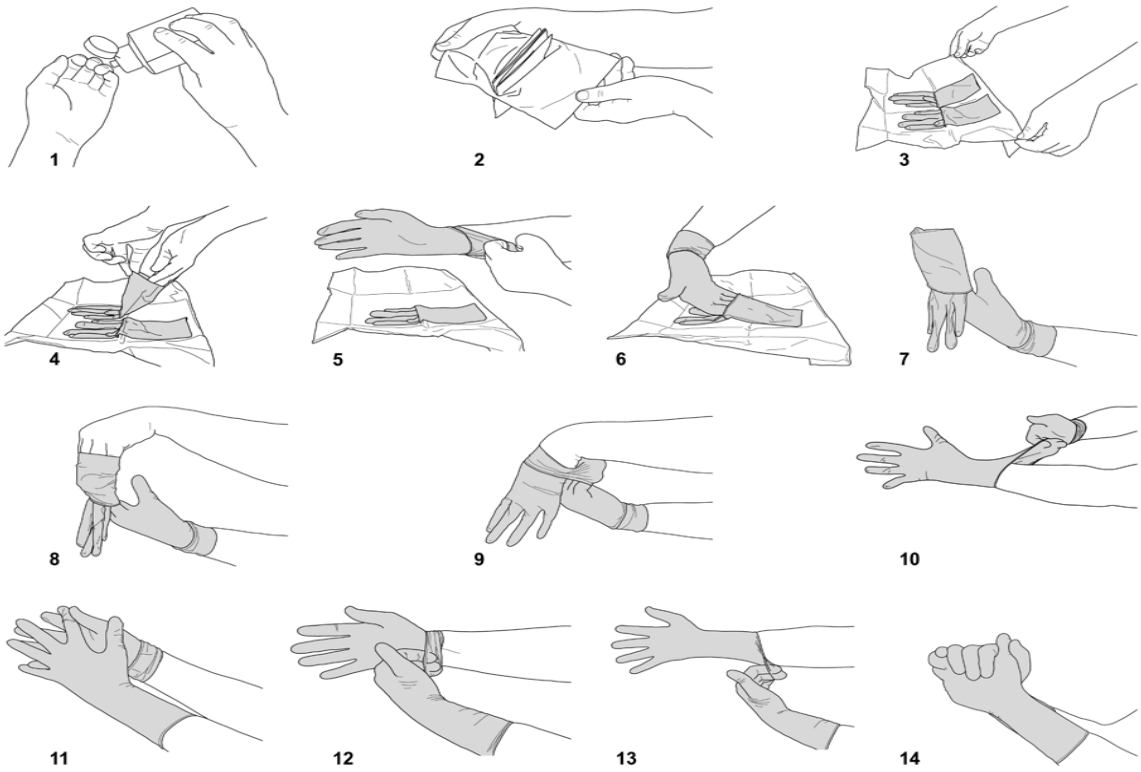
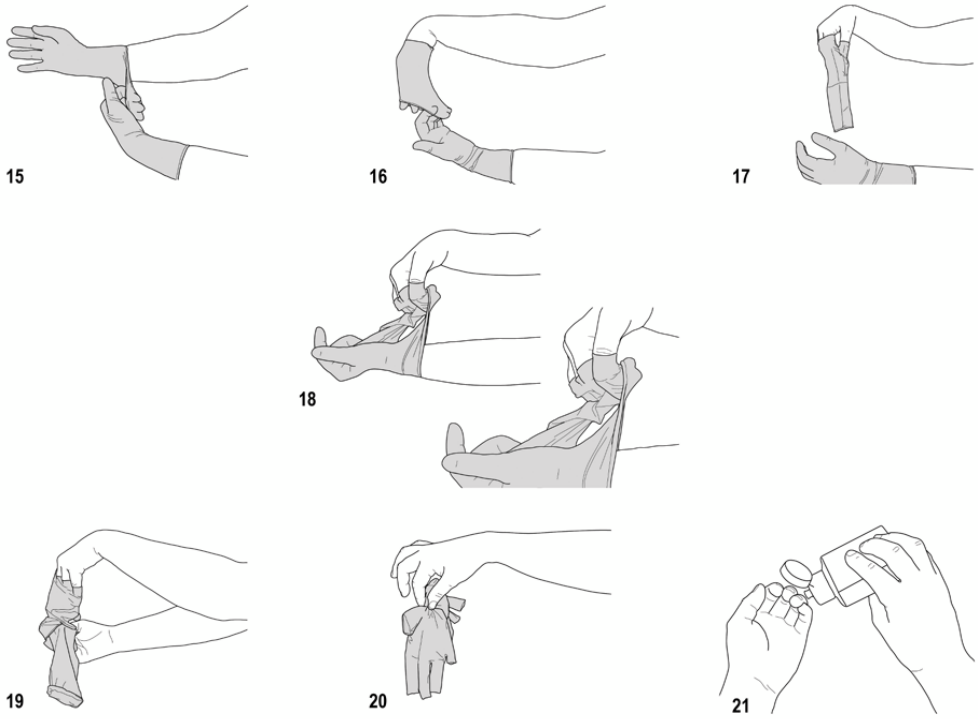


Figure 5.11. How to remove (doff) sterile gloves



Source: WHO 2009a

Some Dos and Don'ts about Gloves

- Do wear the correct size gloves, A poorly fitting glove can limit your ability to perform tasks and may get damaged easily.
- Do change surgical gloves periodically (every 45 minutes) during long cases because the protective effect of latex gloves decreases with time and inapparent tears may occur.
- Do keep fingernails trimmed moderately short (less than 3mm beyond the fingertip) to reduce the risk of tears.
- Do pull gloves up over cuffs of gown (if worn) to protect the wrists.
- Do use water-soluble hand lotions and moisturizers often to prevent hands from drying and cracking due to frequent handwashing and gloving.
- Don't use oil-based hand lotions or creams because they will damage latex surgical and examination gloves.
- Don't use latex gloves if you or the patients have an allergy to latex.
- Don't store gloves in areas where there are extremes of temperature (e.g., direct sunlight, near the heater, air conditioner, ultraviolet light, and X-ray machine). These conditions may damage the gloves (cause breakdown of the material they are made of), thus reducing their effectiveness as a barrier.
- Don't reprocess gloves that are cracked or have detectable holes/tears.
- Don't reprocess examination gloves for reuse.
- Reprocess utility gloves by immersing them in a 0.5% chlorine solution briefly, remove gloves by inverting them, and then soak them in the 0.5% chlorine solution for 10 minutes before washing and drying them for reuse.

Note: A separate pair of gloves must be used for each client to avoid cross-contamination or when moving from one site to another site on the same patient (i.e., from respiratory care to a dressing change). It is preferable to use new and single use (disposable) gloves only.

How to Make Elbow Length Gloves

When readymade elbow length gloves are not available, an effective alternative material (as described below) can be easily made from previously used surgical latex gloves that have been reprocessed (decontaminated, cleaned, and dried using the two methods of either sterilization or HLD).

The acceptable "leak rate" for new surgical and examination gloves designated by regulatory agencies is up to 4% (Davis 2001).

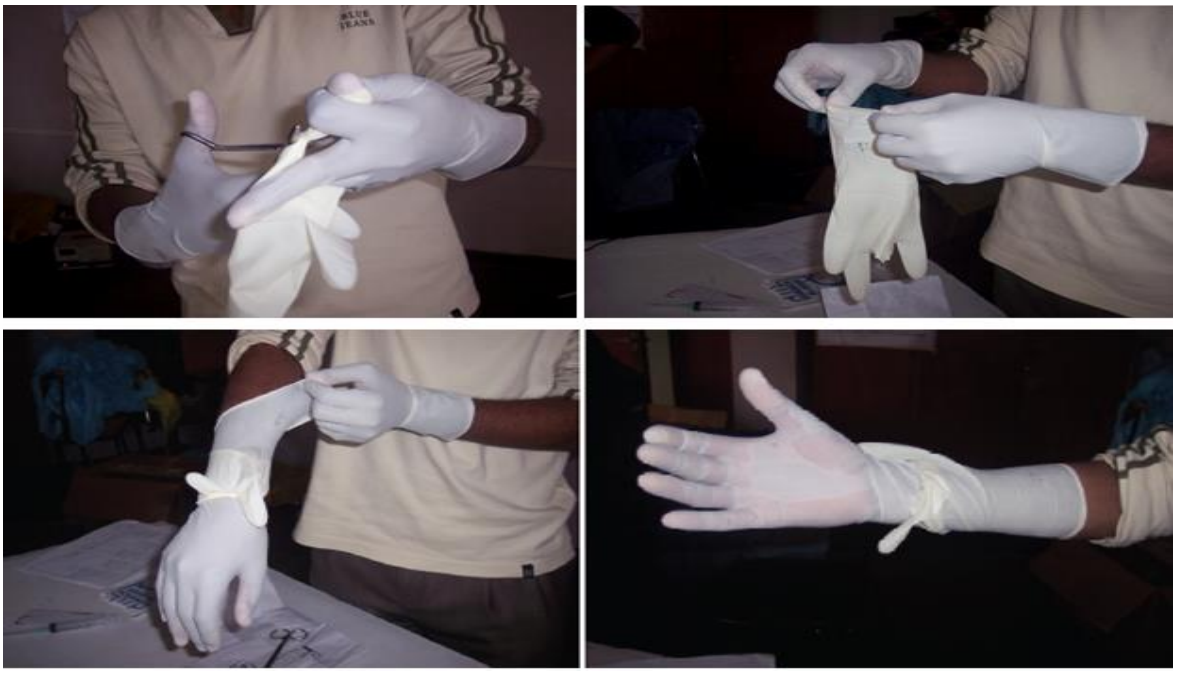
1. Cut one or more fingers completely off (depending on the size of your hands) each glove just below where all the fingers join the gloves.

2. Sterilize or HLD two to three pair of cut-off (fingerless) gloves according to the recommended process for each method, and store the gloves after final processing in a sterile or high-level disinfected container until needed.

   How to Use

   - Perform surgical hand scrub.
   - Put on the intact sterile or HLD surgical gloves to completely cover up the distal end of the fingerless gloves (figure 5.12).
   - Put the fingerless sterile or HLD gloves and pull them up to the forearms.

Figure 5.12. Cutting the four fingers off a glove



Allergic Reactions to Gloves

Allergic reactions to latex rubber gloves are being increasingly reported among HCWs of all types, including housekeepers, laboratory workers, and dentists. If possible, non-latex (nitrile) or low-allergen latex gloves should be used if an allergy is suspected. (Allergic reactions to nitrile also occur, although less frequently.) Wearing powder-free gloves is recommended. (Powdered gloves may result in more reactions because the powder from the gloves carries the latex particles in the air.) If this is not possible, wearing clothes or vinyl gloves underneath latex gloves may help prevent skin sensitization. It will not, however, prevent possible sensitivity of the mucous membranes of the eyes and nose if these gloves are powdered (Garner 1996).

People with sensitivity do have symptoms, such as skin rashes, runny nose, and itchy eyes, which may persist or get progressively worse (i.e., cause breathing problems, such as asthma). An allergic reaction following the use of latex can develop within a month, or take many years to develop.

There is still no therapy or desensitization for a latex allergy. Therefore, the only option is to avoid contact with it (Patriarca G. 2002).

Footwear

Footwear are worn to protect the feet from injury by sharp or heavy items or fluids that may accidentally spill over, drip, or even pour out on them. All footwear should have closed toes, low heels, and nonskid soles. Clean, sturdy shoes are recommended for all clinical areas. Rubber boots or leather shoes provide the best protection. They must be kept clean. For this reason, sandals and other open-toe shoes or shoes made of soft materials are not acceptable. Rubber boots or leather shoes are acceptable, but they must be kept clean and free of contamination from blood or other body fluid spills. Shoe covers are unnecessary if clean and sturdy shoes are available for dedicated use only in the surgical area and are not meant to prevent transmission of bacteria from the floor. However, shoe covers may be needed to prevent contamination of shoes with blood and body fluids (AORN 2019; Bearman, Bryant, Leekha, et al. 2014).

Wash hands before and after donning and removing PPE

Instructions for Putting On and Removing Personal Protective Equipment

Putting on and removing PPE in the proper order and manner is just as important as wearing PPE. Failure to properly put on or remove PPE could lead to exposure to or lack of protection against infectious agents. The order of putting on PPE and removing PPE depends on the purpose for which the PPE is being used. PPE is used for standard precautions, operating theaters, isolation rooms during transmission-based precautions, and during disease outbreaks (e.g., novel respiratory disease, VHF). (See the section on use of PPE during outbreaks of VHF at the end of this chapter.)

Choosing PPE for Standard and Transmission-Based Precautions

For the purpose of standard precautions, PPE are chosen based on the risk of exposure to blood or body fluids during patient care. The choice could be simply a pair of non-sterile gloves if touching contaminated surfaces; or gown, gloves, mask, and eye protection, if extensive splashing is expected. For the purpose of transmission-based precautions, septic items of PPE are designated for each type (e.g., only an N95 respirator if providing care to a suspected case of TB because airborne precautions do not require the use of a gown or gloves). (For more information, see Chapter 3 for standard and transmission-based precautions.) In case you need to wear multiple PPE, the sequence described below should be followed for safely putting on and removing PPE. For details about putting on or removing PPE, see the sections earlier in this chapter about each specific item of PPE.

Sequence for Putting on PPE for Standard and Transmission-Based Precautions

1. Put on protective boots or shoe covers (if needed).
2. Perform hand hygiene.
3. Put on a gown.

4. Put on a procedure mask/N95 respirator.
5. Put on goggles or a face shield.
6. Lastly, put on gloves.

Source: CDC 2004

Sequence for Removing PPE

PPE should be removed at the doorway before leaving the patient room or in the outer room:

1. Remove gloves.
2. Remove goggles/face shield by the "clean" headband or earpieces.
3. Remove the gown.
4. Remove the mask or respirator.
5. Dispose of single-use and reusable PPE in designated containers.
6. Remove shoe covers or boots (if used) before leaving the area.
7. Perform hand hygiene.

Sequence for Putting on PPE for Sterile Surgical Procedures in the Operating Theater

1. Change from street clothes to a clean scrub suit (one that has been processed in the healthcare facility laundry). Remove all jewelry.
2. Put on non-skid, low-heel shoes with closed toes and back, rubber boots, or shoe covers when there is a risk of gross contamination with blood or body fluids.
3. Perform hand hygiene.
4. Put on a plastic apron if the sterile surgical gown is not fluid-resistant.
5. Put on a surgical head cover (and facial hair cover, if needed) to ensure that hair on the head (and beard) are fully covered.
6. Put on a surgical mask, one that fits well and fully covers the mouth and the nose.
7. Put on appropriately sized, well-fitting goggles or a chin-length face shield.
8. Perform a surgical hand scrub using soap and water and ABHR (see Volume 1, Chapter 4: Hand Hygiene).
9. Put on a sterile surgical gown without contamination (figure 5.7A).
10. Lastly, put on sterile surgical gloves without contamination (figure 5.7B).

Note: There may be instances where PPE to protect the HCW from infectious disease may be required, in addition to surgical attire, such as a respirator for surgery on a patient with known or suspected TB, or additional skin coverage for surgery on a patient with known or suspected VHF.

Sequence for Removing PPE Following Sterile Surgical Procedures in the Operating Theater

1. Remove the gloves following the recommended steps and dispose of them in a waste container; do not reprocess or reuse the gloves.
2. Remove the gown, avoid touching the outer side of the gown, and dispose of it in a waste container (if a single-use gown) or place the used gown in a container for processing later.
3. Remove the plastic apron, if one was used, and dispose of it in a waste container (if a single-use apron) or place the used apron in a container for processing later.
4. Remove eye protection.
5. Remove the surgical mask.
6. Perform hand hygiene.
7. These steps will be performed at the end of the day unless any item becomes soiled.
8. Remove the head cover (and facial cover).
9. Remove shoe covers (if worn).
10. Remove shoes.
11. Remove scrub suit.
12. Lastly, perform hand hygiene.

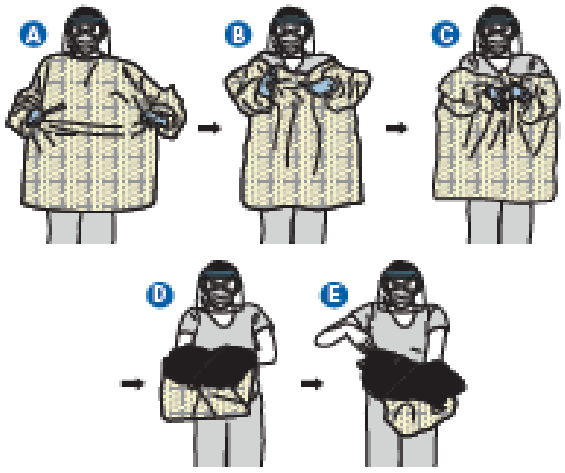
Adapted from: AORN 2019

HOW TO SAFELY REMOVE PERSONAL PROTECTIVE EQUIPMENT (PPE) EXAMPLE 2

Here is another way to safely remove PPE without contaminating your clothing, skin, or mucous membranes with potentially infectious materials. Remove all PPE before exiting the patient room except a respirator, if worn. Remove the respirator after leaving the patient room and closing the door. Remove PPE in the following sequence:

1. GOWN AND GLOVES

- Gown front and sleeves and the outside of gloves are contaminated!
- If your hands get contaminated during gown or glove removal, immediately wash your hands or use an alcohol-based hand sanitizer
- Grasp the gown in the front and pull away from your body so that the ties break, touching outside of gown only with gloved hands
- While removing the gown, fold or roll the gown inside-out into a bundle
- As you are removing the gown, peel off your gloves at the same time, only touching the inside of the gloves and gown with your bare hands. Place the gown and gloves into a waste container

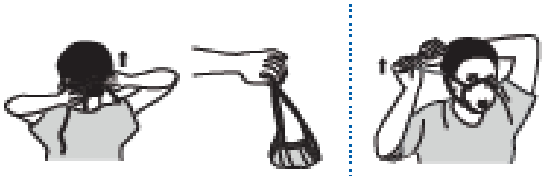


2. GOGGLES OR FACE SHIELD

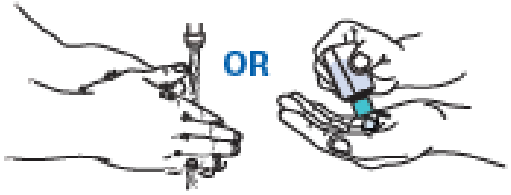
- Outside of goggles or face shield are contaminated!
- If your hands get contaminated during goggle or face shield removal, immediately wash your hands or use an alcohol-based hand sanitizer
- Remove goggles or face shield from the back by lifting head band and without touching the front of the goggles or face shield
- If the item is reusable, place in designated receptacle for reprocessing. Otherwise, discard in a waste container

3. MASK OR RESPIRATOR

- Front of mask/respirator is contaminated —DO NOT TOUCH!
- If your hands get contaminated during mask/respirator removal, immediately wash your hands or use an alcohol-based hand sanitizer
- Grasp bottom ties or elastics of the mask/respirator, then the ones at the top, and remove without touching the front
- Discard in a waste container



4. WASH HANDS OR USE AN ALCOHOL-BASED HAND SANITIZER IMMEDIATELY AFTER REMOVING ALL PPE



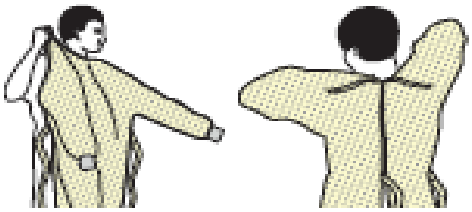
PERFORM HAND HYGIENE BETWEEN STEPS IF HANDS BECOME CONTAMINATED AND IMMEDIATELY AFTER REMOVING ALL PPE

SEQUENCE FOR PUTTING ON PERSONAL PROTECTIVE EQUIPMENT (PPE)

The type of PPE used will vary based on the level of precautions required, such as standard and contact, droplet or airborne infection isolation precautions. The procedure for putting on and removing PPE should be tailored to the specific type of PPE.

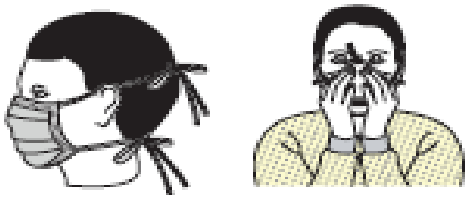
1. GOWN

- Fully cover torso from neck to knees, arms to end of wrists, and wrap around the back
- Fasten in back of neck and waist



2. MASK OR RESPIRATOR

- Secure ties or elastic bands at middle of head and neck
- Fit flexible band to nose bridge
- Fit snug to face and below chin
- Fit-check respirator

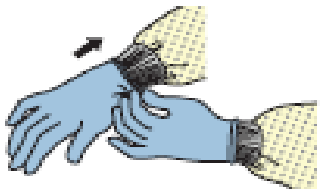


3. GOGGLES OR FACE SHIELD

- Place over face and eyes and adjust to fit

4. GOVES

- Extend to cover wrist of isolation gown



USE SAFE WORK PRACTICES TO PROTECT YOURSELF AND LIMIT THE SPREAD OF CONTAMINATION

- Keep hands away from face
- Limit surfaces touched
- Change gloves when torn or heavily contaminated
- Perform hand hygiene

Source: CDC n.d.

Types of Personal Protective Equipment to Prevent Transmission During Disease Outbreaks

List of Personal Protective Equipment

PPE recommended by WHO for HCWs who provide care and treatment to VHF patients include:

- Fluid-resistant coverall or gown
- Without an attached hood
- With thumb holes or loops
- Waterproof apron
- Waterproof boots
- Fluid-resistant isolation mask with a design that does not collapse against the mouth
- Face shield
- Respirator—required when performing aerosol-generating procedures is expected
- Head cover that covers the head and neck (separate from the gown or coverall)
- Double gloves with cuffs to mid-forearm (nitrile preferred over latex)

SUMMARY

The use of PPE is recommended to protect HCWs from hazards encountered during their regular, daily duties. An adequate supply of PPE should be available for use at the point of care. Management staff should be aware of when and how to replenish PPE supplies. In situations with limited resources, PPE should be prioritized to provide the implementation of standard precautions, at a minimum. Staff should be educated and trained on the indications for PPE, the benefits and limitations of specific PPE, and the correct procedure for putting on, wearing, and removing PPE so that PPE can be used effectively and efficiently. Healthcare facility support and feedback from supervisors are also necessary to create sustained compliance with PPE guidance.

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CHAPTER 6: SHARPS AND INJECTION SAFETY

Key Topics

- Magnitude of unsafe injection
- The risks and impact associated with unsafe injection practices
- Common reasons for prescribing and providing unnecessary and unsafe injections
- Unsafe injection practices: Transmission pathways
- The best practices in injection safety
- Role of the prescriber in injection safety
- Principles in safe injection practices
- Injection devices and their safety features
- Safe handling of medications containing vials (single and multiple dose vials)
- Sharps safety

BACKGROUND

WHO estimates that in developing and transitional Member States, 16 billion healthcare injections are administered each year (i.e., an average of 3.4 injections per person yearly). Concurrently, it is estimated that at least 50% of all injections are unsafe (WHO 2015).

Injection safety baseline studies conducted by FMOH and Making Medical Injections Safer in 2004 and 2005 showed that about 74% of injections were unsafe, about 72% of health facilities practiced unsafe disposal, and the prevalence rate of needle stick injury was 30% to 35%. It is also reported that almost one-half (45%) of the community members have a tendency to prefer injections to other preparations (Habtetsion et al. 2009).

Improper use of syringes, needles, and medication vials during routine healthcare procedures, such as administering injections, have resulted in more than 40 outbreaks in both hospital and non-hospital settings with transmission of bloodborne viruses, including HCV.

A safe injection, as has already been briefly defined, does not harm the recipient, expose the provider to any avoidable risk, and result in any waste that is dangerous to the community. Unsafe injection practices, on the contrary, are ones that could harm the recipient, and/or the provider and/or may result in waste that is dangerous to the community.

Magnitude of Unsafe Injection

Each year, 16 billion injections are given in developing and transitional countries.

Most of the injections are therapeutic (90% to 95%), whereas few (5% to 10%) are given for immunization. The great majority (70%) of these injections are unnecessary and are given when oral medications could have been prescribed (WHO, 2017).

A study of 40 health facilities using a combined survey/observation method found that about 74% of the injections were unsafe. The fact that Ethiopian patients generally prefer injections to other forms of medications further increases the risk of disease transmission. Injection providers (about 47%) are

known to believe that oral medications are less effective than injections for the treatment of fever caused by minor illness (Habtetsion et al. 2009).

Risks and Impact of Unsafe Injection

Table 6.1. Conditions causing risks to communities, patients/clients, and providers

Communities	Patients/Clients	Providers
• Unsafe waste disposal system of health facilities • Receiving injections from informal injectors • Leaving sharps in accessible place to the public, especially children • Sharing needles and syringes • Reusing needles and syringes	• Use of injections when there are other suitable alternatives • Applying pressure to bleeding sites with dirty material or finger • Drug administered at incorrect anatomical site. For example 1. Infants vaccinated in the buttocks rather than in the anterior-lateral thigh 2. Giving large boluses of intramuscular injections 3. Injecting a nerve • Use of unsterile syringes and needles (or use of "new" but damaged compromised package) • Reuse of syringe and needles • Use of opened multi-use vials stored beyond recommended time (contaminated drug use) • Using wrong diluents or wrong amount • Use of expired drugs • Syringes are loaded with different medications • Loading syringe with multiple doses • Drugs and vaccines are stored in the same refrigerator • Accidental switching of drugs • Health workers not following aseptic techniques • Patient/client moves during administration of injection • Sharps are found in unexpected places, like linen • Self-medication	• Shortage or absence of appropriate injection and safety devices • Carrying used needles before disposal • Placing needle on a surface before disposal • Recapping needles (either one or two hand) • Manually detaching needles from syringes • Manipulating used sharps (cleaning, bending, breaking, or cutting hypodermic needle) • Passing on sharps from one health worker to another • Sharps are found in unexpected places, like linen • Overfilling of sharps' containers • Using a syringe on an agitated patient without an assistant or patient/client moves during administration of injection

Risk to Patients

Unsafe injections can result in transmission of a wide variety of pathogens, including viruses, bacteria, fungi, and parasites. WHO estimates that in low- and middle-income countries, 16 billion healthcare injections are administered each year, translating to approximately three injections per person per year, many of which are unnecessary. The reuse of syringes or needles, which is common in many settings, exposes patients to pathogens either directly (via contaminated equipment) or indirectly (via contaminated medication vials). The risks of unsafe injection practices have been well-documented for the three primary bloodborne pathogens: HIV, HBV, and HCV. Worldwide, each year, the overuse of injections and unsafe injection practices combine to cause an estimated:

- 8–16 million HBV infections
- 2.3–4.7 million HCV infections
- 80,000–160,000 HIV infections

(Hutin et al. 2003; Wilburn and Eijkemans 2004; WHO 2015)

Adverse effects are often caused by an unsafe injection. This is an incidence that harms a person receiving healthcare caused by poor injection practices rather than the underlying disease that caused the patient to seek treatment. Adverse events caused by an unsafe injection include:

- **Transmission of bloodborne infections occurs due to** inoculation of infectious agents in the patient's body. There are about 40 bloodborne pathogens that could be transmitted via injection. Among them, HBV, HCV, HIV/AIDS are the most common and have the gravest implications.
- **Injection abscesses** are inflammatory conditions, ranging from the initial signs of inflammation to big swelling occurring from suppurative processes.
- **Paralysis** following the damage of a nerve as a result of injection of a drug into a nerve and trauma.
- **Drug/allergic reactions shock** is a life threatening condition characterized by sudden collapse of the circulatory system due to an immunological response to the injected drug, or other local or systemic allergic reactions.

Risk to HCWs

Globally, in the course of their duties, HCWs are at an increased risk from bloodborne pathogens because they handle sharps, including needles and syringes. It is estimated that 39% of HCV, 37% of HBV, and 4.4% of HIV infection among HCWs worldwide are attributable to occupational exposure to sharps injuries (Prüss-Üstün, Rapiti, Hutin 2005). Both patients and HCWs are at risk of bloodborne disease from unsafe injection practices. Eliminating unnecessary injections and using safe injection practices are the best ways to protect patients and staff from the risks.

Impact of Unsafe Injection

Unsafe injections have always been known to negatively affect people's health, not only patients but also care providers The health problems can range from simple to deadly ones (table 6.2).

Table 6.2. Proportion of infections and total burden of disease caused by unsafe injections

Infections	Estimated burden of infections due to unsafe injection practices	Estimated proportion of infections due to unsafe injection practices
HBV	22 million new cases	32%
HCV	2 million new cases	40%
HIV/AIDS	260,000 new cases	5%
Deaths in 2000 due to unsafe injection practices in the past, 501,000 deaths		

Source: WHO 2017

- **Socioeconomic:** Each year, the annual global burden of indirect medical costs due to HBV, HCV, and HIV/AIDS is estimated to be US$ 535 million.
- **Psychosocial** impact includes**:** Stigma, discrimination, and social isolation following infections such as HIV; stress associated with HIV; burden on the family and the community (unproductive, children will be orphans, etc.); and risk of transmitting infections to the family and the community. The psychosocial impact **c**an be seen at individual, family, community, and country levels.

Common Reasons for Prescribing and Providing Unnecessary and/or Unsafe Injections

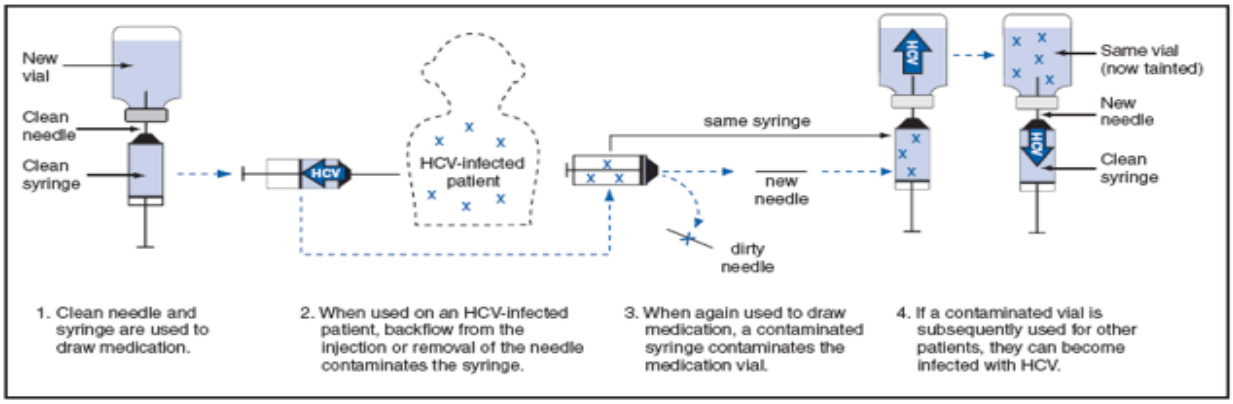
1. Inadequate dissemination/promotion and use of standard treatment guidelines.
2. Prescriber's predilection for injections. Lack of knowledge of the dangers of injections; wrong perception that injections are more effective than oral medications; give more rapid relief; and are more potent. These are some of the factors influencing the overuse of injections. Other known factors are financial incentives for prescribing injections, fear that patients will go elsewhere if therapy is given otherwise, or perceived belief that patients prefer injections.
3. Informal providers giving injections.

Unsafe Injection Practices: Transmission Pathways

Double dipping is the reuse of a syringe that has been used to inject medication in a patient, to withdraw medication from a multi-dose vial using a new needle, and injecting another patient with the medication. This results in contamination of the medication in the vial and in the syringe.

Even if a new needle is attached, when this syringe is used on subsequent patients, patients can become infected with bloodborne pathogens from contamination in the syringe. Even if a new needle and new syringe are used for subsequent patients, they can become infected with bloodborne pathogens from the contaminated liquid in the vial. Figure 6.1 shows the pathway of transmission of bloodborne pathogens, in this case HCV, via unsafe injection practices.

Figure 6.1. Unsafe injection practices and disease transmission



Source: CDC 2008

Best Practices in Injection Safety

1. **Elimination of Unnecessary Injections:** A study conducted in Ethiopia revealed the most commonly prescribed medications were antibiotics, analgesics, antispasmodics, and vitamins (Habtetsion et al. 2009). All these medications were just as effective if they were given by mouth. Many injectable medications have an oral equivalent that is equally strong, effective, and much safer. Therefore, unnecessary injections should be reduced through:

    - **Promoting Rational Prescribing:** Injections should only be used during life threatening conditions, malabsorption syndromes, or inability to swallow.
    - **Educating the Patients:** Encourage patients to accept oral medications; and explain the risks associated with injections, when possible, to limit the use to only when necessary.

2. **Administer Injections Safely**

Make sure that the "right" things/ways are fulfilled when administering injections (table 6.3).

Standards for Administering Injections (table 6.3)

- Prepare a well-laid up tray, including emergency drugs for management or possible drug reaction.
- Wash hands with soap and water. Alcohol could be used as a secondary step after soap and water except for Expanded Programme on Immunization (EPI) injection.
- Dry the hands. You can use small paper towels or any single use towels.
- Check for the integrity of the vial/ampoule for the following: expiry date, breach, leaks, particles, or any contamination.
- Make sure that the right dose, formulation, and route are used for the right patient or client.
- For medications that need to be reconstituted (powder forms), it should be done according to the manufacturer's instructions, and use the correct diluents.
- Draw the right dose as prescribed, including expelling the air using the right injection equipment.
- Ensure aseptic technique while giving the injection.
- Administer the drug at the correct site.
- Dispose of the used syringes and needles immediately in the sharp's container. (Never give used syringes and needles to patients or clients to carry home even if they came with the equipment.)
- A patient should be kept in the room for at least five minutes after the injection has been given and be observed for any possible adverse effect or events.

- Thank the patient or the client.
- Record the date and time of injection administration.

The Role of Prescribers and Providers in Injection Safety

Avoid unnecessary injections. Therefore, injections should only be used in:

- Life threatening conditions
- Malabsorption syndromes
- Inability to swallow

Prescribers and service providers should also:

- Encourage patients to accept oral medications, when possible.
- Injections should be given only when necessary.
- Explain the risks associated with injections.
- Explain to patients the need to take oral drugs as prescribed and review these instruction with them.
- Inform patients about the potential side effects of the medications that are being prescribed.
- Explore why the patients prefer injections.

Table 6.3. Right ways to give a safe injection

Rights	Standards: Always check and verify all "rights"	Method of verification
1. Right patient	What is the name on the prescription? Is this the right patient?	Ask patient/guardian, etc. to repeat name.
2. Right drug	Is the name of the drug on the prescription the same as the injection you are about to administer?	Verify name of drug on prescription with injection to be administered. If you are unsure, verify with the physician or pharmacist.
1. Right formulation	Could the medication be given orally instead of as an injection?	Discuss with patient the available choices.
2. Right injection equipment	Use only sterile, non-reusable syringes, dental cartridge, etc.	Check to ensure that syringe/needle package is unbroken.
3. Right dosage	Check dosage against patient's age, weight, and the pharmacokinetics of the drug.	Read the pharmaceutical recommendations of the drug. If unsure, verify with the physician/prescriber.

Rights	Standards: Always check and verify all "rights"	Method of verification
4. Right time	Follow the specific dose interval.	Be mindful of the action of the drug and why the time interval should be followed. Explain the importance of this to the patient.
5. Right route	Be sure to use the correct route of administration (intra-muscular, intravenous, intra-dermal, or subcutaneous).	Observe the direction of the prescriber. Check prescription or other related records.
6. Right storage	Right temperature, vaccine vial monitor shake test	Check cold chain issues, including vaccine vial monitor.
7. Right method of disposal	Do not recap needle. Dispose of used syringe and needle immediately after use in appropriate safety box. *or* Use the needle cutter and safety box.	Check the safety box for correct method of disposal.

Principles of Safe Injection

Practices

Evidence-based safety practices can be divided into four major areas of intervention:

1. Use Sterile Injection Equipment

Single use syringe and needle for each injection is recommended. Auto-disable syringes are mandatory for all immunization injections.

For curative and other purpose injections, syringes with reuse prevention devices and safety features are recommended. Where these are not available, standard disposable syringes can be used. Studies show that unsafe injection practices, such as using the same needle, syringe, or both for more than one injection or improperly processed syringes and needles are responsible for the transmission of HIV, HBV, and HCV (Drucker, Alcabes, Marix 2001). Therefore, after each use, the assembled needle and syringe should be placed in a container for the disposal of sharps.

2. Prevent Contamination of Injection Equipment and Medications

- Prepare each injection in a clean designated area where blood or body fluid contamination is unlikely.
- Use single dose vials rather than multi-dose vials.

- If multi-dose vials must be used, always pierce the septum with a sterile needle and avoid leaving the needle in place in the stopper of the vial.
- Select pop-open ampoules rather than ampoules that require use of a metal file to open.
- If you are using an ampoule that requires a metal file to open, protect your fingers with a clean barrier (e.g., small gauze pad) when opening the ampoule.
- Inspect the medications and discard those with visible contamination or breaches of integrity (e.g., cracks, leaks).
- Follow product-specific recommendations for use, storage, and handling.
- Swabbing a new vial top or ampoule with an antiseptic or disinfect is unnecessary. If swabbing with an antiseptic is selected for use, use a clean, single-use swab, and maintain the product-specific recommended contact time. Do not use cotton balls stored wet in a multiuse container.
- Swabbing of clean skin before giving an injection is unnecessary. Wash visibly soiled or dirty skin with soap and water. If swabbing with an antiseptic is selected for use, use a clean, single-use swab, and maintain the product-specific recommended contact time. Do not use cotton balls stored wet in a multiuse container.
- Discard a needle that has touched any non-sterile surface.

3. Prevent Injuries to the Provider

Hypodermic needles (hollow bore needles) cause most of the injuries to HCWs at all levels of the health system. Injuries may occur during procedures (clinicians), during cleaning and washing (housekeepers), and handling of waste materials.

Precautions to take before an injection depend on the type of procedure being carried out.

- Anticipate and take measures to prevent sudden patient movement during and after an injection.
- Do not recap, bend, or break needles before the disposal of single-use needles and syringes after giving injections. However, if there is a need to recap a needle for various reasons, the needle should be recapped using the "one-handed" recap method, as follows:
    - First, place the needle cap on a firm and flat surface, and then remove the hand.
    - Next, with one hand holding the syringe, use the needle to "scoop" up the cap
    - (figure 6.2).
    - With the cap now covering the needle tip, turn the syringe upright (vertical) so that the needle and syringe are pointing toward the ceiling.
    - Last, using the forefinger and thumb of your other hand, grasp the cap just above its open end (figure 6.2) and push the cap firmly down onto the hub (the place where the needle joins the syringe under the cap).

Figure 6.2. One-handed recap method

- Do not decontaminate the needle and syringe before disposal.
- Do not disassemble the needle and syringe after use.
- All used syringes and needles or any other sharps should be discarded at the point of use in an enclosed sharps container that is puncture- and leak-proof and sealed before being completely full.
- During injection, disposable gloves are indicated only if excessive bleeding is expected.

4. Prevent Access to Used Needles and Syringes

- Seal sharps containers for transport to a secure area in preparation for disposal. After closing and sealing sharps containers, never open, empty, or reuse them.
- Manage/dispose of sharps waste in an efficient, safe, and environment-friendly way to protect people from voluntary or accidental exposure to used injection equipment.
- Disposal of used syringes, needles, and sharps containers.
- The following guiding principles should be used for the disposal of syringes, needles, and sharps containers:
    - Dispose all sharps in a safety box immediately after injection.
    - If the syringe is a retractable one, make sure to engage the retraction feature before disposing of the syringe.
    - Collect used syringes and needles at the point of use in an enclosed sharps container (safety box) that is puncture- and leak-proof.
    - Do not use boxes that are open, overflowing, or punctured. Get a new one instead. Dispose safety boxes when they are three-quarters full.
    - Dispose of the sharps and sharp containers by burning, burying, or encapsulation.
    - Always put on heavy duty gloves when handling sharps containers.

Box 6.1. Best practices for administering injections

Select safe medicines

- Proper handling of medicines, including keeping them in a clean environment.
- Label them clearly.
- Observe proper storage conditions, including temperature and humidity (as recommended by the manufacturer).
- Check the expiry dates.

Use of sterile equipment

- Use needle and syringe from a sealed package.
- Use syringes with reuse prevention features.

Avoid contamination (adhere to principles of aseptic technique)

- Wash hands.
- Prepare on a clean surface.
- Do not touch the part of the needle that will come into contact with the patient's tissue and avoid recapping. If recapping is necessary, apply the one hand technique.
- Do not leave the needle in the rubber cap of the vial.

Reconstitute drugs or vaccines safely

- Use a new sterile syringe and needle for each reconstitution.
- Use the correct diluents/water for injection.
- Reconstitute according to the manufacturer's specifications.

Disposal of injection wastes and sharps properly

- Immediate disposal of the needle and syringe in a puncture- and leak-proof container.

Disseminate public health education and information

Source: FMOH 2012

Injection Devices and Their Safety Features

Syringes and needles are the major devices needed to provide injections. The following are standard types of syringes used at healthcare facilities (table 6.4):

- Auto-disable syringe
- Manually retractable
- Automatically retractable
- Standard disposable

Both private and public health facilities should use the syringes and needles listed above to provide any type of injection. After an injection, the syringe and needle should be disposed in a safety box.

Special Note:

All patients undergoing an injection should be counseled before the injection is given (e.g., on the type of drug, side effects, possible adverse effects/events following the administration of the injection, and the total number of doses to be given by injection).

Self-injecting patients, such as diabetic patients, should be properly informed about their medications and how to ensure the safety of injection. If a patient needs to take the injection equipment home, he/she should be counseled on the storage, disposal, and sterility of their drugs and equipment.

Table 6.4. Types of injection devices: Advantages and disadvantages

Type of Device	Advantages	Disadvantages
Auto-disable syringes	• Cannot be reused • They save time for HCWs from the burden of sterilization • Eliminate the patient-to-patient disease transmission caused by the use of contaminated syringes and needles	• More expensive than standard disposable (but are still affordable) • Have no safety features • Require a collection and disposal system
Manually retractable	• Cannot be reused • Safety feature: needle retracts inside the barrel • They save time for HCWs from the burden of sterilization • Eliminate the patient-to-patient disease transmission caused by the use of contaminated syringes and needles	• Not automatic; relies on proper actions of the HCW • More costly
Automatically retractable	• Cannot be reused. • Automatic safety feature: needle retracts inside the barrel • They save time for HCWs from the burden of sterilization • Eliminate the patient-to-patient disease transmission caused by the use of contaminated syringes and needles	• Most costly
Standard disposable	• Cheap • Available in the local market • They save time for HCWs from the burden of sterilization • Eliminate the patient-to-patient disease transmission caused by the use of contaminated syringes and needles	• Can be reused without sterilization • Have no safety features • Need sharps container or needle remover • Carry a high risk of infections

Source: FMOH 2012

Safe Handling of Vials Containing Medication (Single-Use and Multi-Dose Vials)

Practical Guidance on the Use of Safe Injection Devices

When using a sterile, single-use device (i.e., a syringe and hypodermic needle that are not separated or manipulated unless necessary):

- Use a new device for every patient, including for withdrawing medication. This practice is considered a basic IPC precaution and is promoted by the WHO (Safe Injection Global Network) and the CDC, among others. Figure 6.3 shows the "ONE and ONLY Campaign," which advocates for one needle, one syringe, and only one use.
- Inspect the packaging of the 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.

Figure 6.3. ONE and ONLY Campaign

Source: WHO 2010

Practical Guidance on Handling Parenteral Medications

When giving a medication:

- ALWAYS follow the one needle, one syringe, one injection rule.
- DO NOT use a single-loaded syringe to administer a medication to several patients, even if you change the needle every time between patients. See figure 6.1. Unsafe Injection Practices and Disease Transmission in this chapter. (Always follow the one needle, one syringe, one injection rule.)
- DO NOT use the same mixing syringe and needle to reconstitute several vials. See figure 6.1. Unsafe Injection Practices and Disease Transmission in this chapter.
- DO NOT combine leftover medications for later use.
- DO NOT use single-use vials for multiple patients, if possible.

When using single-use vials:

- Vials labeled by the manufacturer as "single-dose," "single-use," or "preservative-free" should be used only for a single patient.
- There may be circumstances when the contents of single-use vials must be used for multiple patients. In this situation, contents from an unopened single-use vial can be repackaged one time into multiple single-use syringes for multiple patients. However, this should be performed only by a trained HCW in an area away from patient care and in accordance with strict IPC standards. Label as described below. Store for only 24 hours.
- Check that you have the right medication vial for the patient's prescription.
- Double-check the expiration date, and if the vial has been previously opened, the current date is within 24 hours of opening (unless a shorter or longer time frame is otherwise specified by the manufacturer).
- Follow the principle of one syringe, one needle, one time.
- Discard the single-use vial after use.
- Discard a single-use vial:
    - If sterility or content is compromised.
    - If the expiry date or time has passed.
    - If found to be undated, improperly stored, inadvertently contaminated, perceived to be contaminated, or already punctured, regardless of expiration date.

When using multi-dose vials:

- If a multi-dose vial is assigned to a single patient (e.g., insulin pen), check that you have the right vial for the patient.
- Double-check the expiration date and if previously opened, check that the vial is labeled by the manufacturer as a multi-dose vial and the current date is within 28 days of opening, unless a shorter or longer time frame is otherwise specified by the manufacturer.
- Follow the principle of one syringe, one needle, one time.
- Remove the needle cap and insert the needle tip until it touches the bottom of the bottle.
- When withdrawing medication from a multi-dose vial, avoid double dipping, this may contaminate the contents of the vial and transmit infection to subsequent patients. See the Needles and Syringes section in this chapter.
- If newly opened, label the multi-dose vial. See the Labeling section in this chapter.
- DO NOT store multi-dose vials in patient care areas where they could be inadvertently contaminated.

Discard a multi-dose vial:

- If sterility or content is compromised.

- If the expiry date or time has passed (even if the vial contains antimicrobial preservatives).
- If it is not properly stored after opening, or within 28 days of opening, unless a shorter or longer time frame is otherwise specified by the manufacturer, or follow the manufacturer's instructions for the time the vial can be used once opened.
- If found to be undated, improperly stored, inadvertently contaminated, perceived to be contaminated, or has a visible hole in the rubber septum, regardless of expiration date, if thought to be a single-use rather than multi-dose vial.

Safe Preparation of Parenteral Medication

Injections should be prepared in a designated clean area, away from patient care, where contamination by blood and body fluids is unlikely.

Practical Guidance on Setting Up for Preparing Injections

Three steps must be followed when preparing injections:

1. Keep the injection preparation area free of clutter so that all surfaces can be easily cleaned.
2. Before starting the injection session, and whenever there is contamination with blood or body fluids, clean the preparation surfaces with a surface antiseptic, such as 0.5% sodium hypochlorite solution, 70% alcohol (isopropyl alcohol or ethanol), or other suitable surface disinfectant, and allow the preparation to dry.
3. Perform hand hygiene and assemble all equipment needed for the injection: sterile, single-use needles and syringes; reconstitution solution, such as sterile water or a specific diluent; alcohol swab or cotton wool; and a sharps container (WHO 2010).

Procedure for Vials with a Rubber Septum

Many vials have a rubber septum (stopper).

- Wipe the access rubber septum with 70% alcohol (isopropyl alcohol or ethanol) with a swab or cotton-wool ball, and allow it to dry before piercing the vial or inserting a device into the bottle.
- Use a new, single-use, disposable, sterile syringe and needle for each insertion into a vial.
- Never leave a needle in a multi-dose vial. This practice provides a direct route for microorganisms, including HIV, to enter the bottle and contaminate the fluid between each use.
- Once the loaded syringe and needle have been withdrawn from a multi-dose vial, administer the injection as soon as possible.

Reconstitution

- Always use a sterile syringe and a sterile needle to withdraw the reconstitution solution from an ampoule or a vial, 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.

Delay in Administration

- If a dose has been withdrawn into a syringe and cannot be administered immediately for any reason, cover the needle with the cap using a one-handed scoop technique. Do not keep the medication longer than 24 hours unless a shorter or longer time frame is otherwise specified by the manufacturer. Inject the medication as soon as possible after withdrawing from the vial. See the next section on labeling (WHO 2010).

Labeling

After reconstitution of a vaccine or medication in a multi-dose vial (e.g., BCG vaccine), label the vial and the final medication container with:

- Date and time of preparation
- Type and volume of diluent (if applicable)
- Final concentration
- Expiry date and time after reconstitution
- Name and signature of the person reconstituting the drug

For multi-dose medications that DO NOT require reconstitution (e.g., lignocaine), label the container with:

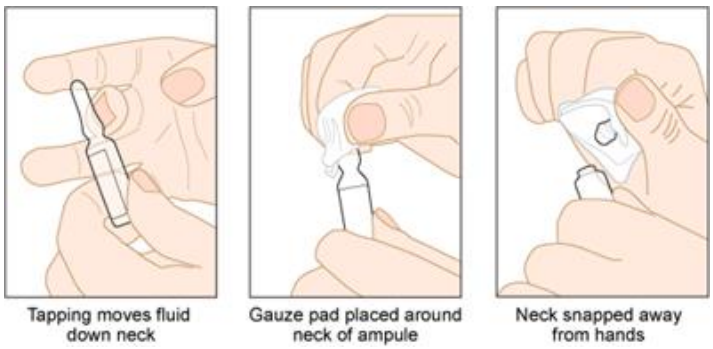
- Date and time of first piercing of the vial
- Expiry date and time after reconstitution
- Name and signature of the person first piercing the vial

Procedure for Pop-Open Ampoules

- Whenever possible, use vials with a rubber septum. If not available, use pop-open ampoules rather than ampoules that require use of a metal file to open. When opening glass ampoules, always protect the fingers with a clean barrier, such as a small gauze pad (figure 6.4).
- Pop-open vials cannot be stored for later use.

(Hutin et al. 2003)

Figure 6.4. Breaking open an ampoule



Source: Doyle & McCutcheon 2015

Safe Administration of Injections

Aseptic techniques should be followed for all injections.

Practical Guidance on Administering Injections

General

When administering an injection:

- Ensure that the patient is adequately prepared for and informed about the procedure.
- Check the drug chart or prescription for the medication and the five "rights": right patient, right drug, right dose, right route, right time.
- Perform hand hygiene.
- Wipe the top of the vial with 70% alcohol (isopropyl alcohol or ethanol) using a swab or cotton-wool ball. Allow it to dry.
- Open the package in front of the patient to reassure the person that the syringe and needle have not been used previously.
- Use a sterile syringe and needle to withdraw the medication from the ampoule or vial.

Important points

- DO NOT allow the needle to touch any contaminated surface.
- DO NOT reuse a syringe, even if the needle has been changed.
- DO NOT touch the rubber septum after disinfection with the 70% alcohol (isopropyl alcohol or ethanol).
- DO NOT reenter a multi-dose vial with the same needle used for mixing or reconstituting medications.
- DO NOT reenter a vial with a needle or syringe used on a patient if that vial will be used to withdraw medication again (whether it is for the same patient or for another patient).

- DO NOT use bags or bottles of intravenous solution as a common source of supply for injections (e.g., normal saline flushes) for multiple patients. These are not manufactured as multi-dose and do not have any preservative.

Practical Guidance on Prevention of Sharps Injuries

- Do not bend, break, manipulate, or manually remove needles before disposal.
- Avoid recapping needles, but if a needle must be recapped, use a single-handed scoop technique (figure 6.2).

How to Withdraw Medication Using an Auto-Disable Syringe?

WHO recommended several years ago that all immunizations be given using auto-disable syringes to improve injection safety. Since then, auto-disposable syringes have been widely used in both campaign and routine immunization settings. Although there are many types of auto-disable syringes, they are all similar in that they only permit the syringe to be filled and be emptied once. Auto-disposable syringes are a single-use, disposable syringe with a metal clip that locks the plunger after a single use (i.e., it cannot be pulled back a second time). To use auto-disable syringes, end-users need to be familiar with or to have a basic orientation.

- Open the sterile pack containing the needle and syringe, and attach the needle firmly.
- Remove the needle cap and insert the needle tip until it touches the bottom of the bottle, as shown in figure 6.5. (To avoid drawing air into the syringe, the needle tip should stay below the fluid level in the bottle.)
- Holding the bottle with one hand, slowly pull back on the plunger of the syringe and draw up fluid to just above the fill line mark (figure 6.5). For the solo shot FX syringes used with depot medroxyprogesterone acetate (DMPA), the “fill line” mark is at 1ml.

Figure 6.5. Withdrawing medication using an auto-disable syringe

Source: FMOH 2012

Withdraw the needle and syringe from the bottle and hold the syringe upright (needle pointing to the ceiling) to see if any air is in the syringe. If there are air bubbles, slowly push the plunger in, but only until the “fill line” mark is reached.

Check that the fluid level in the syringe is at or slightly above the "fill line" mark. If it is below the fill line mark, there may not be enough medication to be effective and the injection should not be administered. In this situation, either inject the medication back into the single dose bottle and draw up the medication again using a new auto-disable syringe and needle, or discard the partially filled syringe and use a new bottle and auto-disable syringe and needle.

Sharps Safety

Safety or Sharps Boxes

A safety or sharps box is a puncture- and leak-resistant container for the disposal of sharps, including hypodermic needles, needles from IV bags, lancets, scalpels, and suture needles. It can be made of thick cardboard or disposable plastic bottles with narrow necks (figure 6.6).

Categories of Sharps:

- Operating room-specific sharps requiring similar disposal include surgical drain trocars, needle point cautery tips, wire sutures, orthopedic drill bits, and a range of hollow needle injection.
- Special needles used by radiologists and anesthesiologists for various medically invasive procedures.
- Routine use needles and other sharps (e.g., blades, pins).

Proper Management of the Safety Box

- Can be free-standing or fixed.
- Should be easily accessible to HCWs for easy disposal of needles.
- Should not be easily accessible to the public.
- Dispose of when three-quarters full.
- Use one box per defined area of need.

Figure 6.6. Standard safety box

Sharps Containers Dos and Don'ts

- Do put sharps containers as close to the point of use as possible, ideally within arm's reach.
- Do attach containers to walls or other surfaces if possible.
- Do mark them clearly so that people will not unknowingly use them for discarding other items.
- Do place them at a convenient height so that staff can use and replace them easily.
- Do mark the fill line at the three-quarters full level.
- Don't shake a container to settle its contents and make room for more sharps.
- Don't place containers in high traffic areas where people could bump into them or be stuck by someone carrying sharps to be disposed of.
- Don't place containers on the floor or anywhere they could be knocked over or easily reached by a child.
- Don't place containers near light switches, overhead fans, or thermostat controls where people might accidentally put their hand into them.
- Don't put the following items on the sharp box: latex gloves, IV bags or extension tubes, dressing materials (like adhesive tape and gauze), compresses, cotton pads, empty vials and ampoules, or broken thermometers.
- Use of best practices can help prevent sharps injuries to HCWs.

Other Sharps Safety Dos and Don'ts

- Do wear gloves when using needles.
- Do discard needles with syringes and other sharps immediately after use.
- Do discard needles and other sharps in a sharps container.
- Do not walk around with needles and other sharps.
- Do use receivers to pass sharps to others and alert them before passing the sharps.
- Do not remove, bend, or break the needle.
- Do not recap needles after use.
- Do not leave sharps lying around the facility.
- Do not point needles and other sharps at yourself or others.

SUMMARY

Injection safety is:

- An integral component of IPC
- An element of standard precautions
- A key element of patient and HCWs safety
- Supported by IPC policies and procedures, such as hand hygiene, housekeeping, and waste management.

Injections present risks to patients, HCWs, and the community, and should be limited when alternative administration routes are available. Safe injection practices are one of the components of standard precautions. A safe injection is one that does not harm the recipient, does not expose the HCW to any avoidable risks, and does not result in waste that is dangerous for the community (Rapiti, Prüss-Üstün, Hutin 2005). Safe injection practices include the proper use of single-use and multi-dose vials. It is the responsibility of each HCW to ensure safe injection practices for every patient.

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CHAPTER 7: DECONTAMINATION AND REPROCESSING OF MEDICAL DEVICES (INSTRUMENT PROCESSING)

Key Topics

- Level of disinfection or sterilization required
- Guideline for processing instruments
- Commonly used disinfectants
- Cleaning
- High-level disinfection
- Chemical disinfectants
- Preparation and packaging for reprocessing
- Processing of endoscopes
- Sterilization
- Safe transport and sterile storage

BACKGROUND

Because the prime concern of safety procedures is to protect both patients and staff from infection, the transmission of infection from medical devices and equipment contaminated with a patient's body fluid is the focal area of interventions in health facilities. Instruments that are reused without being properly processed and made safe are one of the causes of infections in developing countries. HCWs are increasingly at risk of becoming infected with serious bloodborne viruses, such as HBV, HCV, and HIV. Some research findings show that there are 8 to 16 million new infections of HBV annually due to unsterile injections in developing countries. On the other hand, it was found that HIV survives in needles and syringes up to 42 days depending on temperature and other factors (Abdala, Stephens, Griffith, et al. 1999). Therefore, the greatest risk results from staff's direct contact with these life-threatening infections when they perform or assist with surgical procedures (physicians, nurses, and midwives); process surgical instruments and equipment (staff); and perform housekeeping and waste management tasks, including disposal of infectious waste items.

The basic IP processes recommended to reduce disease transmission from soiled instruments, surgical gloves, and other reusable items are by way of, cleaning, and either sterilization or HLD. Regardless of the type of operative procedures, the steps in processing surgical instruments and other items are the same (figure 7.1).

In the effort to create an infection-free environment, it is important that the rationale for each recommended IP process and their limitations be clearly understood by clinic staff at all levels, from healthcare providers to cleaning and maintenance personnel. IP principles require that all reused medical equipment be properly processed before reusing them to avert infections related to medical equipment. Processing reusable instruments is not knowledge and technology intensive. Rather, personnel need only simple and basic training on how to process them after procedures.

After completing an operation or invasive medical procedure or when still wearing gloves, the physician or assistant should dispose of contaminated objects (gauze or cotton and other waste items) in a plastic bag or leak-proof covered container. Disposable sharps (e.g., scalpel blades and suture needles) should be placed in a sharps container. Afterwards, all reusable items should be

cleaned at the point of use (soaked in a solution of warm water and detergent to prevent blood from drying on the surface of the items).

Following precleaning at the point of use, the instruments and reusable items are transported to an instrument processing area, preferably centrally, where they should be thoroughly cleaned with soap and water and be completely rinsed and dried.

Level of Disinfection or Sterilization Required

A rational approach for processing medical devices and surgical instruments for patient care was first described by Earle H. Spaulding more than 50 years ago (Spaulding 1968) and it is still relevant in making decisions about the final approach to instrument processing. Spaulding classified instruments and patient care devices into three categories, based on how the device is used. Items are classified as:

- Non-critical—come in contact with intact skin but not mucous membranes
- Semi-critical—come in contact with mucous membranes or non-intact skin
- Critical—come in contact with sterile areas of the body, including the vascular system (table 7.1)

Table 7.1. Policy for the local decontamination of reusable equipment according to the Spaulding classification

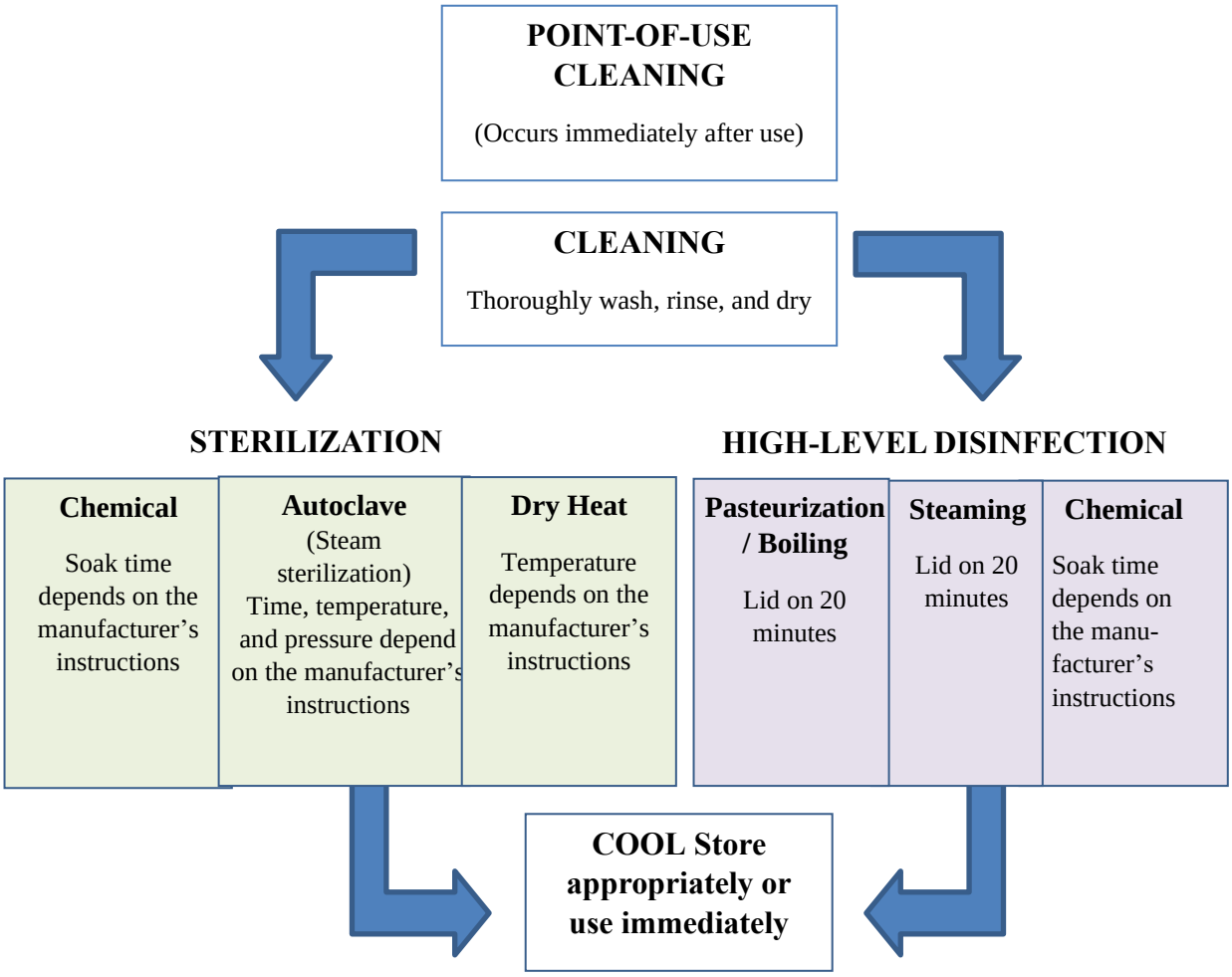
Risk category	Level of disinfection	Examples of medical device
High (critical) Items that are involved with a break in the skin or mucous membrane or entering a sterile body cavity	Sterilization	Surgical instruments, implants/prostheses, rigid endoscopes, syringes, needles
Intermediate (semi-critical) Items in contact with mucous membranes or body fluids	Disinfection (high level)	Respiratory equipment, non-invasive flexible endoscopes, bedpans, urine bottles
Low (non-critical) Items in contact with intact skin	Cleaning (visibly clean)	Blood pressure cuffs, stethoscopes

Adapted from: WHO and PAHO 2016

Guidelines for Processing Items

In all steps, special attention should be given to proper handling of the instruments and other items to minimize the risk of accidental injury or exposure to blood and other body fluids of the sterile processing staff and to attain a high-quality end result.

Figure 7.1. Workflow for instrument processing and other medical devices



Each item, be it soiled or non-soiled metal instruments, requires special handling and processing to:

- Minimize the risk of accidental injury or exposure to blood or body fluids to the cleaning and housekeeping staff.
- Provide a high-quality end product. Specific procedures for processing instruments, equipment, and other items used to provide healthcare services are summarized in figure 7.1.

Commonly Used Chemical Disinfectants

Disinfectants are chemicals that destroy or inactivate microorganisms.

Properties of an Ideal Disinfectant

- Wide antimicrobial spectrum
- Rapidly kills microorganisms

- Active in the presence of organic matter and compatible with soaps, detergents, and other chemicals encountered in use
- Non-toxic
- Does not cause the deterioration of cloth, rubber, plastics, and other materials
- Leaves an antimicrobial film on the treated surface
- Easy to use with clear label instructions
- Pleasant odor or no odor to facilitate its routine use
- Not prohibitively high in cost
- Soluble in water
- Stable in concentrate and at use-dilution
- Good cleaning properties
- Environmentally friendly on disposal

The most commonly used chemical disinfectants in healthcare settings are:

- Alcohols
- Chlorine and chlorine releasing compounds
- Sodium hypochlorite (chlorine bleach)
- Calcium hypochlorite or chlorinated lime
- Sodium dichloroisocyanurate
- Glutaraldehyde
- Iodine and iodophor solutions
- Hydrogen peroxide

Alcohols

Ethyl and isopropyl (2-propyl) alcohol (60% to 90%) are disinfectants that are relatively cheap and commonly available. Their rapid action and absence of chemical residue make them ideal for disinfection of many medical items. The activity of both alcohols, however, drops sharply when diluted below 50%. To attain better results, the optimal concentration of the solution should be kept between 60% to 90% with water (volume/volume).

Advantages

- Rapidly kill all fungi and bacteria, including mycobacteria. Isopropyl alcohol kills most viruses, including HBV and HIV, whereas ethyl alcohol kills all viruses. Both are also tuberculocidal (Rutala 1996).

- Rapid killing action
- Not corrosive to metal
- Less costly in comparison with other disinfectants
- Useful for soaking rubber or latex items occasionally
- Leave no chemical residue and, therefore, do not require rinsing

Limitations

- Evaporate rapidly making extended contact time difficult unless the items are immersed.
- Do not penetrate organic material and are easily inactivated.
- Are flammable.
- May swell or harden rubber and plastic materials if used repeatedly or for prolonged periods of time.
- Damage shellac mounting of lenses in endoscopes.

Considerations for Use

- They are primarily used as antiseptic and as a low or intermediate-level disinfectant (wiping oral and rectal thermometers and disinfecting external surfaces of equipment [stethoscopes, cryoprobe tips, ultrasound probes, Ambu bags or anatomic models]).
- Should be stored in a cool and well-ventilated place because they are flammable.

Chlorine and Chlorine Releasing Compounds

Chlorine solutions are fast acting; Very active against most viruses, relatively cheap; and readily available intermediate-level disinfectants. A major disadvantage is that concentrated chlorine solutions (>0.5%) can corrode metals (WHO and PAHO 2016).

NOTE: CHLORINE SOLUTIONS SHOULD NOT BE USED FOR HLD

Hypochlorites are the most widely used chemicals among chlorine disinfectants and are available in liquid (sodium hypochlorite) and solid (calcium hypochlorite and sodium dichloroisocyanurate) forms. Chlorine-releasing compounds are available in powder (calcium hypochlorite or chlorinated lime) or tablet form (sodium dichloroisocyanurate) (Rutala, Cole, Thomann, et al. 1998).

Soaking instruments in disinfectant before cleaning

According to the WHO and PAHO (2016), soaking instruments in 0.5% chlorine solution or any other disinfectant before cleaning is not recommended for the following reasons:

- It may damage/corrode the instruments.
- The disinfectant may be inactivated by blood and body fluids, which could become a source of microbial contamination and formation of biofilm.
- Transportation of contaminated items soaked in chemical disinfectant to the decontamination area may pose a risk to HCWs and result in inappropriate handling and accidental damage. It may contribute to the development of antimicrobial resistance to disinfectants.

Formaldehyde

Formaldehyde in both liquid and gaseous forms can be used for chemical sterilization and as a HLD (Taylor, Barbeito & Gremillion 1969; Tulis 1973). A commercially available solution of formaldehyde (Formalin), which contains 35% to 40% formaldehyde by weight, should be diluted with boiled water (1:5) to a final solution containing about 8% formaldehyde. Despite its limitation, formaldehyde continues to be used in many countries because both liquid and solid forms (paraformaldehyde) are cheap and readily available. Its use in hospitals and clinics has persisted for many years. Switching to a less toxic compound, such as glutaraldehyde or other newer HLDs, is strongly recommended but difficult to implement because of the high cost of these alternatives.

Note: Formaldehyde is being used as a HLD and as a sterilant in Ethiopia, but it is slowly being phased out globally because of its toxicity.

Advantages

- Not readily inactivated by organic materials.
- Can be used for up to 14 days.
- Can safely be used on surgical endoscopes (laparoscopes) because 8% formaldehyde will not corrode metal or damage instruments lenses, plastics, or rubber.

Limitations

- Causes skin irritation.
- Is a potential carcinogen.
- Irritates the skin, eyes, and respiratory tract, even at low concentrations.
- For sterilization, 24 hours soaking in 8% formaldehyde solution kills all microorganisms, including bacterial endospores.

This compound produces a dangerous gas (bis-chloroethyl-ether) when mixed with chlorine.

Glutaraldehyde

Glutaraldehydes are widely used for chemical sterilization and HLD of medical instruments. Aqueous solutions are acidic (pH < 7) and are activated only when made alkaline. There are many types of glutaraldehydes available worldwide. The most commonly used antiseptic is an alkaline-stabilized 2% glutaraldehyde available commercially as Cidex® or Cidex 7®. These chemicals, which are derivatives of formaldehyde, are also irritating, and their fumes are very unpleasant. Therefore, they should be used only in well-ventilated rooms. Because the stability and activity of glutaraldehydes vary considerably depending on how they are prepared and stored, the manufacturer's directions must be followed carefully.

Do not dilute this chemical unless specified in the manufacturer's instructions.

Advantages

- Not readily inactivated by organic materials.
- Can generally be used for up to 14 to 28 days.
- Can safely be used on surgical endoscopes (laparoscopes) because it will not corrode metal or damage lenses instruments (endoscopes), plastics, or rubber.

Limitations

- Can cause skin irritation or dermatitis with chronic exposure.
- Vapors are irritating to mucous membranes (eye, nose, and mouth) and respiratory tract.
- Works best at room temperature (20 °C to 25 °C or 68 °F to 77 °F).
- Is costly

Orthophthalaldehyde (OPA)

Orthophthalaldehyde (OPA) has several features that makes it a good choice for HLD of instruments and medical devices. It is relatively fast-acting, it is non-irritating to the eyes and nasal mucosa, and it does not require activation. It kills all vegetative bacteria, fungi, and non-enveloped and enveloped viruses. It does not kill all bacterial spores; therefore, it cannot be used to achieve sterilization. It is compatible with most metals and plastics, and can be used to process most endoscopes. However, there are reports of serious anaphylactic reaction in bladder cancer patients; therefore, OPA should not be used to process scopes for use in patients with bladder cancer.

Once the OPA solution is poured into the disinfection container, it can be used for 14 days as long as the solution concentration meets the minimum effective concentration. The concentration must be tested using the approved test strips provided by the manufacturer before the first use and then regularly to assure that the minimum concentration is met. The manufacturer recommends testing the

solution before each use, and it should be done daily, at a minimum. A log should be kept documenting the quality control results. OPA must be used within 24 months of the date of manufacture. Unopened bottles should be stored in a cool, dry place. Once the bottle of OPA is opened, it must be discarded within 75 days or by the bottle expiration date, whichever date comes first. HCWs handling OPA must wear PPE, including gloves and face and eye protection. OPA stains unprotected skin gray.

Items should be thoroughly cleaned and dried before OPA disinfection. The contact time for HLD using OPA is 12 minutes at 20 °C (68 °F). Ensure that all surfaces and lumens contact the disinfectant for the entire soaking time. This means lumens must be filled with disinfectant and free of air bubbles.

After disinfection time, items are removed from the disinfection solution and rinsed. OPA requires three complete rinses in water for one minute each. Items that may come in contact with non-intact skin and mucous membranes may be rinsed with clean, potable water. If the water quality is not reliable, a final rinse with 70% isopropyl alcohol will help eliminate any microbes and speed the drying process. When used for HLD of endoscopes, all lumens and channels should be rinsed with 70% alcohol after the third water rinse to help dry the channels. If items are not rinsed properly, the residual OPA can causes staining of patient's and HCW's skin.

OPA can be safely disposed of in a sewerage system. No deactivation is required before disposal down the drain, although it should be accompanied with large amounts of water.

OPA is not approved for sterilization. If sterilization methods are not available and OPA is used to high-level disinfect items that will be used on sterile tissue, the three rinses should be done with sterile water.

Iodine and Iodophor Solutions

Iodine solutions (1% to 3% aqueous or tincture) and Iodophor (iodine complexes with an organic material) have been used primarily as antiseptics.

Note:

For many years, Iodophors manufactured for use as antiseptics proved to be ineffective for disinfecting inorganic objects and surfaces. Usually, antiseptics have significantly less iodine (Rutala 1996). Whatever the case may be, it is good to make sure that labels are checked.

Iodophors are not HLDs because conclusive evidence is lacking on their effectiveness against bacterial endospores and some fungi. For example, Pseudomonas species, a group of gram-negative bacteria, have been known to multiply in Iodophors (Favero 1985; Rutala 1993). These solutions are generally nontoxic and nonirritating to the skin and mucous membranes. Iodophors must be properly diluted to be effective. Interestingly enough, correctly diluted Iodophors have more active killing power than the full strength Iodophors due to the decreased availability of "free" iodine in the latter.

Advantages

- They do not cause deterioration or softening of plastic items if they are kept dry between soakings.

- Diluted solutions of iodine and Iodophors are nontoxic and nonirritating (unless there is a known allergy to it).
- Can be used for disinfection of blood culture bottles and medical equipment, such as thermometers.

Limitations

- It is an oxidizing agent (causes rust) and should be used only for high-quality stainless-steel equipment or plastic materials.
- Like alcohol and chlorine, iodine and Iodophors are inactivated by organic materials; therefore, only previously cleaned instruments should be placed in iodine or Iodophor solutions.

Note: To effectively avoid inactivation, medical articles/equipment should first be thoroughly rinsed with sterile water or boiled and filtered (if necessary) water at least three times after soaking.

Allergic reactions can also occur to the staff handling iodine solutions and Iodophors. Therefore, they are:

- Primarily used as antiseptic for skin and mucous membranes (aqueous preparations only).
- Used for decontamination when the commercial preparation with aqueous solutions is available but must be made fresh on daily basis.

Hydrogen Peroxide

Hydrogen peroxide (H_2O_2) is often available locally, is relatively cheaper than any other chemical disinfectant, and can be used to achieve HLD and sterilization. It has activity against a wide range of microorganisms, including vegetative bacteria, fungi, and viruses. Hydrogen peroxide (3% solution) works effectively at lower pH and is stable at room temperature. Hydrogen peroxide does not damage glass and plastic articles and is safe on ventilators. It does have compatibility concerns with selected metals, therefore, approval from the device manufacturer should be obtained before use of this method on items where corrosion would be a concern. It has a low toxicity and irritancy rating. No activation is required.

A 3% solution can achieve HLD using a contact time of 30 minutes at 20 °C (68 °F). To achieve sterilization, a higher concentration (7.5% solution) and a longer contact time are required (6 hours at 20 °C [68 °F]).

Follow the manufacturer's instructions for product-specific contact time. After the first use, hydrogen peroxide can be used for a maximum of 21 days. The concentration of hydrogen peroxide must be monitored regularly by testing the minimum effective concentration. Items processed using hydrogen peroxide should be thoroughly rinsed with plenty of water. Chemical irritation has been identified in an endoscopy unit where endoscopes were disinfected with hydrogen peroxide.

The major limitation of this compound is that it is highly corrosive and should not be used to disinfect copper, aluminum, zinc, or brass. It loses its potency rapidly when exposed to heat and light; it should

be stored in a cool and dark place. WHO does not recommend using H_2O_2 in hot (tropical) climates where there are inadequate facilities to keep the product cool because of its instability in the presence of heat and light (WHO 1989).

Other Chemical Sterilants

Paracetic acid (peroxyacetic acid) is rapidly acting and effective against all microorganisms. Unlike other similar compounds, its activity will not be impeded by organic matters on items to be sterilized and it decomposes into safe products. When diluted, it is very unstable and must be used with a specially designed automatic sterilizer (APIC 2002). It is usually used for sterilizing different types of endoscopes and other heat-sensitive instruments.

Para formaldehyde: this solid polymer of formaldehyde may be vaporized by dry heat in an enclosed area to sterilize objects (Taylor et al. 1969). This technique, called "self- sterilization" (Tulis 1973), may be suitable for sterilizing endoscopes and other heat-sensitive instruments.

Gas plasma sterilization (hydrogen peroxide based): this method can sterilize items in less than one hour and has no harmful byproducts. However, it does not penetrate well and cannot be used on paper or linen. A specialized sterilizer is required for performing gas plasma sterilization (Taurasi 1997).

Disposal of Used Chemical Containers

- **Glass containers** may be washed with soap, rinsed, dried, and reused. Alternatively, thoroughly rinse them (at least two times) with water and dispose of by burying.
- **Plastic containers** used for toxic substances, such as glutaraldehydes or formaldehyde, should be rinsed (at least three times) with water and disposed of by burning.

Disposal of Used Chemicals

Waste should be carefully poured down a utility sink drain or a flushable toilet and then rinsed or flushed with water. Liquid wastes can also be poured into a latrine. However, this activity should be done without losing sight of precaution to avoid splashing. Rinse the toilet or sink carefully and thoroughly with water to remove residual wastes.

Products Not to Be Used as Disinfectants

Many antiseptic solutions are incorrectly used as disinfectants. Although antiseptics (sometimes called "skin disinfectants'') are adequate for cleansing skin before surgical procedures, they are not appropriate for disinfecting surgical instruments and gloves. These antiseptics do not reliably destroy bacteria, virus, or endospores. For example, Savlon (chlorhexidine gluconate with or without cetrimide), which is readily available worldwide, is often mistakenly used as a disinfectant.

Antiseptics that Should Not Be Used as Disinfectants

- Acridine derivatives (e.g., gentian or crystal violet)
- Cetrimide (e.g., Cetavlon®)

- Chlorhexidine gluconate and cetrimide in various concentrations (e.g., Savlon)
- Chlorhexidine gluconate (e.g., Hibiscrub®, Hibitane®)
- Chlorinated lime and boric acid (e.g., Eusol®)
- Chloroxylenol in alcohol (e.g., Dettol®)
- Hexachlorophene (e.g., PhisoHex®)
- Mercury compounds

Mercury solutions (such as mercury laurel) can cause birth defects and are too toxic to use as either disinfectants or antiseptics, although they are known to possess functions of low-level disinfectants (Block 1991). Other products frequently used to disinfect equipment are 1% to 2% phenol (e.g., Phenol®), 5% carbolic acid (Lysol®) and benzalkonium chloride, and quaternary ammonium compound (Zephiran®). These are low-level disinfectants and should only be used to decontaminate environmental surfaces (e.g., floors or walls).

Storage of Disinfectants

- Chemical disinfectants should be stored in a cool and dark area.
- Never store chemicals in direct sunlight or in excessive heat (e.g., upper shelves in a tin-roofed building).

Cleaning

Cleaning is a critical step in instrument processing because:

- It makes instruments safer for additional processing, which reduces the risk of infection for the HCWs who handle the instruments.
- It reduces damage to the instruments. At the end of a clinical or surgical procedure, surgical instruments and equipment are contaminated with tissue particles, body fluids, and blood. Long contact with blood is corrosive and can damage surgical instruments.
- It makes the instruments easier to process. Once blood dries on an instrument, it is difficult to clean, especially if the blood has entered the hinges and sockets.
- Bioburden and residual cleaning agents remaining on an item can inactivate chemical disinfectants or sterilants, and protect microorganisms from destruction, which can result in disinfection and sterilization failures (Zuhlsdorf, et al. 2004). In addition, instruments and materials used during an operation will be covered with blood and tissue remains. They may have been in touch also with chemicals and fluids, dirt, and dust. Hinged instruments may have remnants of blood and tissue from the operation. The tubing of hollow instruments may be also full of these soiled materials.

Therefore, it is important to follow all the necessary steps to properly clean instruments before HLD or sterilization. Before transport to the instrument processing area, HCWs should perform point-of-

use cleaning—wiping instruments to remove tissue and blood immediately at the conclusion of the procedure.

Once instruments are in the instrument processing area, cleaning involves thorough cleaning of instruments with water and a detergent and/or an enzymatic cleaner followed by thorough rinsing, and then drying before further processing.

Cleaning is a process of physically removing infectious agents and other organic matters on which they live and thrive but does not necessarily destroy infectious agents. It is an essential prerequisite to ensure effective disinfection or sterilization by reducing the number of microorganisms, especially endospores causing tetanus usually found on soiled instruments and equipment. Neither sterilization nor HLD can be effective without prior cleaning (Porter 1987).

Cleaning using hand soap (bar) or powdered laundry detergent is not advisable because the fatty acids in them react with the minerals in hard water leaving a residue or scum (insoluble calcium salt) that is difficult to remove. Using liquid soap, however, is better in that it mixes more easily with water than bar or powdered soaps. It can also break fats and grease very easily, making the cleaning process easier and more effective. The water used for cleaning purposes should be tap water that is not contaminated. If this is not possible, one may optionally use water boiled for 10 minutes and filtered to remove particulate matter (if necessary), or chlorinated water, water treated with a diluted bleach solution (sodium hypochlorite) to make the final concentration 0.001%.

It is not advisable to use abrasive cleaners (e.g., Vim® or Comet®) or steel wool because these products can scratch or pit metal or stainless steel. These scratches then become a good hiding place for microorganisms and make cleaning more difficult, hence increasing the chance of rusting.

Note: Many cleaning products contain ammonia, which can interact with bleach and cause the formation of toxic fumes. Check the label of any cleaning product to see if it contains ammonia. (Sometimes you can be alerted about it if you encounter the pungent smell of ammonia when opening the container.)

- Cleaning is the first step in reprocessing a device after use.
- Failure to properly clean an instrument may allow foreign material (e.g., soil and organic materials, including microorganisms) located outside and inside the device to hinder disinfection and/or sterilization.
- Cleaning is accomplished by using a manual process with cleaning chemicals (detergent) and water, brushing or flushing, or by using ultrasonic and or washer disinfectors to remove foreign material. Not every facility has a high level of resources, but medical devices must be thoroughly cleaned before disinfection or sterilization, irrespective of available resources.

One can clean without sterilizing, but one cannot sterilize without cleaning!

Table 7.2. Effectiveness of methods for processing instruments

Method	Effectiveness (kill or remove microorganisms)	End point
Cleaning (soap and rinsing with water)	Up to 80%	Until visibly clean
High-level disinfection	95% (does not inactivate endospores)	Boiling or chemical for 20 minutes
Sterilization	100%	High-pressure steam, dry heat, or chemical for the recommended time

Source: Tietjen et al. 2003

As shown in table 7.2, most microorganisms (up to 80%) in blood and other organic material are removed during the cleaning process. Moreover, a study showed that following the standard cleaning, most non lumen surgical instruments were found to contain less than 100 colony-forming units consisting of relatively non-pathogenic microorganisms (Rutala, Cole, Thomann, et al. 1998). This study **confirmed that thorough cleaning is more effective** than was previously assumed, and documented the importance of cleaning in producing the desired safe outcome of surgery.

Once an item is washed, it also needs to be rinsed and dried. Thorough rinsing with clean water removes any soap residue that can interfere with sterilization or HLD. After rinsing, items should be dried, especially if they will be sterilized or high-level disinfected using chemical disinfectants.

It should be noted that water possibly remaining on the surgical articles/equipment (e.g., surgical instruments), if not dried well, dilutes the solution and may hamper the process.

Manual Cleaning Steps

Facilities with minimal resources can adequately clean and prepare devices for sterilization with an effective manual cleaning process. However, it is vital that all devices be disassembled so that all surfaces can be cleaned and disinfected, irrespective of the cleaning method chosen.

- Ensure that the device to be cleaned is compatible with the chemical solution used in the facility.
- Completely submerge immersible items during the cleaning process to minimize aerosolization and to assist in cleaning.
- Remove gross soil using tools, such as brushes and cloths.
- Clean devices that have lumens with an appropriate brush, then manually or mechanically flush with a detergent solution and rinse with potable water.
- Check devices with lumens for obstructions and leakage.

1. Put on PPE, including a water-resistant gown, gloves, face mask, and head cover. If gloves are torn or damaged, they should be discarded; otherwise, they should be cleaned and left to dry for reuse the following day. Even when wearing heavy-duty utility gloves, care should be taken to prevent needle sticks or cuts when washing sharps.

2. Fill sink or appropriate basin with sufficient warm water for complete immersion of the devices being cleaned.
3. Add the appropriate quantity of detergent following the manufacturer's instructions for dosage.
4. Clean the device under the surface of the water so that aerosols are not produced.
5. Use appropriate brushes to properly clean box locks, lumens, and other hard-to-clean areas.
    - Use soft (nylon) bristle brushes so that the surface of the instrument is not damaged.
    - Brushes used to clean lumens must be the same diameter as the instrument to ensure that all internal surfaces can be reached.
    - Brushes must also be long enough to exit the distal end of the instrument.

NOTE: Brushes should be thermally or chemically disinfected at the end of the day. If this is not possible, they should be cleaned and left to dry. Brushes should be replaced when damaged.

6. In another sink or basin, completely immerse the device in clean purified water and rinse the device thoroughly.
7. Air-dry or hand-dry using a disposable clean, non-linting cloth.

Note:

Instruments that will be further processed with chemical solutions must dry completely to avoid diluting the chemicals; however, items to be treated with HLD by boiling or steaming do not need to be dried first.

Items that cannot be cleaned thoroughly should not be reused but should be discarded after use.

Summary of Cleaning

- Surgical instruments should be disassembled to allow for effective cleaning.
- Physical cleaning reduces the bioburden or the microbial load sufficiently to allow the process of sterilization or HLD to be effective.
- Dirt protects microorganisms from contact with the disinfectants, steam, and other chemicals, thereby rendering the process ineffective.
- Some chemicals used for reprocessing devices are inactivated in the presence of organic matter.
- Some chemicals used for reprocessing are inactivated when mixed with other chemicals (incompatible).
- The life of the instruments is prolonged if soil and debris are removed regularly.

Cleaning Products

There is no single cleaning agent that removes all types of bioburden. Bioburden is made up of a variety of matter, which may be soluble or insoluble in water and can be organic or inorganic.

Properties Associated with Ideal Cleaning Agents

- Emulsification
- Surfactation
- Dispersion and suspension
- Water softening
- Free rinsing
- Non-toxic
- Have a neutral PH
- Have a long life
- Be cost effective

Selection of Cleaning Agents

Deposits of dust, soil, and microbial residue on equipment can contribute to HAIs. Cleaning agents remove organic, inorganic, and microbial contaminants. No single compound has all the properties that are required to remove all soil deposits. The first step in cleaning is the use of surfactants or surface-active agents to reduce tension, which assists in soil being held in the cleaning solution.

Enzymatic (proteolytic) cleaners

Gross soil should first be removed by rinsing with detergent and water. If blood has dried or hardened, soaking in a warm solution of an enzymatic cleaner is required. Cleaning agents containing enzymes to break down proteinaceous matter may be used for sensitive equipment if the equipment manufacturer approves their use.

Remember: Enzymatic cleaners are not disinfectants; they only remove protein from surfaces. Rubber or nitrile gloves are recommended when handling enzymatic solutions. Enzymatic cleaners will degrade latex gloves.

Summary of Recommendations

- Disposable sharps shall be disposed of in an appropriate, puncture-resistant, sharps container at the point of use prior to transportation.
- Soiled medical devices shall be handled in a manner that reduces the risk of exposure and/or injury to staff/visitors/patients/residents or contamination of environmental surfaces.

- Contaminated devices shall not be transported through areas designated for the storage of clean or sterile supplies, visit/patient/resident care areas, or high-traffic areas.
- Sterile and soiled devices should not be transported together.
- Reusable medical devices must be thoroughly cleaned before disinfection or sterilization.
- If cleaning cannot be done immediately, the medical device should be pretreated to prevent organic matter from drying on it.
- The process for cleaning (decontamination) should include written protocols for disassembly, sorting, pretreatment, physical removal of organic material, rinsing, and drying.
- It is strongly recommended that catheters, tubing, and other medical devices with small lumens that are very difficult to clean be designated as single-use material and not be reprocessed and reused.

Preparation and Packaging for Reprocessing

The inspection, assembly, and packaging of reusable surgical instruments and medical devices are a crucial part of the reprocessing cycle.

All instruments and other items should be thoroughly cleaned and dried before being disinfected or prepared for sterilization. In some cases, it is not necessary to completely dry the items (needles or the like that have small openings) being sterilized for the small amount of water left inside these openings help in the steam sterilization process. For such items, flushing them with distilled or boiled water just before packaging for steam sterilization should be done after cleaning. Finally, **all jointed instruments should be open (or be unlocked) and disassembled.** Reusable cloth items should be laundered and dried after use or before sterilization to:

- Remove organic matter.
- Prolong the life of the cloth by restoring the fabric's normal moisture (water) content.

Inspection and Function Testing (Post-Cleaning)

- Each set should be inspected separately.
- Box joints, serrations, and crevices should be critically inspected for cleanliness.
- Hinges on devices, such as artery forceps and clamps, should be checked for ease of movement.
- Jaws and teeth should be checked for alignment.
- Ratchets should be checked for security.
- Multi-part instruments should be assembled to ensure that all parts are complete and working.

- Multi-part instruments should be assembled or disassembled for sterilization per the manufacturer's instructions.
- Any damaged, incomplete, or malfunctioning devices should be reported immediately to the supervisor.
- Cutting edges on devices, such as scissors, rongeurs, chisels, and curettes, should be checked for sharpness.
- Hinges on devices, such as artery forceps and clamps, should be checked for ease of movement.
- Each device should be checked after each cleaning cycle to ensure that all screws on jointed devices are tight and have not become loose during the cleaning process.

Placing Items in Surgical Trays or Sets

Devices should be prepared for sterilization in the following way:

- Clean and dry
- Jointed instruments in the open or unlocked position
- Multi-part or sliding pieces disassembled, unless otherwise indicated by the device manufacturer
- Devices with concave surfaces that will retain water must be placed in such a manner that condensate does not collect
- Heavy items arranged so as to not damage lighter more delicate items
- Sharp instruments with tips protected without being too tight

Assembly

The purpose of assembly and checking is to ensure that:

- All devices are present in accordance with the surgical tray list.
- All devices are assembled correctly in accordance with the manufacturer's instructions.
- All devices are placed in the correct tray in a manner that ensures ease of use by the user.

The area where assembly and checking takes place should be a designated and controlled area to optimize the effect of the sterilization process and minimize the contamination of the sets.

Packing and Wrapping for Steam Sterilization

Wrapping items to be sterilized permits sterile items to be handled and stored without being contaminated. (Figure 7.2 shows the typical wrapping techniques.) Materials used for wrappers should:

- Allow air removal and steam penetration.

- Act as a barrier to microorganisms and fluids.
- Capable of withstanding high temperatures.
- Resist tears and punctures and be free of holes.
- Be nontoxic and low-lint.
- Not be costly.

Types of materials that can be used as wrappers include:

- **Muslin cloth (140 thread count):** Use two double thickness wraps (four layers in all) because this is the least effective of all materials used for wrapping. Use for both steam and dry heat sterilization.
- **Paper:** Double wrapping (two layers) is recommended. Use it for steam sterilization only and avoid reuse.

Tips for Wrapping

- At least two layers of wrapping should always be used to reduce the possibility of contaminating the contents during unwrapping.
- Do not wrap packages too tightly. If they are wrapped too tightly, air can become trapped at the center of the packages preventing the temperature from getting high enough to kill all microorganisms. Wrapping with strings or rubber bands or tying linen too tightly can also prevent steam from reaching all surfaces.
- The outer wrapper of the pack can be loosely secured using linen ties. Packs can be secured with linen ties made from the same cloth. Hemmed strips of about one-half inch wide and of varied lengths. One or two of such strips can be used for each package. Because they can fit to almost any size of package, they eliminate the need for an expensive and hard-to-remove indicator tape.
- Do not wrap items in any waterproof material, such as plastic or canvas for steam sterilization because the steam cannot penetrate the material and leaves the item unsterilized.
- Wrappers should not be reused if they are torn, stained with oils, or have hard or gummy deposits.

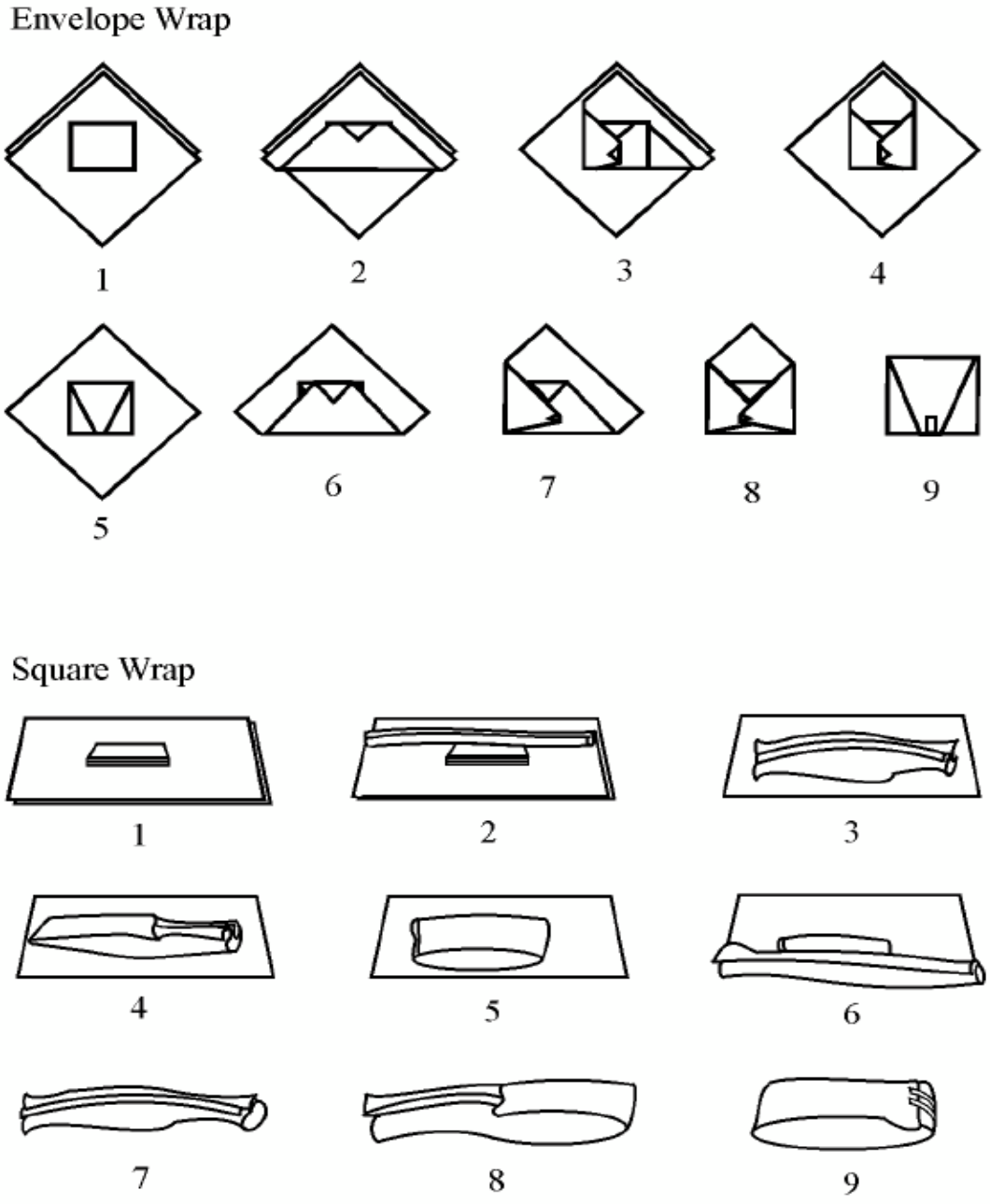


Figure 7.2. Typical wrapping techniques

Source: Tietjen et al. 2003

Packing and Wrapping for Dry Heat Sterilization

Packaging materials for dry heat sterilization should allow easy heat penetration, provide an adequate barrier to microorganisms after sterilization, resist tearing or puncturing before and after sterilization, have proven seal integrity, allow for ease of aseptic presentation, be free of toxic ingredients, be low-linting or lint-free, and be cost-effective and readily available. The material should have been approved for use with dry heat sterilization.

Packaging Materials for Dry Heat Sterilizer

- Medical-grade paper, bleached crepe paper, cellulose, and synthetic fibers
- Aluminum foil (thicker than domestic use foil)
- Glass bottles, vials, and ampoules for liquids
- Non-perforated glass or metal containers
- Transparent peel pouches approved by the manufacturer for use in dry heat sterilizers

High-Level Disinfection

Sterilization is the safest and most effective method for the reprocessing of surgical instruments because it kills all vegetative microorganisms and microbial spores. However, sterilization is not always suitable because some materials cannot withstand the high temperatures used during the sterilization process and sterilization may not be consistently available in some low-resource settings.

There are three levels of disinfection: low-level, intermediate-level, and high-level. The level of disinfection needed is based on how the item will be used. Per the Spaulding classification, devices that come in contact with intact skin are classified as non-critical items and should be processed by intermediate- or low-level disinfection. Surgical instruments and medical devices that come in contact with non-intact skin or mucous membranes (classified as semi-critical devices) must, at a minimum, be high-level disinfected, although sterilization is always preferable, when possible.

High-level disinfection can be achieved by:

- Pasteurization/ boiling in water
- Steaming
- Soaking instruments in chemical disinfectants (chemical disinfection)

To be effective, all steps in performing each method must be monitored carefully.

The highest temperature that boiling water or low-pressure steam will reach is 100 °C (212 °F) at sea level. Because the boiling point of water is 1.1 °C lower for each 1,000 feet in altitude, it is best to boil or steam items to be high-level disinfected for a minimum of 20 minutes. This provides a margin of safety for variations in altitudes up to 5,500 meters (18,000 ft) and at the same time eliminates the risk of infection from some, but not all endospores.

Boiling Versus Steaming

In both boiling and steaming, moist heat is used to kill microorganisms. Steaming has several distinct advantages over boiling for the final processing of surgical gloves and other items, such as plastic cannula and syringes. It is less destructive but more cost-effective because it uses much less fuel than boiling. For example, only about one liter of water is needed to steam gloves or instruments, whereas four to five liters are required for boiling. Besides, it is free from discoloration of instruments resulting from calcium or other heavy metals contained in some tap water because the steam contains only pure water molecules. Last, although boiling and steaming gloves are equally easy to do, drying

boiled gloves is not practical because it is difficult to prevent contamination while they are being dried in the open air. If steaming is instead opted for, they remain in the closed steamer pan, which results in little or no contamination of the gloves.

The major limitation of steaming is that if the steamers available locally are small, they can practically be used only for a small number of items (e.g., one set of instruments or 15 to 20 pairs of surgical gloves) per tray or pan. For steaming to be effective, the bottom pan must contain enough water to continue boiling throughout the steaming process. By contrast, large boiling pots are easier to use for metal instruments and do not need to be monitored the entire time to be sure that the process is being done correctly.

Both boiling and steaming share some advantages and limitations over chemical HLD, which is the only other method of HLD.

Advantages

- Inexpensive procedures
- Easily taught to HCWs
- Requires no special chemicals or dilutions and leaves no chemical residue
- Heat sources (boilers or rice cookers) are commonly available

Limitations

- Length of processing time must be carefully measured (i.e., start timing only after the steam begins to escape or water has reached a rolling boil). Once timing starts, no additional items or water can be added.
- Objects cannot be packaged before HLD; therefore, there is a greater chance of contamination if the items are to be stored.
- Requires a fuel source that may be unreliable.

High-Level Disinfection by Boiling

Pasteurization can be used to achieve HLD of instruments and medical devices. It is carried out by heating at 77 °C (170.6 °F) for 30 minutes or boiling at 100 °C (212 °F) for 20 minutes.

Boiling has been a common practice for HLD of instruments and equipment used for semi-critical and sometimes critical procedures because it was the only available option in some low-income countries.

Pasteurization/boiling in water is an effective and practical way to high-level disinfect instruments and other items. Although boiling instruments in water for 20 minutes will kill all vegetative forms of bacteria, viruses (including HBV, HCV, and HIV), yeasts and fungi, it will not kill all endospores reliably.

Instructions for HLD by Boiling

STEP 1 Clean all instruments along with other items to be high-level disinfected.

STEP 2 If possible, completely immerse items in the water. Adjust the water level so that there is at least 2.5 cm (1 inch) of water above the instruments. Moreover, make sure that all bowls and containers to be boiled are full of water. For example, one needs to empty bowls that turned bottom side up and float on the surface containing air pockets.

> **Note:**
>
> A study documented that the interior temperature of a plastic cannula floating on the surface of boiling water reaches a temperature of 96 °C to 98 °C in less than a minute. Therefore, for items that float (e.g., syringes, plastic manual vacuum aspiration [MVA] cannula, or rubber items), it is not necessary that they be fully covered by the water to achieve HLD if the pot is covered with a lid Greenslade et al. 1993).

STEP 3 Close the lid over the pan and bring the water to a gentle rolling boil. Boiling too vigorously wastes fuel, rapidly evaporates the water, and may damage delicate (or sharp) instruments or other items. A gentle rolling boil is sufficient and will prevent instruments or other items from being bounced around and possibly damaged by striking other instruments or the side walls of the pot.

STEP 4 Start timer. In the HLD log, note the time on the clock and record the time when the rolling boil begins.

STEP 5 Boil all items for the required time: 30 minutes at 77 °C (170.6 °F) or 20 minutes at 100 °C (212 °F).

Tips on Boiling

- Always boil for the required time period in a container with a lid.
- Start timing when the water begins to boil.
- Metal instruments should be completely covered with water during boiling.
- Do not add anything to the pot after timing begins.

STEP 6 Remove all items after the recommended time with a high-level disinfected forceps. Never leave boiled instruments in the water that has stopped boiling. As the water cools and the steam condenses, air and dust particles are drawn down into the container and may contaminate the instruments (Perkins 1983).

STEP 7 Use instruments and other items immediately, or pick them up with high-level disinfected forceps or gloves and place the objects in a high-level disinfected container with a tight-fitting cover. If any pooled water remains in the bottom of the container, remove the already dried items, and place them in another high-level disinfected container that is dry and can be tightly covered.

Protecting the Life of Instruments that Are Frequently Boiled

Lime deposits may form on metal instruments that are frequently boiled. This scale formation caused by lime salts in the water is difficult to avoid. However, following the steps below can minimize the problem of lime deposits. The steps are:

STEP 1 Boil the water for 10 minutes at the beginning of each day before use. (This precipitates much of the lime salt in the water on to the walls of the boiling pot before objects are added.)

STEP 2 Use the same water throughout the day, adding enough water only to keep the surface at least one inch above the instruments to be high-level disinfected. (Frequently draining and replacing the water, and boiling too vigorously increase the risk of lime deposits on instruments.)

STEP 3 Drain and clean the boiler or pot at the end of each day to remove lime deposits.

High-Level Disinfection by Steaming

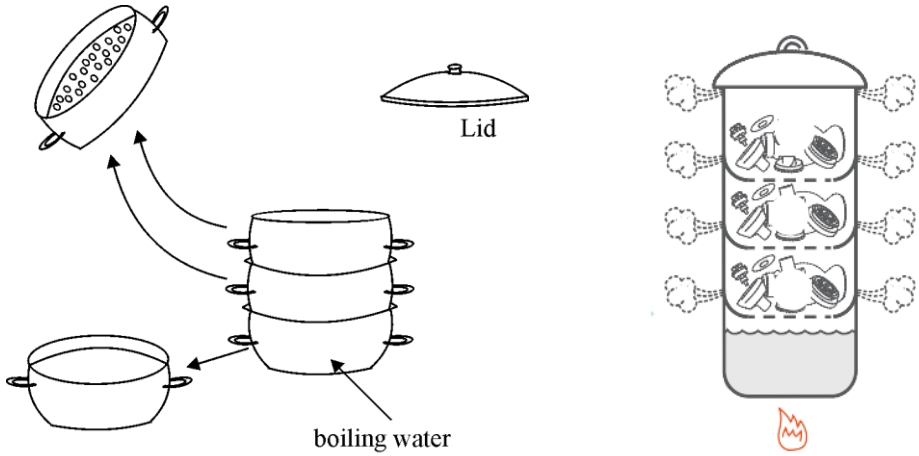
Steaming surgical gloves has been used as the final step in processing gloves for many years in Indonesia and other parts of Southeast Asia. A study conducted on the practice confirmed the effectiveness of this process of making gloves ready for reuse (McIntosh, et al. 1994).

The steamer used in the study (figure 7.3) consists of:

- A bottom pan (approximately 31cm in diameter) for boiling water
- One, two, or three circular pans with multiple 0.5cm (diameter) holes in their bottoms to permit the passage of steam through them and water back down to the bottom pan
- A lid that fits on the top pan

HLD by steaming is an option for plastic items used for patient care.

Figure 7.3. Steamer used for HLD



Two types of tests were conducted to determine whether surgical gloves and other items could be high-level disinfected using this process. In the first set of experiments, a thermocouple was placed inside a glove in each of the three pans and the rate and extent of the temperature change was recorded. When 5 to 15 pairs of surgical gloves were placed in each of the three pans, the temperature reached 96 °C to 98 °C in less than four minutes in the bottom and middle pans, and within six minutes in the upper pan. Thereafter, the temperature remained constant throughout the remaining 20 minutes. In the second set of experiments, batches of new surgical gloves were contaminated with *Staphylococcus epidermidis*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Candida albicans*, and *Bacillus subtilis* (heat-sensitive) and *Bacillus stearothermophilus* (heat-resistant) endospores. Next, the gloves were placed in each of the three pans and steamed for 20 minutes. After this, the gloves were removed from the pans and incubated for 24 hours in sterile media and then were placed on blood agar. In all cases (6, 15, and 30 gloves per pan), there was no growth of any microorganisms or *B. subtilis* endospores within 24 hours. As was expected, only a reduction in the number of *B. stearothermophilus* (heat-resistant) endospores occurred, nothing more than that.

Materials Needed for HLD by Steaming

- Steamer pan without holes to hold water (such as momo steamer)
- Two to three additional pans with holes to allow steam to move to the upper pan. The pans should be deep enough to fit the largest item being steamed.
- A tight-fitting lid to cover the upper pan
- An additional bottom pan for drying the processed items

Instructions for HLD by Steaming

After instruments and other items have been thoroughly cleaned, they are ready for HLD by steaming.

STEP 1 Perform hand hygiene.

STEP 2 Fill the bottom pan of the steamer with approximately one liter of clean water, about half the volume of the pan.

STEP 3 Place instruments, plastic MVA cannula, and other items in one of the steamer pans with holes in its bottom (figure 7.3). To make removal from the pan easier, do not overfill the pan.

Repeat this process until the three steamer pans have been filled. Stack the filled steamer pans on top of a bottom pan containing water for boiling. A second empty pan without holes should be placed on the counter next to the heat source (Step 7).

STEP 4 Place a lid on the top pan and bring the water to a full rolling boil.

It should be noted that when water only simmers, very little steam is formed and the temperature may not get high enough to kill microorganisms.

STEP 5 When steam begins to come out between the pans and the lid, start the timer or note the time on a clock and record the time in the HLD log.

STEP 6 Steam items for 20 minutes.

STEP 7 Remove the top steamer pan and put the lid on the pan that was below it (the pan now on top). Gently shake excess water from the pan just removed.

STEP 8 Put the pan just removed onto the empty pan (Step 3). Repeat until all pans are restacked on this empty pan and cover the top pan with the lid. This step allows the items to cool and dry without becoming contaminated.

STEP 9 Allow items to dry in the air while in the steamer pans (1 to 2 hours) before using.

STEP 10 Using high-level disinfected forceps, transfer the dry items to dry, high-level disinfected containers with a tight-fitting cover. Instruments and other items can also be stored in the stacked and covered steamer pans as long as a bottom pan (with no holes) is used.

High-Level Disinfection Using Chemicals

Although several disinfectants are commercially available in most countries, four disinfectants — OPA, glutaraldehydes, formaldehyde, and peroxide—are routinely used as high-level disinfectants. (Table 7.3 provides guidelines for preparing and using these disinfectants.) These chemicals can achieve HLD if the items being disinfected are thoroughly cleaned before immersion. A HLD should be selected for use based on the characteristics of the items to be disinfected, the physical area (i.e., whether it is well ventilated), and the skills of personnel available to do the procedure.

Key Steps in Chemical High-Level Disinfection

- Thoroughly clean instruments and other items that may have been contaminated with blood and body fluids, and thoroughly clean and dry them before placing them in the disinfectant solution.
- Completely immerse all items in the HLD.
- Soak them for 20 minutes.
- Remove items using high-level disinfected or sterile forceps or gloves.
- Rinse well with boiled and filtered (if necessary) water three times and air dry.
- Use promptly or store in a dry, high-level disinfected and covered container.

Adapted from: Tietjen and McIntosh 1989

How to Prepare an HLD Container

- For small containers, boil water in the covered container for 20 minutes, then pour out the water, which can be used for other purposes. Replace the cover and allow the container to dry.

- For large containers, fill a plastic container with 0.5% chlorine solution and immerse the cover in chlorine solution as well. Then soak them for 20 minutes. Thereafter, rinse the cover and the inside of the container three times with boiled water and allow them to dry in the air. Note that large metal containers cannot be high-level disinfected using chemicals.

Factors That Affect the Disinfection Process

- **Quantity and location of the microorganisms:** As the quantity of microorganisms increases, longer exposure times and higher concentrations of chemical disinfectants are needed to effectively disinfect instruments and devices. Therefore, it is essential that HCWs thoroughly clean items before disinfection.
- **Quantity and location of organic matter:** The presence of organic matter, such as tissue particles, blood, and other body fluids, can inactivate some disinfectants and compromise their effectiveness. In addition, biofilm formation makes it more difficult to adequately clean items. Thorough cleaning of instruments and devices is essential to reduce organic materials and biofilms before the disinfection process (Acosta-Gnass, Stempliuk 2009).
- **Concentration of the disinfectant:** The concentration of the disinfectant should be such that it effectively kills microorganisms and, at the same time, does not harm the instruments and devices being disinfected.
- **Physical and chemical factors:** Some disinfectants require a specific temperature or pH level to be effective. Always follow the manufacturer's instructions for use.
- **Duration of exposure:** Each disinfection method and disinfectant is associated with a specific amount of time that is necessary for achieving the desired results.
- **Resistance of microorganism to the chemical agent:** Resistance of microorganisms to various disinfectants can occur. Therefore, it is important to periodically review for documented or potential resistance of microorganisms to the disinfectant being used.

Sterilization

Sterilization is a process in which the destruction of all microorganisms, including bacterial endospores, takes place. This can be achieved by either physical or chemical methods and is especially necessary for medical devices penetrating sterile body sites or having direct contact with the blood (Spaulding 1939).

The proper sterilization of medical devices, surgical instruments, supplies, and equipment used in direct patient care and/or surgery is very critical in the modern healthcare delivery system and has great impact on patients' safety. Sterilization in health facilities can be achieved by high-pressure steam (autoclaves), dry heat (oven), chemical sterilants (glutaraldehyde or formaldehyde solutions), or physical agents (radiation).

Note: Rinsing an item with alcohol and then igniting it with a match (flaming) is not an effective method of disinfection or sterilization.

Essentials of Sterilization Process:

1. The sterilants and sterilizing equipment must be validated and appropriate in design and operation to correctly integrate key yardsticks like: time, temperature, contact, pressure (for steam sterilization), and the right sterilants (for chemical sterilization) to be as effective as they should be.
2. Instruments must be thoroughly cleaned to reduce dirt to guarantee effectiveness of the sterilization process. The more dirt, the greater the challenge to the sterilization process. Therefore, it could be said that the effective sterilization is entwined with an effective removal of dirt before making the instrument ready for sterilization.
3. There must be close and adequate contact between the chemical sterilant and all surfaces and crevices of the device to be sterilized.

The Effectiveness of Any Sterilization Method is Also Dependent on Four Other Factors

1. The type of microorganism present
2. The number of microorganisms present
3. The amount and type of organic material that protects the microorganisms. Blood or tissue remaining on poorly cleaned instruments acts as a shield to microorganisms during the sterilization process.
4. The number of cracks and scratches on an instrument that might harbor microorganisms.

Important Reminder: Sterilization is a process, not a single event; therefore, all phases and steps in the process must be carried out correctly.

Method of Sterilization

- High-pressure steam sterilization (autoclaves)
- Dry heat sterilization (oven)
- Chemical sterilization
- Other methods

Standard Conditions for Steam Sterilization

Steam sterilization (Gravity): In the usual practice, the temperature in the steaming process should be 121 °C (250 °F) and its pressure, 106 kPa (15 lbs/in^2), the time being 20 minutes for unwrapped items and 30 minutes for wrapped items. As an alternative, it could be set at a higher temperature of 132 °C (270 °F) with the pressure of 30lbs/in^2, and the duration being 15 minutes for wrapped items. Whatever the case may be, one should allow all items to dry before removing them from the sterilizer.

Note: Pressure settings (kPa or lbs/in^2) may vary slightly depending on the sterilizer used.

When possible, follow the manufacturer's recommendations.

Remember:

- **Exposure time begins only after the sterilizer has reached the target temperature.**
- **Do not overload the sterilizer (leave at least 7.5 cm [3 inches] between the items and walls of sterilizer). Overloading alters heat convection and increases the time required to sterilize.**

Source: Perkins 1983

High-Pressure Steam Sterilization (Autoclaves)

Steam sterilization is generally considered the method of choice for sterilizing instruments and other items used in healthcare facilities. In settings where electricity is a problem, instruments can be sterilized in a non-electric steam sterilizer using kerosene or another fuel as a heat source.

Rationale of Steam Sterilization

- Saturated steam is an extremely effective carrier of thermal energy that makes it many times more effective in conveying the necessary energy to the items to be sterilized than dry air.
- Steam is an effective sterilant in that it can soften any resistant and protective outer layer of the microorganisms allowing coagulation of the inner sensitive portion of the microorganisms.

Advantages

- Most commonly used effective method of sterilization.
- Sterilization cycle time is shorter in steam sterilization than in any other type of sterilization.

Limitations

- Requires a continuous source of heat (wood fuel, kerosene, or electricity).
- Requires a trained biomedical technician to perform preventative maintenance.
- Requires strict adherence to time, temperature, and pressure settings.
- Difficult to produce dry packs because breaks in procedure are common (e.g., not allowing items to dry before removing, especially in hot, humid climates).
- Repeated sterilization cycles can cause pitting and dulling of cutting edges of instruments (i.e., scissors).
- Plastic items cannot withstand high temperatures.

There are three types of high-pressure steam sterilizers:

- Gravity displacement

- Prevacuum
- Flash or immediate use sterilizers

Gravity Displacement Sterilizers

Tabletop models are relatively simple to operate. They are essentially horizontal pressure cookers (figure 7.4). A pool of water in the bottom of the sterilizer is heated until it turns into steam using a power source of electricity or kerosene. The steam then rises to the top of the chamber because it is lighter than the cool air in the chamber. As more and more steam is produced, the cool air is forced out of the chamber through the drain near the bottom of the chamber. When the steam pushes all the cool air out, steam enters the drain, triggering the thermally (heat) regulated valve to close. Once the valve is closed, the steam continues to build up pressure until the operating temperature (normally 121 °C/250 °F) is reached. The timer can now be activated and be counted down. At the end of the cycle (normally 20 minutes for unwrapped items and 30 minutes for wrapped items), the relief valve opens to allow the steam to escape. Usually the steam passes through the water reservoir where it condenses back to water and thus does not enter the room. After the pressure on the gauge reads zero, the door can be opened 12cm to 14cm (5 to 6 inches). Items inside it should be left to cool for 30 minutes. If steam is still present (and the chamber is quite warm), condensation of the moist air may cause wetness of the items or packs if they are placed on a cool or cold surface.

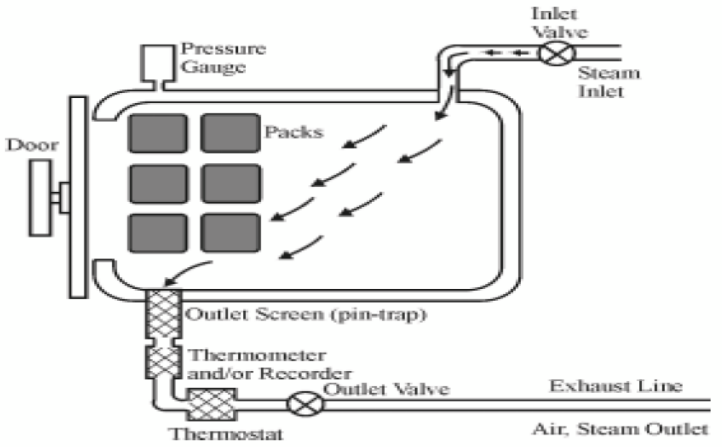


Figure 7.4. Simplified diagram of a gravity displacement steam sterilizer

Adapted from: Tietjen et al. 1992

Prevacuum Sterilizers

These sterilizers are similar to the gravity displacement sterilizers except that they have a vacuum pump system to remove the air in the chamber before the steam is let in. This step reduces the total cycle time. Most prevacuum sterilizers are operated at the same temperature (121 °C/250 °F) as gravity displacement sterilizers. However, a special type of vacuum sterilizer, called a high-speed vacuum sterilizer is operated at a higher temperature (134 °C/275 °F). The vacuum system not only shortens the cycle time, but also reduces the chance of creation of air pockets. Because a prevacuum sterilizer is more complex to operate, it is necessary to monitor its functioning closely and maintain it on regular basis.

Flash Sterilizers

These are small tabletop prevacuum sterilizers, usually located in operating rooms or adjacent to them. They operate at a higher temperature (134 °C/275 °F) and thus have a shorter cycle time. Due to their small size, their use is normally limited to the sterilization of unwrapped surgical instruments for emergency purposes (e.g., dropped instruments).

Most healthcare facilities often use gravity displacement sterilizers. In most countries, high-speed vacuum and flash sterilizers are usually found only in large referral hospitals (Webb 1986).

Operation

Instructions for operating the steam sterilizers (autoclaves) and their routine maintenance should be included in the basic training of healthcare staff. A steam sterilizer will reliably sterilize items only when kept in good working condition and operated correctly. Sterilization by steam requires four conditions: adequate contact, sufficient temperature, proper time, and sufficient moisture. Even if these conditions are all necessary for sterilization to take place, sterilization failures in clinics and hospitals are most often caused by the lack of steam contact or failure to attain the adequate temperature (Webb 1986).

Contact

The most frequent reason for sterilization failure is the lack of contact between the steam and the microorganisms. This failure may be related to human error or mechanical malfunction. Frequent causes of steam contact failure include:

- Failure to clean the object being sterilized adequately.
- Instruments that are closed locked or stacked.
- Packages wrapped too tightly.
- Packs that are overstuffed.
- Wrong position of the container
- Clogged strainer
- Other mechanical problems

Temperature

The next most important factor in steam sterilization is temperature. The most commonly used temperature for steam sterilization is 121 °C (250 °F). When an object at room temperature is placed in a sterilizer, the steam transmits thermal energy to the object until the object reaches the same temperature as the steam. Under normal circumstances, this equilibrium occurs in a few minutes. If the steam is unsaturated (too dry) or if the steam is prevented from reaching all parts of the object, the temperature may never reach the level required for sterilization. The only way to be certain that the sterilizer is working correctly is to make sure that the temperature at all points inside the load has reached the full operating temperature of 121 °C (250 °F).

Timing

Just as it takes a certain amount of time to cook food, sterilization/killing microorganisms does need time to do the work. In both cases, the hotter the temperature, the less time is required. Sterilization time is measured in D-values. A D-value is the amount of time required to kill 90% of the microorganisms present. Different microorganisms are killed in different scales/measures of time. In other words, each kind of microorganism has a different set of D-values corresponding with certain measure/level of temperature.

Moisture

Last, but surely not least, is the moisture requirement. Adequate moisture content of the sterilizer atmosphere is mandatory for effective sterilization by steam.

Adequate moisture content implies that the steam must be "saturated," having a relative humidity of 100%. When any cool object is placed in the sterilizer, the steam at the surface of the object cools and becomes supersaturated. Water begins to condense on the surface of the object. This condensation produces two immediate effects:

- The volume of gas in the sterilizer chamber decreases as the steam (water vapor) changes to liquid state and more steam is drawn into the chamber and, hence, comes into increased contact with the articles being sterilized.
- A very large amount of thermal energy is transferred to the object, raising the temperature of the article significantly. The amount of heat released is best explained by comparing the calories required to change the temperature of steam against the calories absorbed when water is converted to water vapor (steam).

If the steam is not saturated (less than 100% relative humidity), two problems will soon develop that individually or together interfere with the adequacy of the sterilization process:

- Articles in the sterilizer will remain dry and the microorganisms present cannot be killed as readily as under wet conditions. (Water vapor softens the capsules of microorganisms making them more vulnerable to destruction by heat.)
- Articles in the sterilizer will remain "cool" much longer, especially if they are wrapped. Again, using the home kitchen as an example, if a kettle of beans is placed in an oven (dry heat), it may take hours for them to cook. On the other hand, if they are placed in a pressure cooker (saturated steam), they will cook much more quickly. Saturated steam is a much better "carrier" of thermal energy than dry air.

In summary**,** saturation of the steam is vital to sterilizer operation because water vapor is the best carrier of thermal energy, which at times makes the microorganisms more vulnerable to destruction by heat (Webb 1986).

Effective Sterilization Depends on Correctly Following Procedures of the Process

The procedures include:

- Routine maintenance

- Preparing items to be sterilized
- Packaging and wrapping
- Loading
- Operating
- Unloading the sterilizer

It is only when all these procedures are strictly undertaken that items would certainly be sterilized.

Routine Maintenance

Although there are many brands of steam sterilizers, routine maintenance practices are generally the same regardless of the make or type. For routine maintenance:

- The outlet screen (or pin-trap) should be removed daily and cleaned using a mild soap and brush under running water.
- The chamber should be cleaned daily using a soft cloth, or for large sterilizers, a long-handled mop that is used only for this purpose. Do not use abrasives or steel wool because they may scratch the stainless steel surface and increase the occurrence of corrosion.
- All door gaskets should be cleaned daily with a lint-free cloth and checked for defects. Defective rubber gaskets should be replaced.
- The carriage (loading cart used to hold the packs placed in a sterilizer) should be cleaned daily using a mild soap and lint-free cloth. (The wheels of the loading cart should also be cleaned at this time, removing any string or other debris.)
- The exhaust line (or chamber drain) should be flushed weekly. This will keep the drain free of substances that might hinder air or steam removal from the chamber. Before flushing the exhaust line, check the maintenance instructions because trisodium phosphate solution (a special type of soap) is often recommended (Department of Health, Education and Welfare 1975; Webb 1986).

This solution can be prepared by adding one ounce of trisodium phosphate to one liter (one quart) of hot water. If this chemical is not available, the exhaust line can be flushed with hot water containing a mild soap solution. To do this, one should first remove the screen. Then pour one liter (one quart) of the solution down the drain using a funnel. Complete the process by pouring a liter of hot water to rinse out the soap and replace the screen. Usually, high-pressure steam sterilizers (autoclaves) also have specific instructions on their operation and routine maintenance. Managers should make copies of these instructions to make available to service staff. If replacement copies are needed, they can be obtained by writing to the individual manufacturer (normally the address can be found on the autoclave) or the donor agency providing with the equipment.

Note: To aid the prevention of dulling of the sharp points and cutting edges, wrap the sharp edges and needle points in gauze before sterilizing. Repair (sharpen) or replace instruments, as needed.

Loading and Unloading

Objectives

- To load items into the autoclave in such a way that it allows passage of the most steam through the load.
- To unload the steam autoclave so as to maintain the sterility of the items processed through a sterilizing cycle.

General Principles

- The total weight of an individual pack should not exceed 11 kg (24 pounds).
- When loading, leave sufficient space for steam to circulate freely and avoid overloading. Always leave three inches between the top-most pack and the top of the chamber. Items should not touch the chamber wall. Never overload the sterilization chamber.
- Do not place packages on the floor of the chamber.
- Place all packs (linen, gloves, etc.) on edge and place canisters, utensils, and treatment trays on their sides.
- Place instrument sets in trays having mesh or perforated bottoms flat on the shelves.
- In combination loads of cloth (or paper) packs and instruments trays, place linens on top shelves and trays on lower shelves. This prevents any condensation (moisture), which forms on cool metal when steam initially contacts with the item from dripping onto linen packs (Department of Health, Education and Welfare 1975).
- Load packages containing similar types of items in one load, when possible. For example, all textile packs should be sterilized in one cycle.
- Surgical gloves should be sterilized by themselves or placed on the top shelves.
- Nested packs should be positioned in the same direction to help prevent air pockets so that the condensation can drain and the steam can circulate freely. Shelves (metal wire) or a loading cart must be used to ensure proper loading. It is preferable to use the cart that comes with the sterilizer (figure 7.5).

Note: If an item goes in wet, it will come out wet. All items (instruments, basins, and glassware) must be dry before being loaded into the sterilizer. This helps prevent “wet packs.” The sterilizer is capable of drying items that have become moist during a properly loaded and operated sterilization process, but it still cannot remove excess moisture.

Metals and Glassware

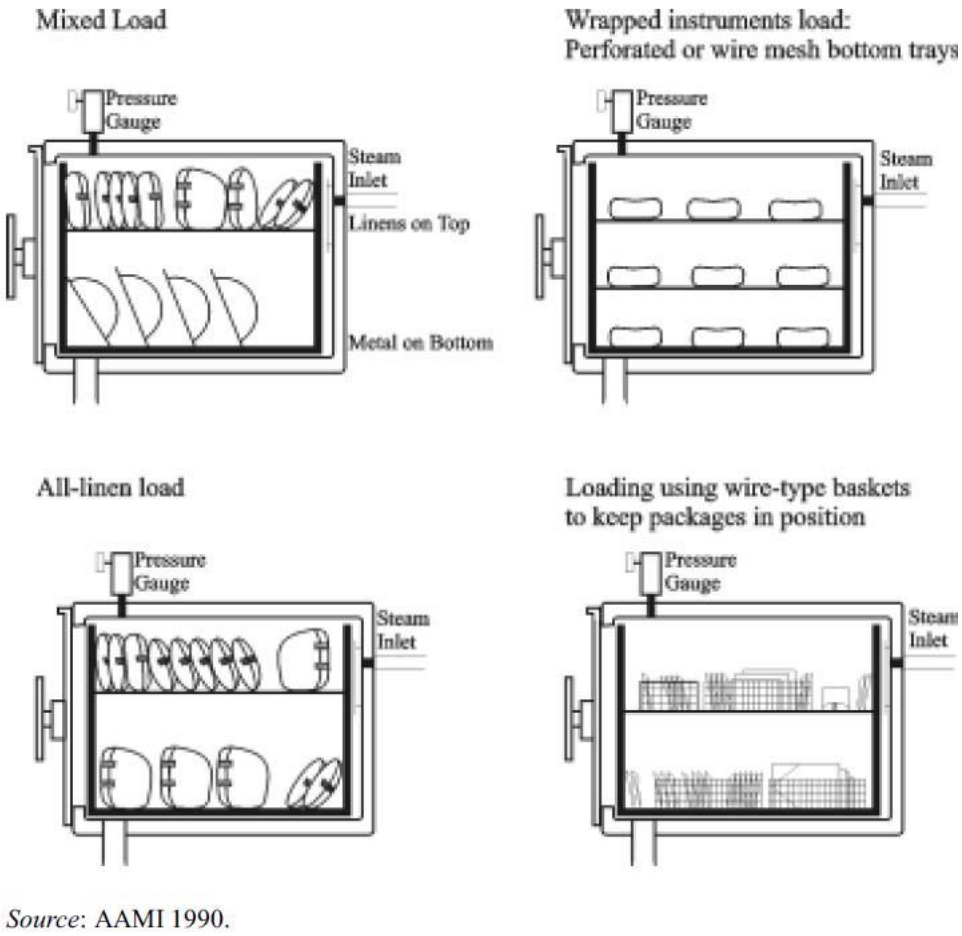
- Instrument sets should not exceed 8 kg (18 lbs.). Basin sets should not exceed 3 kg (7 lbs.).
- This is done for reasons of limiting the amount of condensation that forms when steam contacts cool metal. Using these limits ensures that the items will dry during the sterilization cycle.

- Solid containers should be placed on their sides to allow airflow out of them. If air is trapped in a solid container, it will prevent the steam from contacting the inner surface and prevent sterilization.

Linens

- Linen packs should not be too large and heavy (not more than 5 kg or 12 lbs.) to secure better steam penetration of the pack in 30 minutes (the time allowed for sterilizing wrapped items).
- Packs containing sheets, table covers, and towels are most impenetrable, and it is difficult for the steam to reach each fiber. Such packs must be placed on the edge of the shelf to insure better steam penetration.

Figure 7.5. Loading the steam sterilizer



Source: AAMI 1990.

Liquids

- Sterilize liquid and solution bottles separately from all other items.
- Liquids must be sterilized by themselves. The amount of liquid in the bottle, not the size of the container, determines the time required for sterilization.
- Use only borosilicate heat-resistant glass (Pyrex®).

- Use only automatic self-sealing caps for closure.

Combination Loads

- In loads that combine linens (fabrics) and metal items, place linens on top shelves and metal items below. This prevents condensation from dripping onto the linen packs, causing them to absorb the excess moisture.
- When a load is made up of wrapped and unwrapped items requiring different times to ensure sterilization, the longest required time **(**i.e., 30 minutes) must be used.
- The fundamental rule in loading the sterilizer is to prepare all items and arrange the load in such a manner as to encounter the least possible resistance to the passage of steam through the load (i.e., from the top of the chamber toward the bottom).

Unloading Tips

- Open the sterilizer door slightly 12–14 cm (5–6 inches) at the end of the cycle (when the chamber gauge reaches "0") and allow items to remain inside to reduce the potential for condensation (formation of water drops on the packages).
- Allow instrument packs to dry completely before removal (usually takes 30 minutes). Cooling time could be as long as two hours, based on room temperature and humidity.
- Do not handle the packs during the cooling time.
- Place sterile trays and packs on surfaces padded with paper or fabric (avoid placing warm packs on cold metal surfaces so as to prevent condensation).
- Store when packs reach room temperature (usually takes about one hour).
- Sterilized packs and articles should be handled gently and used as reasonably as possible.
- Return any pack that drops on the floor for reprocessing (remove items from the package and repackage before reprocessing).

(Acosta-Gnass, Stempliuk 2009; Tietjen, Bossemeyer, McIntosh 2003)

If a pack is dropped, turns out to be moist, or comes into contact with moisture, it must be considered contaminated.

Steam Sterilizing Liquids

Sterile water can be prepared only by steam sterilization.

Instructions

- All liquids should be in heat-resistant glass (Pyrex) closed with automatic self-sealing caps.
- Load steam sterilizer with liquids only.
- Wait until the thermometer indicator shows 121 °C (250 °F) and 106 kPa (15lbs/in$_2$).

- Time the sterilization using a clock. The amount (volume) of solution in the bottle determines the sterilization time, not the size of the bottle:

  75 to 200 ml 20 minutes
  200 to 500 ml 25 minutes
  500 to 1000 ml 30 minutes
  1000 to 1500 ml 35 minutes
  1500 to 2000 ml 40 minutes

Note: If bottles of solutions with different volumes are sterilized in the same load, use the sterilization time recommended for the bottle containing the largest volume of liquid.

- When the sterilization cycle has ended, release the pressure slowly, taking not less than 15 minutes, until the chamber pressure is at "0." Turn the operating valve off and open the door only 1 cm (½ inch). (Suddenly opening the door all the way after a sterilization cycle could cause liquids to boil over or bottles to burst.) Wait an additional 30 minutes for the chamber to cool before removing the load.

Instructions for Operating a Steam Sterilizer

STEP 1 Thoroughly clean and dry all instruments and other items to be sterilized.

STEP 2 All jointed instruments should be in an open or unlocked position, whereas instruments composed of more than one part or sliding parts should be disassembled.

STEP 3 Instruments should not be held tightly together by rubber bands or by any other means that will prevent steam contact with all surfaces.

STEP 4 Arrange packs in the chamber to allow the free circulation and penetration of steam to all surfaces.

STEP 5 When using a steam sterilizer, it is best to wrap clean instruments or other clean items in a double thickness of muslin or newsprint. (Unwrapped instruments must be used immediately after removal from the sterilizer, unless they are kept in a covered, sterile container.)

STEP 6 Sterilize at 121 °C (250 °F) for 30 minutes for wrapped items and 20 minutes for unwrapped items; set time of the clock.

STEP 7 Wait 20 to 30 minutes (or until the pressure gauge reads zero) to permit the sterilizer to cool sufficiently. Then open the lid or door to allow steam to escape. Allow the instrument packs to dry completely before removal, which may take up to 30 minutes. (Wet packs act like a wick drawing in bacteria, viruses, and fungi from the environment.) Wrapped instrument packs are considered unacceptable if there are water droplets or visible moisture on the package exterior when they are removed from the steam sterilizer chamber. If using rigid containers (e.g., drums), close the gaskets.

STEP 8 To prevent condensation when removing the packs from the chamber, place sterile trays and packs on a surface padded with paper or fabric.

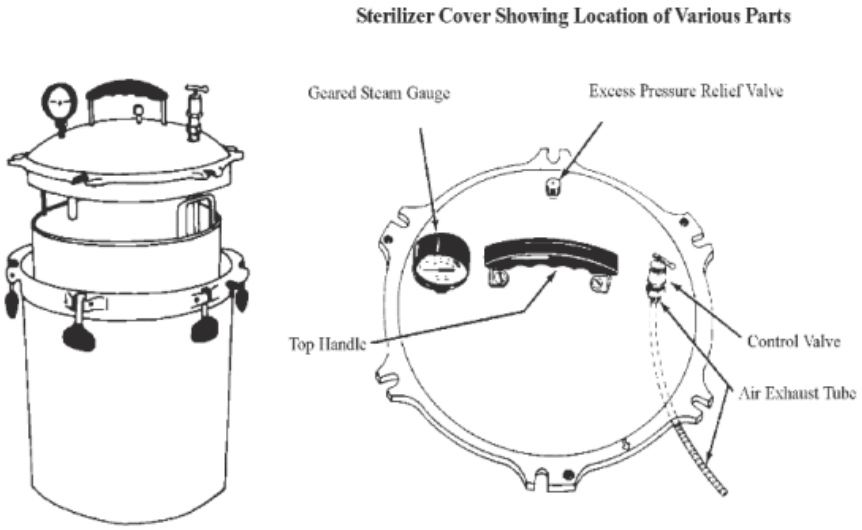
STEP 9 After sterilizing, items wrapped in cloth or papers are considered sterile as long as the pack remains clean, dry (including no water stains), and intact. Unwrapped items must be used immediately or stored in covered sterile containers.

- Maintain a steam sterilizer log including heat begun, correct temperature, and pressure achieved, heat turned down, and heat turned off.
- Each load should be monitored with mechanical (time, temperature, and pressure) and chemical (internal and external chemical test strips) indicators.
- Autoclave should be tested daily with an air-removal test to ensure the proper removal of air.
- If steam escapes from the safety valve or under the lid, the autoclave is not working correctly. Rather, it is merely steaming items at low-pressure (which may be equivalent to HLD, not sterilization).
- If steam escapes from the safety valve instead of the pressure valve, the pressure valve must be cleaned and inspected.
- If steam escapes from under the lid, the gasket (rubber ring) must be cleaned and dried or replaced.

Non-Electric Gravity Displacement Steam Sterilizer

To operate a non-electric gravity displacement steam sterilizer (figure 7.6):

Figure 7.6. Non-electric gravity displacement steam sterilizer



Source: Tietjen et al. 2003

- Clean and dry all instruments to be sterilized.
- Put all jointed instruments in the opened or unlocked position. Disassemble instruments composed of more than one part or sliding parts.

- Wrap clean instruments or other objects, as described earlier in this chapter. Instruments should not be held tightly together by rubber bands or by any other means that will prevent steam contact with all surfaces. (See the Packaging Medical Devices and Surgical Instruments for Steam Sterilization section in this chapter.)
- Arrange packs loosely in the chamber to allow for the free circulation and penetration of steam to all surfaces. Follow the manufacturer's instructions for load size.
- Bring water to a boil until steam escapes from the pressure valve; turn down the heat but keep steam coming out of the pressure valve. Do not allow the sterilizer to boil dry. Steam should always be escaping from the pressure valve.
- Sterilize for 30 minutes for wrapped objects, 20 minutes for unwrapped objects. Time with a clock. Start timing only after the temperature and pressure have reached the required parameters.
- After the appropriate time, turn off the heat and wait about 30 minutes (or until the pressure gauge reads zero) to permit the sterilizer to cool sufficiently before opening the lid to allow steam to escape.
- Allow instrument packs to dry completely before removal; this may take an additional 30 minutes.
- Damp packs act like a wick, drawing in microorganisms from the environment. Wrapped instrument packs are considered unacceptable if there are water droplets or visible moisture on the outside of the package when removed from the sterilizer chamber.
- To prevent contamination by condensation, place sterile trays and packs on a surface padded with paper or fabric after removing them from the chamber. (Do not store trays or packs in a plastic dust cover until they reach room temperature; this usually takes about one hour.)

Dry Heat Sterilization Method

Dry heat sterilization is caused by hot air that destroys microorganisms through oxidation that causes slow destruction of the microorganism's protein. Dry heat sterilization methods have limited value because it is difficult to maintain the same temperature throughout the process. Moreover, dry heat sterilization takes longer than steam sterilization because the moisture in the steam sterilization process significantly speeds up the penetration of heat and shortens the time needed to kill microorganisms. When available, dry heat is a practical means by which needles and other sharp instruments are sterilized. Dry heat sterilization can be achieved with a simple oven as long as a thermometer is used to verify the temperature inside the oven. Dry heat sterilization is accomplished by thermal (heat) conduction. Initially, heat is absorbed by the exterior surface of an item and then passed to the next layer. Eventually, the entire object reaches the temperature needed for sterilization.

Note:

Just as with steam sterilization, thorough cleaning of the object before dry heat sterilization is critical. If an instrument is not properly cleaned, effective sterilization cannot be ensured regardless of how long the instrument is heated.

Advantages

- An effective method as dry heat reaches all surfaces of instruments by conduction, even for instruments that cannot be disassembled.
- Protective of sharps or instruments with a cutting edge (fewer problems with dulling of cutting edges).
- Leaves no chemical residue.
- Eliminates "wet pack" problems in humid climates.

Limitations

- Plastic and rubber items cannot be dry heat sterilized because temperatures used (160 to 170 °C) are too high for these materials.
- Dry heat penetrates materials slowly and unevenly.
- Requires oven and continuous source of electricity

Conditions for Effective Use of Dry Heat Sterilizers

- **Adherence to specific instructions**: Instructions about the load, volume, and thermal resistance of the material must be considered at all times.
- **Airflow rate and distribution**: Irrespective of how airflow and air distribution are managed, they affect heat energy transfer efficiency. The heated air must be distributed uniformly within the load. Optimum air speed reduces microbial resistance by dehydrating cells and thus reduces sterilization time.
- **Load configuration and distribution**: The size and density of the load and the number and shape of the instruments affect airflow and air distribution.
- **Temperature**: The higher the temperature, the shorter the exposure time. The range is from 121–180 °C (250–356 °F), but 160–170 °C (320–338 °F) is the optimum.
- **Time**: The time depends on the temperature chosen.

Instructions for Operating a Dry Heat Oven

To ensure correct operation, consult specific operating instructions supplied by the oven's manufacturer.

STEP 1 Decontaminate, clean, and dry all instruments and other items to be sterilized.

STEP 2 If desired, wrap instruments in aluminum foil or place in a metal container with a tight-fitting closed lid. Wrapping helps prevent recontamination before use. Hypodermic or suture needles should be placed in glass tubes with cotton stoppers.

STEP 3 Place loose (unwrapped) instruments in metal containers or on trays in the oven and heat them to the desired temperature.

STEP 4 After the desired temperature is reached, begin timing. The following temperature/time ratios are recommended (APIC 2002):

170 °C (340 °F) 60 minutes
160 °C (320 °F) 120 minutes
150 °C (300 °F) 150 minutes
140 °C (285 °F) 180 minutes
121 °C (250 °F) overnight

Note: Use dry heat only for items that can withstand a temperature of 170 °C (340 °F) (Perkins 1983). Needles and other instruments with cutting edges should be sterilized at lower temperatures (160 °C [320 °F]) because higher temperatures can destroy the sharpness of cutting edges (Perkins 1983).

Depending on the temperature selected, the total cycle time (preheating, sterilization time, and cool down) will range from about 2.5 hours at 170 °C to more than 8 hours at 121 °C.

STEP 5 After cooling, remove packs and/or metal containers and store.

Loose items should be removed with sterile forceps/pickups and used immediately or placed in a sterile container with a tight-fitting lid until the time of use.

Dry heat:

- Heat treatment in 170 °C (340 °F) for an hour (total cycle time—placing instruments in the oven for one hour, and then cooling for 2 to 2.5 hours), or
- Heat treatment in 160 °C (320 °F) for 2 hours (total cycle time is from 3 to 3.5 hours).

Preventing Errors

- Sterilization equipment should be calibrated and processes should be validated.
- The coldest point should have a minimum temperature of 170 °C (338 °F) for sterilization to be effective.
- Instruments should be wrapped in materials that can withstand high temperatures (aluminum foils, stainless steel containers, peel pouches).
- Do not stack the packages tightly; leave enough room between surfaces.
- Carry out chemical and biological controls on a regular basis as per the manufacturer's instructions.

Chemical Sterilization

Chemical sterilization is an alternative to high-pressure steam or dry heat sterilization; it is often called "cold sterilization." If objects need to be sterilized, and when the available methods such as high-pressure steam or dry-heat sterilization would damage them or equipment are not available (or operational), they can be chemically sterilized.

Many chemicals, both in liquid and gas form, are available for processing instruments. Chemicals that are approved as sterilants can also be used as HLDs, but those approved only for HLD cannot be used as sterilants. Formaldehyde is no longer included as a sterilant or a HLD due to its toxicity (table 7.3).

Table 7.3. Liquid chemicals used for sterilization

Chemical	Sterilant	Soak time for sterilization	HLD?	Soak time for HLD	Effective life
Glutaraldehyde 2%–4%	Yes	10 hrs at 20–25 °C (68–77 °F) *or* 7 hrs, 40 min at 35 °C (95 °F)	Yes	20–90 min at 20–25 °C (68–77 °F)	14 days
Glutaraldehyde 3.4% and isopropanol 20.1%	Yes	8 hrs at 20 °C (68 °F)	Yes	10 min at 20 °C (68 °F)	14 days
Hydrogen peroxide 7.5%	Yes	6 hrs at 20 °C (68 °F)	Yes	30 min at 20 °C (68 °F)	21 days
Peracetic acid 0.31%–0.38%	Yes	2 hrs at 20 °C (68 °F)	Yes	5 min at 25 °C (77 °F)	5 days
Hydrogen peroxide 8.3% and paracetic acid 7%	Yes	5 hrs at 25 °C (77 °F)	Yes	5 min at 25 °C (77 °F)	5 days
Hydrogen peroxide 1.0% and paracetic acid 0.08%	Yes	8 hrs at 20 °C (68 °F)	Yes	25 min at 20 °C (68 °F)	14 days

Adapted from: FDA 2015; Rutala, Weber, Healthcare Infection Control Practices Advisory Committee 2008

Instructions for the Use of Chemical Sterilization

STEP 1 Thoroughly clean and dry all instruments and other items to be sterilized.

STEP 2 Check the expiry date on the container and prepare the chemical sterilant solution following the manufacture's instruction.

STEP 3 Completely submerge items in a clean container filled with the chemical solution and place the lid on the container for the recommended period of time.

STEP 4 Remove objects from the solution with sterile forceps; rinse all surfaces three times in sterile water; and air dry them. Ideally, three separate (sequential) rinse containers should be used.

STEP 5 Store objects in a sterile container with a tight-fitting lid if they will not be used immediately.

Monitoring Sterilization Procedures

Sterilization procedures can be monitored routinely using a combination of biological, chemical, and mechanical indicators as parameters. Different sterilization processes have different monitoring requirement.

Biological Indicators

Monitoring the sterilization process with reliable biological indicators at regular intervals is strongly recommended. Measurements should be performed with a biological indicator that employs spores of established resistance in a known population. The biological indicator types and minimum recommended intervals should be:

- **Steam Sterilizers:** A highly resistant but relatively harmless (nonpathogenic) microorganism called *Geobacillus stearothermophilus* is used to test steam sterilizers. As used in hospitals and clinics to test sterilizers, this microorganism has a D-value of about two minutes at 121 °C (250 °F). In other words, it would take two minutes at 121 °C (250 °F) to kill 90% of the test microorganisms present. Through research, mathematical calculation and intelligent "guesses," authorities have generally agreed that for normal hospital sterilization, about six *Geobacillus stearothermophilus* D-values (or about 12 minutes) should be sufficient to kill essentially all pathogenic microorganisms and give a large margin of safety. For reasons of the absence of internal temperature sensing devices, such as temperature-specific chemical indicators in many countries, extra time is recommended as an added safety margin. Therefore, twenty minutes for unwrapped and 30 minutes for wrapped packs are considered sufficient to kill most microorganisms. This biological indicator should be done weekly, and as deemed necessary.
- **Dry-Heat Sterilizers:** *Bacillus subtilis* is used as an indicator on a weekly basis, and as deemed necessary. Similar to *Geobacillus stearothermophilus,* the recommended time and temperature are found to be effective in the sterilization of the instruments.

Chemical Indicators

Chemical indicators include indicator tape or labels that monitor time, temperature, and pressure for steam sterilization and for dry heat sterilization. These indicators should be used on the inside and outside of each package or container.

- **External indicators** are used to verify whether the items have been exposed to the correct conditions of the sterilization process and the specific pack has been sterilized.
- **Internal indicators** are placed inside a pack or container in the area most difficult for the sterilization agent to reach (i.e., the middle of a linen pack). This is the indicator that tells whether the item has been sterilized.

Chemical indicators, such as heat sensitive tape or glass vials containing pellets that melt at certain temperatures and duration, do not imply achieved/successful sterilization. However, they do indicate whether mechanical or procedural problems have occurred in the sterilization process.

Mechanical Indicators

Mechanical indicators for sterilizers provide a visible record of the time, temperature, and pressure for the sterilization cycle. This is usually a printout or graph from the sterilizer or it can be a log of time, temperature, and pressure kept by the person responsible for the sterilization process that day.

Storage

All sterile items should be stored appropriately to protect them from dust, dirt, moisture, animals, and insects. The storage area should be located next to the place of sterilization or connected to it in a separately enclosed area with limited access that is used just to store sterile and clean patient care supplies. In smaller clinics, this area may be just a room close to the Central Supplies Department or in the operating room.

Instructions for Storing Sterile Items

1. Keep the storage area clean, dry, dust-free, and lint-free.
2. Control the temperature and humidity (approximate temperature 24^{o}C and relative humidity <70%) when possible.
3. Packs and containers with sterile (or high-level disinfected) items should be stored 20cm to 25 cm off the floor, 45cm to 50cm from the ceiling, and 15cm to 20cm from an outside wall.
4. Do not use cardboard boxes for storage because cardboard boxes shed dust and debris and may harbor insects.
5. Date and rotate the supplies (first in/first out). This process serves as a reminder, but does not guarantee sterility of the packs.
6. Distribute sterile and high-level disinfected items from this area.

Shelf Life

- The shelf life of an item (how long items can be considered sterile) after sterilization is event-related. An item remains sterile until something causes the package or container to become contaminated as time goes on since sterilization is not the determining factor.
- To make sure that items remain sterile until you need them, prevent events that can contaminate sterile packs and protect them by placing them in plastic covers (thick polyethylene bags). An event can be a tear or worn-out area in the wrapping, the package becoming wet or anything else that will enable a microorganism to enter the package or container.
- Before using any sterile item, look at the package to make sure that the wrapping is intact and the seal is unbroken, clean, and dry (and having no water stains).
- If the quality of the wrapping clothes is poor and plastic bags are not available, limiting the shelf life is a reasonable option to resort to and to secure the sterility of the instruments.

The Shelf Life of Sterilization Depends on the Following Factors

- Quality of the wrapper or container.

- Number of times a package is handled before use.
- Number of people who have handled the package.
- Whether the package is stored on open or closed shelves.
- Condition of storage area (e.g., humidity and cleanliness).
- Frequent or improper handling or storage.
- Use of plastic dust cover and method of sealing (AORN 1992).

Note: To make sure that items remain sterile until you need them, prevent events that can contaminate sterile packs, and protect them by placing them in plastic covers (bags).

In some healthcare facilities, where replacement of supplies is limited and the cloth used for wrapping is of poor quality, time as a limiting factor also serves as a safety margin. If plastic covers (bags) are unavailable for the sterilized items, limiting the shelf life to a specific length of time (e.g., one month) may be a reasonable decision as long as the pack remains dry and intact.

Other Sterilization Methods

Gas Sterilization: One of the first uses of formaldehyde gas was to fumigate rooms, a practice that has long been proven to be ineffective and unnecessary (Schmidt 1899). Due to the irritating nature of its vapor on the skin, eyes, and respiratory tract, and its carcinogenic effects, the use of formaldehyde in this form should be limited.

Ethylene oxide (ETO) is the other gas that is most frequently used in the United States and several other countries for sterilization of heat- and moisture-sensitive surgical instruments, such as plastic devices and delicate instruments. However, sterilization using ETO is a more complicated (requires a two-hour exposure time and a long aeration period) and costly process than either steam or dry heat sterilization because items that are sterilized by ETO need to be aerated (exposed to the outside) so that the residual ETO gas can diffuse out of the packages and items. This can take longer, leading to complete cycle times of 24 hours or more (Steelman 1992). Moreover, it requires sophisticated equipment and skilled staff specially trained for its safe use, making it impractical for use in many countries (Gruendemann, Mangum 2001). ETO is also hazardous to HCWs, patients, and the environment.

Because ETO is moderately toxic when inhaled, regular exposure to low levels (greater than one part per million) may produce harmful effects in humans. Moreover, the gas is irritating to the eyes and mucous membranes. Likewise, the residual ETO on instruments can cause skin injuries and inflammatory reactions in patients. Above all, because of the toxicity of this gas and category as a potential carcinogen and mutagen, the disposal of it is difficult (Gruendemann, Mangum 2001).

Ultraviolet Light Sterilization

Ultraviolet (UV) light has been used to help disinfect the air for more than 50 years (Morris 1972). However, UV irradiation has limited energy; UV light does not penetrate dust, mucous, or water. Therefore, despite the manufacturer's claims, it cannot be used to sterilize water.

Theoretically, an intense UV light can be both bactericidal and veridical; however, practically, it was found that only limited disinfection of instruments can be achieved. For surfaces that cannot be reached by the UV rays (e.g., inside the barrel of a needle or laparoscope), any microorganisms present will not be killed (Morris 1972). For these and other issues, UV radiation is neither practical nor effective method in most situations (Riley, Nardell 1989).

Sterilization for Prion Disease

Prion diseases, such as Creutzfeldt-Jakob disease (CJD), are a group of degenerative brain diseases that have received much attention during the past few years. They occur in animals (dogs, cows, and primates) and in humans, and are rapidly fatal once symptoms develop. In humans, CJD remains rare, with an incidence of less than one per million in the general population (Holman, et al. 1996). CJD poses a unique IP problem because prions that are protein-containing infectious agents can survive recommended heat or high-pressure steam sterilization processes. In addition, chemical disinfectants, including such sterilants as gluteraldehyde and formaldehyde, are not strong enough to eliminate the infectivity of prions on contaminated instruments and other items. Therefore, surgical instruments and other critical devices contaminated with high-risk tissue (i.e., brain, spinal cord, and eye tissue) from patients with known or suspected CJD require special treatment (Weber, Rutala 2001).

For handling and processing of prion-contaminated instruments, please refer to Jhpiego's *Infection Prevention and Control: Reference Manual for Health Care Facilities with Limited Resources* (2018) or WHO and PAHO's *Decontamination and Reprocessing of Medical Devices for Heath Care Facilities* (2016).

SUMMARY

Applying Spaulding's classification of non-critical, semi-critical, or critical items determines the method that should be used to process instruments. Cleaning is the most important step in instrument processing because it makes instruments safer for additional processing, prevents bioburden from drying on instruments, and ensures that there are no residual bioburden or cleaning chemicals on the instruments that may interfere with the subsequent HLD or sterilization process. Policies should be in place and all HCWs who perform instrument cleaning throughout the facility should be trained and competent in the appropriate way to clean surgical instruments and other equipment. All semi-critical instruments and devices that come into contact with mucous membranes and non-intact skin should be, at a minimum, high-level disinfected. HLD can be carried out by soaking in a high-level disinfectant, steaming, or by boiling. Sterilization of medical devices and surgical instruments plays a vital role in reducing surgical site infections and infection as a result of other invasive procedures. Monitoring the quality of the sterilization process and appropriately following recommendations will assist healthcare facilities to optimize the safety of sterile medical devices and surgical instruments used for patient care.

Table 7.4. Preparing and using chemical disinfectants

Disinfectant (common solution or brand)	**Effective Concentration**	**How to Dilute**	**Skin Irritant**	**Eye Irritant**	**Respiratory Irritant**	**Corrosive**	**Leaves Residue**	**Time Needed for HLD**	**Time Needed for Sterilization**	**Activated Shelf Life**[a]
CHEMICALS FOR STERILIZATION OR HIGH-LEVEL DISINFECTION										
Chlorine	0.1%	Dilution procedures vary[b]	Yes (with prolonged contact)	Yes	Yes	Yes[c]	Yes	20 minutes	Do not use	Change every 14 days, sooner if cloudy.
Formaldehyde (35B40%)	8%	1 part 35B40% solution to 4 parts boiled water	Yes	Yes	Yes	No	Yes	20 minutes	24 hours	Change every 14 days, sooner if cloudy.
Glutaraldehyde(Cidex7)	Varies (2–4%)	Add activator	Yes	Yes (vapors)	Yes	No	Yes	20 minutes at 25EC[d]	10 hours for Cidex7	Change every 14–28 days; sooner if cloudy.
Hydrogen Peroxide (30%)	6%	1 part 30% solution to 4 parts boiled water	Yes	Yes	No	Yes	No	20 minutes	Do not use	Change daily; sooner if cloudy.
CHEMICALS FOR DISINFECTION (alcohols and Iodophors are not high-level disinfectants)										
Alcohol (ethyl or isopropyl)	60B90%	Use full strength	Yes (can dry skin)	Yes	No	No	No	Do not use	Do not use	If container (bottle) kept closed, use until empty.
Iodophors (10% povidone-iodine) (PVI)	Approximately 2.5%	1 part 10% PVI to 3 parts water	No	Yes	No	Yes	Yes	Do not use	Do not use	If container (bottle) kept closed, use until empty.

[a] All chemical disinfectants are heat and light sensitive and should be stored away from direct sunlight and in a cool place (<40EC).
[b] See Tables 10.1 and 10.2 for instructions on preparing chlorine solutions.
[c] Only corrosive with prolonged (>20 minutes) contact at concentrations >0.5% if not rinsed immediately with boiled water.
[d] Different commercial preparations of Cidex and other glutaraldehydes are effective at lower temperatures (20°C) and for longer activated shelf life. Always check manufacturers' instructions.

Adapted from: Rutala 1996.

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CHAPTER 8: PROCESSING REUSABLE TEXTILES AND LAUNDRY SERVICES

Key Topics

- Minimum requirements for standard laundry
- Periodic monitoring and routine maintenance issues
- Key steps in processing textiles
- The use of PPE
- Collecting, transporting, and sorting used textiles
- Washing and drying (laundering) used textiles
- Storing, transporting, and distributing hygienically clean textiles

BACKGROUND

Although soiled textiles may contain large numbers of microorganisms, there is little risk to health workers during textile processing. If work-related infections occur, it often happens because HCWs are not using gloves or other PPE, or are not washing their hands during or after collecting, transporting, and sorting soiled items. Therefore, no special precautions are necessary, regardless of a patient's diagnosis, if standard precautions are taken in all situations.

Minimum Requirements for Standard Laundry

- Maintain the receiving area for contaminated textiles at negative pressure compared with the clean areas of the laundry in accordance with the FMOH Infrastructure Directorate construction standards for healthcare facilities in effect during the time of facility construction.
- Ensure that laundry areas have handwashing facilities and products, and appropriate PPE available for workers.
- Use and maintain laundry equipment according to the manufacturer's instructions.
- Do not leave damp textiles or fabrics in machines overnight.
- Disinfection of washing and drying machines in residential care is not needed as long as gross soil is removed from items before washing. Therefore, proper washing and drying procedures are sufficient.

Periodic Monitoring

- Monitoring/inspection of the laundry unit on a weekly basis (cleanness, functionality, availability of all necessary detergent, PPE, and water, and all activities, including collection, storage, and recording/information [to assess work efficiency] of the unit). *Facility should develop a monitoring checklist that includes the above requirements.*
- Include the laundry activity in weekly, monthly, quarterly, and yearly plans and report accordingly.

- Use microbiologic sampling during outbreak investigations if epidemiologic evidence indicates a role for healthcare textiles and clothing in disease transmission.

Maintenance of the Laundry

- Use and maintain laundry equipment according to the manufacturer's instructions.
- Make sure that spare parts are available for parts that can be easily damaged and needing replacement on a regular basis.
- Train laundry staff on user's maintenance and assign a focal person for managing the machine and reporting.

Types of Personal Protective Equipment to Use in the Laundry

Utility gloves, plastic or rubber apron, protective eyewear, and closed shoes that protect the feet from dropped items and spilled blood and body fluids should always be used when collecting and handling, transporting, sorting, and handwashing soiled textiles or loading them in automatic washers.

Note: If utility gloves are not available, putting on two pairs of examination or reprocessed surgical gloves (double gloving) provide some protection for staff responsible for collecting, transporting, and sorting soiled textiles and other items.

Processing Textiles

Processing textiles consists of all steps required to collect, transport, and sort soiled textiles and to launder (wash, dry, and fold or pack), store, and distribute them. Safely processing textiles from multiple sources is a complex process. To reduce the risk of contamination, procedures should be in place to safely handle, process, and store textiles.

Staff handling the textiles should be properly trained on the processing procedures and should protect themselves by applying standard precautions while collecting, transporting, and sorting soiled textiles. They should wear thick utility or heavy-duty household gloves to minimize the risk of accidental injury from a needle stick or other sharp object, including broken glass. Staff responsible for washing soiled items should wear utility gloves, protective eyewear, and plastic or rubber aprons and rubber boots.

Table 8.1. Recommended PPE for processing textiles

Activity	Type of PPE
Collecting soiled textiles	Thick utility or heavy-duty household gloves
Transporting soiled textiles	Closed-toe shoes to minimize the risk of accidental injury from sharp objects or contact with blood or body fluids
Sorting soiled textiles	Thick utility or heavy-duty household gloves
Handwashing soiled textiles	Protective eyewear and mask or face shield
Loading washers	Fluid-resistant gowns or plastic or rubber aprons
Handling disinfectant cleaning solutions	Closed-toe shoes

Source: OSHA n.d.; Sehulster, Chinn, Arduino, et al. 2015

Principles and Key Steps in Processing Textiles

- Wear heavy-duty utility gloves and other PPE when collecting, handling, transporting, sorting, and washing soiled textiles (see the section on PPE).
- Use PPE for standard precautions, carefully scrape off solid body fluids (e.g., stool or vomit) using a firm, flat object, and dispose in the toilet or sluice before the item is placed in the collection container.
- Use leak-proof containers for all textiles, or at least those grossly contaminated with blood or body fluids, to protect staff from exposure to blood and body fluids.
- Do not sort textiles in patient care areas.
- Confine the soiled textiles to designated areas until transported to the laundry. Using the principles of standard precautions, handle all discarded textiles as soiled, including items on which there is no visible contamination.
- All textiles present during procedures, regardless of whether they are visibly dirty or were used in the procedure, such as sterile towel drapes contained in an opened surgical pack that were not used during the procedure, must be laundered before they can be sterilized and reused.
- Transport textiles in covered containers or closed bags.
- Handle soiled textiles with minimum agitation to avoid contamination of the air, surfaces, and individuals.
- Handle soiled textiles as little as possible and with minimum contact to avoid accidents, injuries, and the spread of microorganisms.
- Sort textiles in the laundry area carefully before washing.
- Follow special guidelines for textiles used in isolation areas for patients with highly infectious diseases (e.g., VHF). Consult the FMOH or WHO IPC guidelines.

Collecting, Transporting, and Sorting Used Textiles

Design, Ventilation, and Space Requirements for Processing Textiles

- Processing areas for textiles should be physically separated from the patient care and food preparation areas.
- Laundry areas should have hand hygiene facilities.
- Processing areas for soiled textiles must be physically separated (e.g., divided by walls) from areas used for folding and storing clean textiles. If separate rooms are not possible, a physical barrier between the clean and soiled textile areas should be constructed.
- Processing areas considered “soiled areas” should be adequately ventilated.
- For facilities with natural ventilation, airflow should be away from other areas and the air should be exhausted out of the building.

Collecting, Handling, and Transporting Used Textiles

After invasive medical or surgical procedures or when changing textiles in patient rooms, the following precautions and procedures should be applied in each situation (CDC 2011; Sehulster, Chinn, Arduino, et al. 2015). There are special guidelines for textiles used in isolation areas for patients with highly infectious diseases (e.g., VHF).

Collecting

- Collect and remove soiled textiles from patient rooms after each procedure daily, or as needed.
- Use standard precautions, including PPE (see above), when collecting used textiles.
- Do not sort textiles in patient care areas.
- Collect used textiles at the point of use. Use leak-proof containers for all textiles; cloth bags are adequate for patient care textiles not soaked with blood or body fluids.
- Roll items that are heavily contaminated with blood or body fluids carefully into the center of the item and place in a leak-proof bag or a container with a lid if leak-proof bags are not available.
- Do not sort or rinse textiles heavily contaminated with blood and body fluids in patient care areas.
- Label clearly or use color coded containers for collecting and transporting used textiles.
- Wash and dry containers routinely before subsequent use. (See the Environmental Cleaning chapter in this volume for guidance on disinfectants.)

Note: If utility gloves are not available, put on two pairs of non-sterile gloves (double gloving). This provides some protection for HCWs responsible for collecting, transporting, and sorting soiled textiles and other items.

Handling

- Handle soiled textiles as little as possible. To avoid the spread of microorganisms in the environment and among HCWs and patients, do not shake soiled textiles.
- It is not necessary to routinely double bag or use additional precautions for textiles used by patients in isolation. Two bags may be indicated if the textile cannot be placed in the bag without contaminating the outside of the bag.

Transporting

- Transport collected soiled textiles to the processing area in closed bags, containers with lids, or covered carts.
- Transport soiled textiles and clean textiles separately. If there are separate carts, trolleys, or containers available for soiled and clean textiles, they should be labeled accordingly. If soiled and clean textiles are transported in the same cart or container:

- Clean the containers and trolleys or carts thoroughly after transporting soiled textiles using disinfectant cleaning solution. (For detailed information, see Volume 1, Chapter 9: Environmental Cleaning.)
- Keep soiled textiles in separate areas of the same cart from where clean textiles are located and cover both.

Sorting Soiled Textiles

Careful sorting of textiles is extremely important for the safety of HCWs. Sorting must be carefully performed because soiled textiles (e.g., large drapes and towel drapes) from the operating theater and other procedure areas may contain sharps (e.g., scalpels, sharp-tipped scissors, hypodermic and suture needles, and sharp-tipped towel clips). In addition, bedding from patients' rooms may contain soiled dressings (e.g., blood-stained or wet with other body fluids).

Sorting textiles allows for customization of washing processes for various categories of textiles or soil level. It also increases efficiency during inspection, folding, ironing, etc. Soiled textiles may also contain non-infectious items (e.g., coins and keys). These items pose no risk and should be returned directly to the patient. Please note that:

- The processing area for soiled textiles must be separate from other areas used for folding and storing clean textiles, patient care, and food preparation.
- Maintain adequate ventilation and physical barriers between the clean and soiled textile areas.
- Do not sort or prerinse soiled textiles in patient care areas; they should be sorted in the laundry area.
- Sort soiled textiles into appropriate wash loads by classification, such as color, type of fabric, soil type or soil load, and/or type of item (e.g., white items, cloth nappies/diapers, cotton/wool items, mop heads, surgical drapes).
- Always wear protective eyewear, utility gloves, appropriate footwear, and plastic or rubber apron when handling soiled textiles.
- Wash hands after removing the gloves. Although infrequent infection is related to sorting, they have been attributed to the failure of handwashing and proper use of PPE (McDonald 2002).

Washing (Laundering) and Drying Textiles

All textiles (e.g., bed sheets, surgical drapes, and gowns) used in the direct care of a patient must be thoroughly washed and dried before reuse. Laundering removes pathogens from textiles, making them hygienically clean and ready for use. Laundered textiles are not sterile and are not required to be, including for neonatal ICUs (Sehulster, Chinn, Arduino, et al. 2015).

Laundering standards in hospitals should address key, specific standards, for example, water quality and temperature, amount of agitation needed, and chemical properties needed to properly clean surgical attire. Effective laundering is dependent on the factors listed below, which, when used together, have a greater effect than when used separately.

- Duration of cleaning
- Mechanical action (i.e., agitation)
- Chemicals used in the process
- Temperature of water and air in the dryer machine

If one of these factors is decreased (e.g., temperature), then other factors (e.g., chemicals, mechanical action, or time) must be increased to result in the same level of cleanliness.

Laundering cycles consist of flush, main wash, disinfecting (bleaching), rinsing, and souring (addition of a mild acid agent).

Decontamination of textiles by presoaking with soap, water, and chlorine solution before washing is not necessary unless the item is heavily soiled or will be hand washed. Repeated soaking of textiles in chlorine solution, even dilute solution, can cause the fabric to deteriorate more quickly.

Note: The storage time for soiled textiles before washing is a practical issue related to available storage space and aesthetics, not an IP concern.

Handwashing Textiles

Using Cold Water

Using cold water saves energy. Cool water cycles rely heavily on the action of bleach to kill microbes. Temperatures of 22–25ºC (71–77ºF) for washing textiles is satisfactory for removing microbes if the water cycle, type of soap or detergent, strength of chlorine solution, and other additives are used in proper concentrations. WHO recommends soaking textiles in 0.05%–0.5% chlorine solution for 15–30 minutes and then washing with soap and water to remove the bleach (AORN 2012; Fijan and Turk 2012; Sehulster, Chinn, Arduino, et al. 2015; South East Asia Regional Office [SEARO]/WHO 2004).

Washing Textiles By Hand

The steps to properly hand wash textiles are:

STEP 1 Wear PPE while washing textiles by hand.

STEP 2 Separate heavily soiled textiles from non-soiled textiles and wash separately.

STEP 3 Wash the entire item in water with soap to remove all dirt and debris, even if not visible.

STEP 4 Soak in clean water with chlorine solution (0.05%–0.5%) for 30 minutes. Add sour (a mild acid agent) to prevent yellowing of the textile.

STEP 5 Wash again with soap and water to remove bleach.

STEP 6 Check the item for cleanliness. Rewash if it is still dirty or stained.

STEP 7 Rinse the item with clean water.

(Sehulster, Chinn, Arduino, et al. 2015; SEARO/WHO 2004)

Machine Washing Textiles

Heavy-duty washers or dryers are recommended for larger healthcare facilities (e.g., hospitals). To properly machine wash textiles:

STEP 1 Wear PPE while handling and loading machines.

STEP 2 Separate heavily soiled textiles from non-soiled textiles and wash separately.

STEP 3 Follow the manufacturer's instructions to adjust the temperature settings, cycle time, type of soap, and other washing agents to be added.

STEP 4 For hot-water washing at 70–80°C (158–176°F), use soap for ≥ 25 minutes to aid in loosening soil. Add bleach and souring agent if stain removal is required. If not using hot water, soak the textiles in 0.05%–0.5% chlorine solution for 15–30 minutes and then wash with soap and water to remove the bleach.

STEP 5 When the wash cycle is complete, check the item for cleanliness. Rewash if it is dirty or stained. (Heavily soiled textiles may require two wash cycles.)

(CDC 2011; SEARO/WHO 2004)

When using a machine for washing textile:

- Do not overload the machine.
- A prewash rinse cycle of 15 minutes will remove remaining gross spillage.
- In cold water washes, chemicals, such as bleach, must be added (2 ml of household bleach for every liter of water) with detergent to facilitate disinfection.
- During the rinse cycle, souring agent should be added to the rinse cycle to reduce alkalinity and prevent yellowing. This decreases the likelihood of skin irritation and further reduces the number of bacteria present.
- Air dry or machine dry before further processing. Textiles should be dried as soon as possible after washing to prevent the regrowth of any bacteria not killed by the washing procedure.

Please note that: Lower temperature or cold water washing are satisfactory if the cleaning products (type of soap or detergent, amount of bleach and other additive) are appropriate and used in proper concentrations. Using cold water also saves energy.

Drying, Inspecting, and Folding Textiles

Steps to dry, inspect, and fold hand- and machine-washed textiles:

STEP 1 Completely air or machine-dry cleaned textiles before further processing. A cycle in the dryer has been associated with elimination of pathogenic bacteria. For air-drying, direct sunlight is preferred. Keep the fabric off the ground, away from dust and moisture.

STEP 2 After textiles are totally dry, check for holes and threadbare (worn) areas. If these are present, the item must be discarded or repaired before reuse or storage.

For holes, punctures, or tears or large areas to be repaired, the item should be patched with the same quality material by stitching or heat sealing; otherwise, the item should not be used for direct patient care or surgical procedures. Worn textiles can be cut into pieces and used as cleaning cloths.

For surgical drapes, the percentage of exposed surface allowed to be patched depends on the sterilization method used to process the item and the number of layers of fabric from which the drape is made. For example, a drape should have no more than five patches per area 30 centimeters (12 inches) square, or no more than 20% of the drape covered with patches. Patches should be avoided, if possible, because they increase the thickness of the item and decrease steam penetrability when sterilization is required.

STEP 3 Air-dried textiles should be ironed. Ironing has been associated with the elimination of pathogenic bacteria and is essential to prevent parasites in some regions.

STEP 4 Clean, dry textiles should be folded. If sterile textiles are required (e.g., in the operating theater), prepare and sterilize wrapped packs. In neonatal ICUs, hygienically laundered textiles can be safely used; it is not necessary to use sterilized textiles (AORN 2012; Bearman, Bryant, Leekha, et al. 2014; Sehulster, Chinn, Arduino, et al. 2015; SEARO/WHO 2004; Tietjen, Bossemeyer, McIntosh 2003).

Storing, Transporting, and Distributing Hygienically Clean Textiles

Storing Hygienically Clean Textiles

Procedures for proper storing of hygienically clean textiles:

- Store clean textiles in clean, closed storage areas.
- Store clean textiles in an area free of pests, dust, and lint and at room temperatures of 20–25.6 °C (68–78 °F).
- Use physical barriers to separate folding and storage rooms from soiled areas.
- Ensure that storage shelves are 2.5 to 5 cm (1 to 2 inches) from the wall.
- Bottom shelf: 15 to 20 cm (6 to 8 inches) from the floor
- Top shelf: 30 to 45 cm (12 to 18 inches) below the ceiling
- Keep shelves clean and textiles covered, which can be achieved by covering clean textiles on a clean cart.
- Wrap bundles of clean textiles in plastic or other suitable material and close securely.
- Restrict access to the laundry storage room to authorized staff.
- Store hygienically clean surgical attire as close to the point of use as possible to avoid any microbial contamination.

- Handle stored textiles as little as possible.

(APIC 2014; Sehulster, Chinn, Arduino, et al. 2015)

Transporting Clean Textiles

Procedures for proper transporting of clean textiles:

- Hygienically clean and soiled textiles should be transported separately. If separate trolleys or containers are used for clean and soiled textiles, they should be labeled accordingly.
- If clean and soiled textiles must be transported in the same cart, the following are options in order of preference:
    - Thoroughly clean the containers and trolley with disinfectant cleaning solution (e.g., 0.5% hypochlorite solution) before transporting hygienically clean textiles.
    - Keep hygienically clean textiles in separate areas of the same trolley where soiled textiles are located and cover both.
    - Wrap or cover hygienically clean textiles during transport to avoid contamination.

Distributing Hygienically Clean Textiles

It is important to protect hygienically clean textiles from environmental contaminants (e.g., dust and dirt) until they are distributed for use. Outbreaks associated with textiles have resulted from contamination of clean textiles; several outbreaks of *Bacillus cereus* in hospital settings were linked to contaminated textiles (Balm, Jureen, Teo, et al. 2012; Duffy, Harris, Gade, et al. 2014; Hosein, Hoffman, Ellam, et al. 2013).

To avoid contamination of textiles in healthcare facilities:

- Do not leave extra textiles in patients' rooms.
- Handle clean textiles as little as possible.
- Avoid shaking clean textiles where dust and lint can be released into the room.
- Do not conduct routine microbiologic sampling of clean textiles.
- Clean soiled mattresses and pillows using the following guidelines before putting clean textiles on them:
    - Clean plastic-covered mattresses and pillows by wiping them down with detergent. Mattresses without plastic covers that have any blood or body fluids should have the stains removed by either steam cleaning or manual washing. HCWs should wear PPE during this cleaning process (Sehulster, Chinn, Arduino, et al. 2015; SEARO/WHO 2004).

Key Notes:

- Do not presort or wash textiles at the point of use.
- Workers should not carry wet and soiled textiles close to their bodies even though they are wearing a plastic or rubber apron.
- Presoaking in soap, water, and bleach is necessary only for heavily soiled textiles.
- Ironing, especially using a steam iron, will destroy pathogens.
- Handle stored textiles as little as possible.
- Sterilization is the preferred end process for surgical gowns, textile drapes, and wrappers.

SUMMARY

Facility staff are often responsible for handling and processing reusable textiles at the facility. Although soiled textiles may contain large numbers of microorganisms, the overall risk of disease transmission is low if textiles are handled, transported, and laundered in a manner that avoids the transfer of microorganisms to patients, HCWs, and the environment. Healthcare-related outbreaks can occur because of contaminated textiles and HCWs can experience injuries and exposure if these recommendations are not followed. Guidelines for processing textiles and PPE are provided in table 8.2.

Table 8.2. Guidelines for processing textiles and PPE

ITEM	DECONTAMINATION	CLEANING	HIGH-LEVEL DISINFECTION	STERILIZATIC
Protective eyewear (plastic goggles and face shields)	Wipe with 0.5% chlorine solution. Rinse with clean water. After each procedure or when is visibly soiled.	Wash with liquid soap and water. Rinse with clean water, then air or towel dry.[2] After each procedure or when visibly soiled.	Not necessary	Not necessary
Linens (caps, masks, scrubsuits or covergowns)	Not necessary. (Laundry staff should wear plastic aprons, gloves, and protective foot and eyewear when handling soiled items.)	Wash with liquid soap and water, removing all dirt particles. Rinse with clean water, air or machine dry.[2] Air-dried attire can be ironed before use.	Not necessary	Not necessary
Aprons (heavy plastic or rubber)	Wipe with 0.5% chlorine solution. Rinse with clean water. Between each procedure or each time they are taken off.	Wash with liquid soap and water. Rinse with clean water, air or towel dry at the end of the day or when visibly soiled.[2]	Not necessary	Not necessary
Footwear (rubber shoes or boots)	Wipe with 0.5% chlorine solution. Rinse with clean water. At the end of the day or when visibly soiled.	Wash with liquid soap and water. Rinse with clean water, air or towel dry at the end of the day or when visibly soiled.[2]	Not necessary	Not necessary
Surgical gowns, linen drapes and wrappers	Not necessary. (Laundry staff should wear plastic aprons, gloves and protective foot and eyewear when handling soiled items.)	Wash with liquid soap and water, removing all particles. Rinse with clean water, air or machine dry.[2]	Not practical	Preferred
Paper or disposable plastic items	Place in plastic bag or leakproof, covered waste container for disposal.			

Source: Tietjen et al., 2003

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CHAPTER 9: ENVIRONMENTAL CLEANING IN HEALTHCARE SETTING

Key Topics

- General principles of cleaning
- Ways of preparing disinfectant cleaning solutions
- When and how to clean low and high-risk areas
- Cleaning spills of blood or other body fluids
- Cleaning the housekeeping equipment

BACKGROUND

The accumulation of dust, soil, and microbial contaminants on environmental surfaces is both unsightly and a potential source of HAIs. Effective and efficient cleaning methods and schedules are, therefore, necessary to maintain a clean and healthy environment in healthcare settings (Chou 2002).

Housekeeping practices in healthcare facilities address the general cleaning of health facilities, including the compound, the floors, walls, various types of equipment, tables, and other surfaces. Housekeeping activities are not expensive or technology intensive in most cases. The purpose of general housekeeping is to:

- Reduce the number of microorganisms that may encounter patients, visitors, staff, and the community.
- Provide a clean and pleasant atmosphere for patients and staff.

Most areas in health facilities, such as waiting rooms and administrative offices, are normally of low risk because they can be cleaned using only soap and water. In high-risk areas, where heavy contamination is expected, sources of contaminations, such as toilets and latrines, and blood or body fluid spills, can be handled by such disinfectants as 0.5% chlorine or 1% phenol, which should be added to the cleaning solution (SEARO 1988). Using a disinfectant in addition to soap and water is also recommended in other high-risk areas, such as operating rooms, pre- and postoperative recovery areas, dressing areas, and ICUs.

Patient rooms, especially those items that might be touched with bare hands by patients and staff, should be cleaned using a disinfectant solution to minimize the risk of infection. A study in this area (McFarland, et al. 1989) found that when patients who did not have *Clostridium difficile* were admitted to a room previously occupied by a patient with these bacteria, the risk of infection from the bacteria for these new patients was known to increase many fold, even in the context of the correct use of precautions to prevent cross contamination.

If the purpose of housekeeping, as stated above, is to be achieved, it is important that housekeeping staff be trained to perform their assigned tasks and are supervised on a regular basis. As part of their training, it is important that the housekeeping staff:

- Understand the risk of exposure to contaminated items and surfaces when performing environmental cleaning procedures.
- Follow recommended policies and guidelines, including the use of appropriate PPE.

General Principles for Cleaning

- Scrubbing (frictional cleaning) is the best way to physically remove dirt, debris, and microorganisms.
- Cleaning is required before any disinfection process because dirt, debris, and other materials can decrease the effectiveness of many chemical disinfectants.
- Cleaning products should be selected based on their use, efficacy, safety, and cost.
- Cleaning should always progress from the least soiled areas to the most soiled areas, and from high to low areas so that the dirtiest areas and debris falling on the floor will be cleaned up last.
- Dry sweeping, mopping, and dusting should be avoided to prevent dust, debris, and microorganisms from getting into the air and landing on clean surfaces. Airborne fungal spores are especially important because they can cause fatal infections in immune-suppressed patients.
- Instructions for mixing (dilution) should be strictly followed when using disinfectants. (Too much or too little water may reduce the effectiveness of disinfectants.)
- Cleaning methods and written cleaning schedules should be based on the type of surface, the amount and the extent of the soil present, and the purpose of the area.
- Routine cleaning is necessary to maintain the standards of cleanliness. Also, schedules and procedures should be consistent and posted.

How to Select Cleaning Products

There are different types of cleaning products that are used for different purposes. The housekeeping staff, in particular, and health facility staff, in general, have to get a clear idea on how to select a cleaning product and for what purpose. There are some basic facts that should be remembered before selecting products. An ideal cleaning product should accomplish the following:

- Suspending fats in water (suspended fat in water).
- Saponification of fat (make fats water-soluble)
- Surfaction (decreasing surface tension of water and allowing greater penetration of the agent into the dirt or soil).
- Dispersion (break up of soil into small particles).
- Protein destruction (break up proteins).
- Softening the water by removing calcium and magnesium from it.

The Main Guiding Principles for Resource Limited Areas

- Unnecessarily expensive products should not be selected.
- What is selected and bought should be based on evidence (not be left to chance).
- The right product should be for the right purpose.

In conclusion, it is believed that the selection of disinfectants and other cleaning products should be based on the following factors:

- Intended use of the product/s
- Efficacy of the product/s
- Acceptability of the product/s
- Environment friendly
- Safety of the product/s
- Cost-effectiveness of the product/s

Personal Protective Equipment for Housekeeping

The housekeeping staff in health facilities deal with dirt, soils, and other materials that expose them to risks of infections and other health hazards. To avoid hazardous exposure, they must be equipped with the relevant PPE.

Some of PPE for housekeeping purposes are:

- Gloves, preferably utility or heavy-duty gloves
- Protective shoes
- Plastic or rubber apron
- Masks
- Protective eye wears
- Housekeeping staff should use the above-mentioned PPEs for:
    - Handling disinfectant cleaning solutions
    - Cleaning patient care areas
    - Cleaning heavily contaminated areas
    - Handling soiled linens
    - Handling soiled items and instruments
    - Handling or disposing of waste
    - When spills or splashes are expected

How to Prepare a Disinfectant Solution

Disinfectants

Disinfectants are only for disinfecting after cleaning and are not substitutes for cleaning unless they are a combined detergent-disinfectant product. Before disinfecting, use a cleaning product to remove all organic material and soil. Low-level disinfection is generally adequate for environmental cleaning procedures, but there are specific cases where intermediate-level disinfection with sporicidal properties (e.g., C. difficile) is required.

Combined detergent-disinfectants

Combined (one-step) detergent-disinfectant products can generally be used in place of a two-step (separate detergent and disinfectant product) process when disinfection is indicated for specific environmental cleaning procedures.

The disinfectant cleaning solutions contain both disinfectants for decontamination and detergents (soap) for cleaning. When we use chlorine solution, we should be cautious. Although chlorine-containing solutions (sodium hypochlorite) are excellent and inexpensive disinfectants, they should not be mixed with cleaning solutions containing an acid (e.g., phosphoric acid) like ammonia or ammonium chloride. Doing so will release chlorine gas and other by-products that can result in temporary illness (nausea, tearing, headache, or shortness of breath) of the staff inhaling fumes in a poorly ventilated area (CDC 1991). To find out if a cleaning solution contains ammonia, first check the label. If it is not mentioned among the ingredients, you may still be able to detect ammonia when opening the product by its pungent and burning smell. If one is exposed to chlorine gas or ammonium chloride or other unpleasant (noxious) gases with strong odors, the subject should immediately leave the room or the area until it becomes completely ventilated.

STEP 1 Prepare a 0.5% chlorine solution from liquid concentrates or from chlorine powder compounds (Equation 9.0-1). Alternative disinfectants that can be used are 1% to 2% phenols or 5% carbolic acid.

STEP 2 Add enough detergent to the 0.5% chlorine solution or another disinfectant to make a mild and soapy cleaning solution.

How to Prepare Chlorine Solution

Formula for making a dilute solution from a concentrated solution

- Check concentration (% concentrate) of the chlorine solution.
- Determine total parts of water using the formula in Equation 9.0-1.
- Mix one part concentrated bleach with the total parts water required.

Equation 9.0-1. Formula for making a dilute solution from a concentrated solution

$$Total\ Parts\ (TP) of\ water = \left[\frac{\%\ Concentrate}{\%\ Dilute}\right] - 1$$

Example: Make a dilute solution (0.5%) from 5% concentrated solution

STEP 1: Calculate totals parts water

$$Total\ Parts\ (TP) of\ water = \left[\frac{5\ \%}{0.5\ \%}\right] - 1$$

$$= 9$$

STEP 2: Take one-part concentrated solution and add to nine parts of water.

Formula for making a dilute solution from a dry powder

- Check concentration (% concentrate) of the powder you are using.
- Determine the amount of chlorine (gm) to be add in a liter of water using the formula below.
- Mix the calculated amount of dry powdered with one liter of water.

Equation 9.0-2: Formula for making a dilute solution from a dry powder

$$Gm/Lit = \left[\frac{\%\ Dilute}{\%\ Concentrate}\right] * 1000$$

Example: Make a dilute chlorine solution (0.5%) from a concentrated powder (35%)

STEP 1: Calculate grams/liter:

$$Gm/Lit = \left[\frac{0.5\ \%}{35\ \%}\right] * 1{,}000$$

$$= 14.2\ gm/lit$$

STEP 2: Add 14.2 grams to 1 liter of water

Cleaning Methods

Cleaning should start with the least soiled area and extend to the most soiled area and from high to low surfaces. Common methods of cleaning are briefly described.

Figure 9.1: Frequently touched surfaces at health facilities (Examination room)

Source: Curless et al. 2018

Wet Mopping Method (Preferable for Floor Cleaning)

Double-bucket technique: Two different buckets are used here, one containing a cleaning solution and the other containing water for rinsing. The mop is always rinsed and wrung out before it is dipped into the cleaning solution. The double-bucket technique extends the life of the cleaning solution (fewer changes are required), saving both labor and material costs.

Triple-bucket technique: The third bucket is used for wringing out the mop before rinsing, which extends the life of the rinse water.

Flooding Followed by Wet Vacuuming Method

- It is preferable for surgical suits.
- It eliminates mopping and minimizes the spread of microorganisms.
- It increases the contact time of the disinfectant and the area to be cleaned.
- Preferably, it should be done at night when the traffic flow of the facility is low.

Wet Dusting

- Should be used for cleaning walls, ceilings, doors, windows, furniture, and other environmental surfaces.
- Clean clothes or mops are made wet with cleaning solution contained in a basin or bucket. The double-bucket system minimizes the contamination of the cleaning solution.
- Dry dusting should be avoided, and dust cloths should not be shaken for fear of spreading microorganisms.
- Should be performed in a systematic way using a starting point as a reference to ensure that all surfaces have been reached.
- Check for a stain that may indicate possible leaks when doing high dusting (ceiling tiles and walls). Leaking holes or cracks should be repaired as soon as possible because moist structure provides a reservoir for fungal growth.

Dry Vacuuming

- This is recommended only for cleaning carpets.

Risk-Based Environmental Cleaning Frequency Principles

Probability of contamination: Heavily contaminated surfaces and items require more frequent and thorough environmental cleaning than moderately contaminated surfaces, which in turn require more frequent and rigorous environmental cleaning than lightly or non-contaminated surfaces and items.

Vulnerability of patients to infection: Surfaces and items in care areas containing vulnerable patients (e.g., immunosuppressed) require more frequent and rigorous environmental cleaning than surface and items in areas with less vulnerable patients.

Potential for exposure to pathogens: High-touch surfaces (e.g., bed rails) require more frequent and rigorous environmental cleaning than low-touch surfaces (e.g., walls). Every facility should develop cleaning schedules, including:

- Identifying the person responsible
- The frequency
- The method (product, process)
- Detailed SOPs for environmental cleaning of surfaces and noncritical equipment in every type of patient care area (CDC 2021).

Risk based area categorization & cleaning schedule: In health facilities, housekeeping activities should be scheduled. The housekeeping schedule should be planned, written, and closely followed. Cleaning schedules should be developed according to the need of each area.

Walls, windows, ceilings, and doors, including door handles: These areas should be cleaned when visibly dirty with a damp cloth, detergent, and water. In general, routine damp dusting is adequate for these areas (disinfection is unnecessary). These surfaces are seldom heavily contaminated with microorganisms as long as the surfaces remain dry and intact (Russell, Hugo, Ayliffe 1982).

Chairs, lamps, tables, tabletops, beds, handrails, grab bars, lights, tops of doors, and counters: These items should be wiped daily, and whenever visibly soiled, with a damp cloth containing disinfectant cleaning solution. A disinfectant should be used when contamination from blood or other body fluid spills are present.

Non-critical equipment (e.g., stethoscopes and blood pressure cuffs): These items can be wiped daily, and whenever visibly soiled, with a damp cloth with detergent and water. However, if the equipment is visibly soiled with blood or other body fluids, or when the patient is under contact precautions, it should be cleaned and disinfected before it is reused.

Floors are usually cleaned (daily and as needed) with a wet mop, detergent, and water. A disinfectant should be used during an actual or potential contamination from such sources as blood or other body fluid spills, as described below.

Sinks are scrubbed frequently (daily or more often, as needed) with a separate mop, cloth, or brush using a disinfectant cleaning solution. Following this, it needs to be rinsed with water.

Toilets and latrines are scrubbed frequently (daily and more often, as needed) with a separate mop, cloth, or brush and a disinfectant cleaning solution.

Patient rooms should be cleaned daily and right after a patient is discharged, using the processes described above. The same cleaning process applies to rooms of patients who are under isolation precautions. Any cleaning equipment used in the rooms of patients under isolation precautions should be cleaned and disinfected before being used in another room.

Procedure rooms: Wipe horizontal surfaces, equipment, and furniture used for procedures with a disinfectant cleaning solution after each procedure and whenever visibly soiled. Clean blood or other body fluid spills, as described below.

Examination rooms: Wipe horizontal surfaces with a disinfectant cleaning solution whenever visibly soiled. Linen or paper on the examination table should be changed and laid out for each patient. Clean blood or other body fluid spills, as described below.

Laboratory: Wipe countertops with a disinfectant cleaning solution after each shift and whenever visibly soiled. Clean blood or other body fluid spills, as described below.

Curtains: Change and clean curtains according to the routine schedule and when visibly soiled.

Carpets: Vacuum carpets daily in patient rooms or weekly in offices or conference rooms.

Soiled linen: Collect soiled linen daily (or more often, as needed); put them in closed and leak-proof containers.

Waste: Collect waste from all areas at least daily (or more frequently, as needed) and avoid overflowing.

Waste containers: Clean contaminated waste containers each time following emptying. Clean non-contaminated waste containers when visibly soiled and at least once a week. Use a disinfectant cleaning solution and scrub to remove soil and organic material.

Schedule and Procedures for the Operating Room

- At the beginning of each day, all flat (horizontal) surfaces (table, chairs, etc.) should be wiped with a clean, lint-free, and moist cloth to remove dust and lint that may have collected overnight.
- Total cleaning is not necessary between each case for surgical procedures.
- Total cleaning or terminal cleaning (mopping floors and scrubbing all surfaces from top to bottom) of the operating room should be done at the end of each day.

Note: Do not dry mop or sweep the operating room. (This causes dust, debris, and microorganisms to become airborne and contaminate clean surfaces.)

Total Cleaning

STEP 1 Remove covered contaminated waste container and replace it with a clean container. Arrange for burning (incineration) or burial as soon as possible.

STEP 2 Close and remove sharps containers when three-quarters full.

STEP 3 Remove soiled linen in closed leak-proof containers.

STEP 4 Soak a cloth in disinfectant cleaning solution and wipe down all surfaces, including counters, tabletops, sinks, lights, etc. Wash from top to bottom so that any debris that falls on the floor will be cleaned up last.

Note: All areas of the surgical suite, scrub sinks, scrub or utility areas, hallways, and equipment should be totally cleaned regardless of their being used during the 24-hour surgery period.

Walls and ceilings: Wipe them with a damp cloth with detergent and water as needed for visible soil.

Note: If walls and ceilings are deteriorating or damp, cover them up with clean plastic sheets during procedures.

Chairs, lamps, sink tabletops, and counters: Wipe them with a damp cloth with disinfectant cleaning solution.

Operating room lamps: Wipe them with a damp cloth with disinfectant cleaning solution.

Note: The double- or triple-bucket method is recommended for cleaning the operating room and other areas of the surgical suite.

Operating room table: Wipe it with a 0.5% chlorine solution (or other approved disinfectant) to decontaminate. Then clean the top, sides, base, legs, and any accessories (e.g., leg stirrups) with a damp cloth and disinfectant cleaning solution.

Floors: Clean with a wet mop using a disinfectant cleaning solution.

Vents (heating or air conditioning): Wipe them with a damp cloth with soap and water.

Spills: Clean spills with a 0.5% chlorine solution or other locally available and approved disinfectants (see below).

Operating room bed: Wipe all surfaces and mattress pads with a disinfectant cleaning solution.

Instrument tables (trolley and mayo stand) and other flat surfaces: Wipe all flat surfaces that have come into immediate contact with a patient or body fluids with a disinfectant cleaning solution.

Center of operating room surrounding the operating room bed: Mop it with a disinfectant cleaning solution (if visibly soiled).

Waste: Collect and remove all waste from the operating room in closed leak-proof containers.

Sharps containers: Close and remove containers from the operating room when they are three-quarters full.

Soiled linen: Remove soiled linen in leak-proof covered waste containers.

Note:

- Cleaning the filters in air conditioners regularly will help them run more efficiently and decrease the growth of molds.
- Because all patients are considered potentially susceptible and at times infectious, standard precautions are to be used and no additional measures are necessary even if a client is known to have an infection.

How to Clean Spills of Blood and Other Body Fluids

Regardless of the risk-level of an area, spills or contamination from blood or body fluid (e.g., vomitus), must be cleaned and disinfected immediately using a two-step process (clean and disinfect). Do not use combined detergent-disinfectant product; use intermediate-level disinfectant.

This is the general process for cleaning of spills of blood or body fluids:

1. Wear appropriate PPE.
2. Confine the spill and wipe it up immediately with absorbent (paper) towels, cloths, or absorbent granules (if available) that are spread over the spill to solidify the blood or body fluid (all should then be disposed as infectious waste).

3. Clean thoroughly using neutral detergent and warm water solution.
4. Disinfect by using a facility-approved intermediate-level disinfectant.
5. Immediately send all reusable supplies and equipment (e.g., cleaning cloths, mops) for reprocessing (i.e., cleaning and disinfection) after the spill is cleaned up (CDC 2021).

How to Manage Spills of Mercury from Broken Thermometer and Blood Pressure Equipment:

- Put examination gloves on both hands.
- Collect all droplets of mercury with a spoon.
- Place in a small, closed container for disposal (possibly encapsulation and burial of the waste away from water resource area) or reuse.
- Wash or clean the area with a chlorine solution.
- Remove used gloves carefully and wash hands properly.

How to Clean Soiled and Contaminated Cleaning Equipment

STEP 1 Decontaminate cleaning equipment that has been contaminated with blood or body fluids by soaking it for 10 minutes in a 0.5% chlorine solution or other locally approved and available disinfectants.

STEP 2 Wash cleaning buckets, cloths, brushes, mops, and the like with detergent and water daily or right away if visibly dirty.

STEP 3 Rinse them in clean water.

STEP 4 Dry them completely before reuse. (Wet clothes and mop heads are heavily contaminated with microorganisms.)

SUMMARY

- Housekeeping practices in the healthcare facilities include the compound, the floors, walls, various type of equipment, tables, and other surfaces.
- Dust, soil, and microbial contaminants on environmental surfaces are potential source of HAIs.
- Effective and efficient cleaning methods and schedules are necessary to maintain a clean and healthy environment in healthcare settings.
- Cleaning should start with the least soiled area and extend to the most soiled area, and from high to low surfaces.
- It is important that housekeeping staff be trained to perform their assigned tasks and are supervised on a regular basis.

- Total cleaning or terminal cleaning (mopping floors and scrubbing all surfaces from top to bottom) of the operating room should be done at the end of each day.
- Do not dry mop or sweep the operating room.

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CHAPTER 10: HEALTHCARE WASTE MANAGEMENT

Key Topics

- Categories of healthcare waste
- Reduction of healthcare waste
- Segregation of waste at point of generation
- Management of the healthcare waste process
- Waste treatment and disposal methods

BACKGROUND

Healthcare waste, produced in the course of delivering healthcare, is potentially hazardous, and effective management is critical to IPC in healthcare. A healthcare facility is responsible for managing public health and protecting the environment with regard to the waste produced. However, the waste management process (generation, collection, transport, storage, and disposal) entails considerable complexity, involving clinical and non-clinical staff across a facility, and often depends on outside agencies.

Managing waste remains particularly challenging for facilities in limited-resource settings. Lack of organization, financial resources, training, segregation, equipment, locations for storage, access to PPE, municipal support, and safe disposal locations have been identified as among the challenges (Awodele, Adewoye, Oparah 2016; Caniato, Tudor, Vaccari 2016). WHO (2017), in reporting a WHO/UNICEF joint assessment, found that just over half (58%) of sampled facilities from 24 countries had adequate systems in place for the safe disposal of health-care waste. Public interest in waste management practices of healthcare facilities and the impact on climate and the environment continues to grow. Knowledge of the potential for harm from healthcare waste continues to be relevant to governments and communities. (WHO 2014).

Risks from healthcare waste include exposure to pathogenic organisms, harmful chemicals, toxins, or radioactive substances, and injury from sharp items. Anyone who comes into contact with waste, both in the community and in the facility (HCWs, patients, visitors, laundry workers, cleaners, porters, etc.) may be at risk. Exposure to toxic agents contained in healthcare waste can cause skin, respiratory tract, and neurological conditions. Recommendations for reducing the risk from injury and infection are described in this chapter.

Infectious healthcare waste includes waste that has the potential for causing infection. HCWs can be infected when they are exposed to waste through a skin puncture, broken skin, splashes into the mouth or eyes, inhalation, or ingestion. Infectious conditions potentially transmitted from healthcare waste include gastrointestinal conditions (i.e., diarrhea and vomiting), respiratory conditions, skin and eye infections, meningitis, bloodborne virus infections (e.g., HIV, HBV, and HCV), and hemorrhagic fever, including EVD.

Standard precautions protect HCWs from the risks of handling infectious waste at each point throughout the waste management process. All waste should be handled using Standard Precautions and Transmission-Based Precautions, and waste that includes any items potentially contaminated with blood and body fluids should be managed as infectious waste.

Applying IPC recommendations to all aspects of waste handling (generation, collection, transport, storage, and disposal) minimizes the risks to human health and the environment.

Categories of Healthcare Waste

Categorizing the waste produced in healthcare facilities is a useful method to understand the handling and disposal requirements for each type of waste.

Approximately 75%–90% of the general waste produced by healthcare facilities is non-contaminated and poses no risk of infection to those who handle it. Similar in nature to municipal waste, all or most general waste can be discarded in dumps or landfills or burned in incinerators (WHO 2014).

Infectious waste from healthcare facilities must be handled and disposed of properly because it may carry microorganisms that have the potential to infect individuals who come in contact with it.

There are other types of waste generated in healthcare facilities that do not contain infectious agents but are considered hazardous because of the potential harm they can cause to the environment. Table 10.1 provides details on the various categories of waste generated by healthcare facilities, as defined by WHO.

Table 10.1. Categories of waste generated by healthcare facilities

Waste category	Descriptions and examples
Non-hazardous healthcare waste	
General waste	Waste that does not pose any particular biological, chemical, radioactive, or physical hazard (e.g., paper boxes, newspapers, magazines, polyethylene bottles, polyester bags, wood, other papers, metals [e.g., aluminum cans and containers], high-density polyethylene [e.g., milk containers, saline bottles], glass, and construction/demolition materials).
Hazardous healthcare waste	
Sharps waste	Used or unused sharps (e.g., hypodermic, intravenous, or other needles, auto-disable syringes, syringes with attached needles, infusion sets, scalpels, pipettes, knives, blades, and broken glass).
Infectious waste	Infectious waste is waste that is potentially contaminated with blood, body fluids, or pathogenic organisms, including but not limited to laboratory cultures, microbiological stocks, excreta, and items soiled with blood or body fluids.
Pathological waste	Waste that contains human tissues or fluids, organs, body parts, fetuses, and unused blood products.
Pharmaceutical waste	Pharmaceuticals that are expired or no longer needed and items contaminated by or containing pharmaceuticals.
Cytotoxic waste	Cytotoxic waste contains by-products of drugs that kill dividing cells, which are used for treatment of certain cancers. It also includes waste materials that can damage human genes (e.g., DNA) and may cause cancers or congenital deformities in babies. This waste can include sharps, PPE, and body fluid exposed to the drugs.

Waste category	Descriptions and examples
Chemical waste	Waste containing chemical substances (e.g., laboratory reagents, film developer); disinfectants that are expired or no longer needed; solvents; and waste with a high content of heavy metals (e.g., batteries, broken thermometers, and blood pressure gauges).
Radioactive waste	Waste containing radioactive substances (e.g., unused liquids from radiotherapy or laboratory research; contaminated glassware, packages, or absorbent paper; urine and excreta from patients treated or tested with unsealed radionuclides; and sealed sources—containers in which radioactive substances are stored and sealed).

Adapted from: WHO 2014.

Sources of Healthcare Waste

The types and amount of healthcare waste generated in a healthcare facility depend on the size of the facility and the range of services provided. The larger the facility (e.g., university hospital, regional hospital) and the more services provided (e.g., tertiary healthcare facility with a trauma center, cancer treatment department), the more waste is produced and the greater the variety of waste generated. Table 10.2 provides examples of healthcare waste from different sources in healthcare facilities.

Table 10.2. Healthcare waste from different sources in a healthcare facility

Location	Sharps	Infectious and pathological waste	Chemical, pharmaceutical, and cytotoxic waste	Non-hazardous or general waste
Major sources				

Location	Sharps	Infectious and pathological waste	Chemical, pharmaceutical, and cytotoxic waste	Non-hazardous or general waste
Medical ward	Hypodermic needles, IV set needles, broken vials, and ampoules	Dressings, bandages, gauze, and cotton contaminated with blood or body fluids; gloves and masks contaminated with blood or body fluids	Broken thermometers, blood pressure gauges, spilled drugs, and spent disinfectants	Packaging, food scraps, paper, flowers, empty saline bottles, non-bloody diapers, non-bloody intravenous tubing, and bags
Operating theater	Needles, intravenous sets, scalpels, blades, and saws	Blood and other body fluids, suction canisters, gowns, gloves, masks, gauze, and other waste contaminated with blood and body fluids, tissues, organs, fetuses, body parts	Used disinfectants and waste anesthetic gases	Packaging, uncontaminated gowns, gloves, masks, hats, and shoe covers

Location	Sharps	Infectious and pathological waste	Chemical, pharmaceutical, and cytotoxic waste	Non-hazardous or general waste
Laboratory	Needles, broken glass, petri dishes, slides and cover slips, and broken pipettes	Blood and body fluids, microbiological cultures and stocks, tissue, infected animal carcasses, tubes and containers contaminated with blood or body fluids	Fixatives, formalin, xylene, toluene, methanol, methylene chloride and other solvents, and broken lab thermometers	Packaging, paper, and plastic containers
Pharmacy store			Expired drugs, spilled drugs	Packaging materials and empty containers
Radiology			Silver, fixing and developing solutions, acetic acid, and glutaraldehyde	Packaging materials
Chemotherapy	Needles and syringes		Bulk chemotherapeutic waste, vials, gloves, and other material contaminated with cytotoxic agents, and contaminated excreta and urine	Packaging materials
Vaccination campaigns	Needles and syringes		Bulk vaccine waste, vials, and gloves	Packaging materials
Environmental services	Broken glass		Disinfectants, cleaners, spilled mercury, and pesticides	Packaging, flowers, newspapers, magazines, cardboard, plastic, glass containers, yard, and plant waste
Engineering			Cleaning solvents, oils, lubricants, thinners, asbestos, broken mercury devices, and batteries	Packaging, construction or demolition waste, wood, and metal
Food services				Leftovers, food scraps, plastic and paper packaging, and containers

Location	Sharps	Infectious and pathological waste	Chemical, pharmaceutical, and cytotoxic waste	Non-hazardous or general waste
Minor sources				
Physician's office (Outpatient department)	Needles and syringes, broken ampoules, and vials	Cotton, gauze, dressings, gloves, masks, and other materials contaminated with blood and other body fluids	Broken thermometers and blood pressure gauges, expired drugs, and used disinfectants	Packaging, papers, newspapers, magazines, uncontaminated gloves, and masks

Source: WHO 2014

Management of Healthcare Waste

Reduction of Healthcare Waste

The preferred strategies for reducing healthcare waste are to minimize waste generation by preventing waste production, reducing waste production, reusing and recycling waste, and recovering useful substances from waste. The least preferable strategy is treating and disposing of healthcare waste.

Healthcare facilities can take several steps to minimize waste, including monitoring the consumption of hazardous substances and chemicals. Purchasing supplies with minimal packaging and using reusable medical devices, where feasible, are other ways to minimize healthcare waste. In addition, recycling waste when technologies are available will help minimize waste.

Chemical waste minimization options include:

- Using less toxic, environmentally friendly chemicals
- Using minimum concentrations when possible
- Ensuring good inventory control
- Designing proper storage areas
- Developing spill prevention and clean-up procedures (WHO 2014)

Segregation of Waste at Point of Generation

Although general waste is the least expensive and easiest to dispose of, infectious and hazardous waste, which makes up 15% of waste, is more expensive and risky to handle. When general waste is mixed with infectious or hazardous waste, the cross-contamination is introduced and all the resulting waste must be treated as infectious and hazardous.

Mixed waste occurs when wastes are not properly separated at the point of generation or are mixed during any part of the waste management process. Segregation at the point of waste generation will reduce the amount of waste that the facility must treat as infectious or hazardous and is a key strategy for improving waste management at healthcare facilities.

Note: Training HCWs and having conveniently placed sharps containers close to where sharps are used will help eliminate problems with improper disposal.

Use the following guidelines when disposing of infectious and general waste at the point of generation in all types of healthcare facilities:

- The HCW who generates the waste should segregate it where it is generated (e.g., before leaving a patient's room, examination room, operating theater, or laboratory).
- The waste should be separated into the local or WHO categories (based on its potential hazard and final disposal method).
- Separating wastes by hand after generation puts HCWs at risk and should not be allowed.
- Deposit infectious waste in a labeled or color-coded, leak-proof, puncture-resistant container.
- Use leak-proof (plastic or galvanized metal) containers with tight-fitting covers for contaminated and hazardous wastes to protect patients and HCWs.
- Where available and feasible, use sturdy plastic bags/bin liners inside the waste collection containers to assist with waste collection and transport. Do not reuse plastic bags or bin liners.
- Use puncture-resistant sharps containers for all disposable sharps (e.g., sharps that will not be reused).

Methods to encourage waste segregation include:

- Employ a "three-bin system" to segregate waste into separate bins for general, non-hazardous wastes, infectious waste, and sharps.
- Use standardized, colored plastic bags (if available) or colored waste containers or standardized, clearly labeled containers to alert HCWs to the contents of the containers.
- Place waste containers and sharps containers at or close to the point of waste generation so that waste and sharps can be placed directly in the container.

Note: The sharps container should be placed at the point of use so that HCWs do not have to carry sharp items.

- Use tools, such as a kidney dish or bowl, to separate waste and transport it safely from the point of waste generation to waste containers when waste containers and sharps containers cannot be placed close to the point of waste generation.
- Train HCWs on the importance, categories, and methods of waste segregation.

Note: It is important to train all HCWs, including clinicians and cleaning staff, and to educate patients to keep infectious and non-infectious waste separate.

- Use workplace reminders (posters, signs) to remind staff how to segregate waste.

- Talk to HCWs in each area of the facility about the barriers to segregation in their departments because they will vary widely according to the types of tasks performed and the workflow. WHO's recommendations for waste segregation are described in table 10.3.

Table 10.3. WHO's recommendations for waste segregation

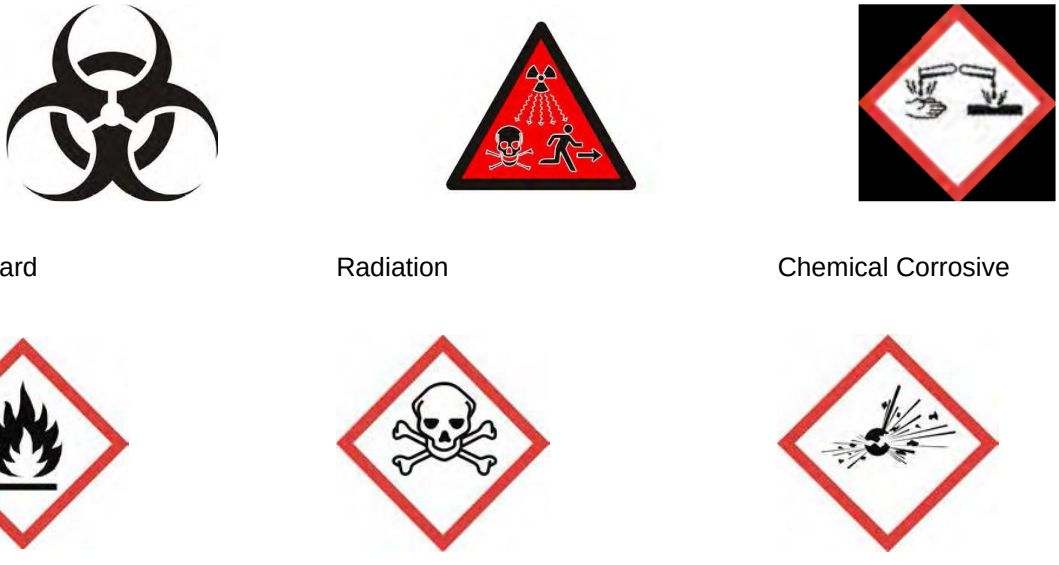
Type of waste	Color of container and markings	Type of container
Highly infectious waste	Yellow, marked "highly infectious" with biohazard symbol	Strong, leak-proof plastic bag or container capable of being autoclaved
Other infectious waste (includes all pathological waste)	Yellow with biohazard symbol	Leak-proof plastic bag or container
Sharps	Yellow, marked "SHARPS" with biohazard symbol	Puncture-proof container
Chemical and pharmaceutical waste	Brown, labeled with appropriate hazard symbol	Plastic bag or rigid container
Radioactive waste	Labeled with radiation symbol	Lead box
General healthcare waste	Black	Plastic bag or container

Source: WHO 2014

After segregation in patient care areas, separation during collection, transport, and storage of waste must be maintained to obtain any benefit. All HCWs, including cleaners, porters, and those collecting, transporting, storing, and disposing of the waste, must be educated about the importance of segregation.

In addition, use symbols to indicate the different categories of infectious and hazardous waste (figure 10.1).

Figure 10.1. Hazardous waste symbols for healthcare facilities



Source: Curless et al. 2018

Collection and Transportation of Waste in Healthcare Facilities

To manage waste in healthcare facilities and to ensure timely and safe disposal, waste collection and transportation systems should be developed using the following criteria:

- Waste collection routes should be carefully planned and drawn out, taking into consideration the principle of collecting from least to most infectious waste (e.g., the laboratory would be last on a collection route).

> **Note:** Waste bags and sharps containers should NOT be filled more than three-quarters full.

- Waste collection timetables for each route should be carefully planned according to the waste generation patterns of the various departments. For example, operating theaters, labor and delivery areas, laboratories, and outpatient clinics may generate more waste at different times than other areas and require more frequent collection schedules.

> **Note:**
> - Never use hands to compress waste into containers.
> - Hold plastic bags at the top.
> - Keep bags from touching or brushing against the body while lifting or during transport.

- Collect waste on a regular basis, such as daily or sooner, if needed, according to the rate it is generated and the size of the waste containers. Waste bags and sharps containers should NOT be filled more than three-quarters full.
- Staff should be trained to understand the risks and safety procedures for handling waste:
    - Do not mix infectious/hazardous and general waste during collection or transport.
    - Collect and transport infectious waste to disposal sites in leak-proof, covered, contaminated-waste containers.
    - Do not use equipment (e.g., wheelbarrow, trolley/cart) that is used to hold and transport waste for any other purpose in the healthcare facility.
    - Use PPE when handling wastes.

Steps for the Collection and Transport of Solid Infectious Wastes

STEP 1 Wear heavy-duty or utility gloves and closed-toe shoes when handling and transporting all waste.

STEP 2 Collect waste containers and transport to the storage area or treatment area for final disposal.

STEP 3 Clean infectious-waste containers each time they are emptied using soap/detergent and water, disinfect with a low- to intermediate-level disinfectant, and allow to dry before reuse. Clean non-contaminated-waste containers at least once a week or when visibly soiled.

STEP 4 Remove utility gloves and perform hand hygiene after handling wastes.

STEP 5 Wash and dry gloves (Volume 1, Chapter 9: Environmental Cleaning).

When using plastic bags/bin liners:

- Tie bags securely to provide a barrier between the waste and the HCW.
- Label bags with the date and type of waste in them.
- Do not shake or squeeze bags in an attempt to reduce volume when sealing them.
- Carry sealed bags at the top (i.e., by their necks) to the transportation trolley/cart/bin.
- Do not lift or hold bags by the bottoms or sides.
- Carry bags away from the body.
- Ensure that bags are not broken, opened, or dropped.
- Do not throw bags.

When bags/bin liners are not available:

- Use waste containers with lids.
- Clearly identify the containers by appropriate color/labeling, for example, "pathological waste," "infectious waste," and "general municipal waste."

(WHO 2014)

Steps for the Collection and Transport of Sharps Containers

STEP 1 Wear heavy-duty utility gloves and closed-toe shoes.

STEP 2 Pick up the sharps container from the clinical area. Ensure that the container is closed tightly so that no sharps are spilled during transport.

STEP 3 Place the container in the designated part of the storage area when it is ready for disposal.

STEP 4 Remove utility gloves and perform hand hygiene after handling waste.

STEP 5 Wash and dry gloves (Volume 1, Chapter 9: Environmental Cleaning).

Storage of Waste in Healthcare Facilities

Waste storage areas in the healthcare facility should be kept clean, organized, protected from pests and the public (children or scavengers), and well-shaded to reduce heat buildup. Recommendations for waste storage areas include:

- An easy-to-clean hard floor with good drainage
- Separate areas for infectious and general waste
- Separate cabinets to store pharmaceutical and other toxic wastes

- A good water supply with a sink for hand hygiene
- Regular cleaning
- Identification (signs) as a "waste storage area"
- Lockable door/gate

Disposal of Healthcare Waste

Recommended Waste Disposal Methods

Countries committed to minimizing the level of dangerous, cancer-causing chemicals (e.g., dioxin and furans) in groundwater can adopt recommended approaches for waste treatment/dips. However, meeting current guidelines may be challenging for facilities in resource-limited settings. Waste minimization to limit the volume of hazardous waste produced and waste segregation to minimize the proportion of the total waste that is infectious/hazardous are key waste management measures in all settings. Choosing the best currently available waste disposal method and working toward safer waste disposal to protect the community and the environment is essential. Table 10.4 summarizes options for waste treatment that healthcare facilities can choose, based on available resources and the volume and types of waste generated. (WHO 2014).

Table 10.4. Methods for treating healthcare waste

Method	Brief description
Non-burn methods	
Non-infectious waste	
Thermal processes	Use of heat to destroy microorganisms in the waste
Chemical processes	Disinfectants (e.g., chlorine dioxide, sodium hypochlorite, peracetic acid, lime solution, ozone gas, dry inorganic compounds) used to treat waste
Irradiation technologies	Irradiation from electron beams, cobalt-60, or ultraviolet sources to destroy microorganisms
Biological processes	Use of natural living organisms to degrade organic matter (e.g., composting of kitchen wastes)
Mechanical processes	Grinding, mixing, and compacting to reduce waste volume and to supplement other healthcare waste processes (e.g., after waste disinfection)
Infectious waste	
Autoclaving	Use of high-pressure steam to kill microorganisms in infectious waste and sterilize medical instruments
Integrated, steam-based treatment	A continuous flow system that uses mechanical processes before, during, and/or after steam-based processes (similar to autoclaving) that transfers heat to the waste, making the waste unrecognizable
Microwave technologies	Steam-based system that uses moist heat and steam generated by microwave energy
Dry-heat treatment	Dry-heat system that heats waste by conduction, natural or forced convection, or thermal radiation
Chemical treatment	Chemical disinfection for treating liquid waste (e.g., blood and body fluids); solid waste should be shredded or mixed before it is chemically disinfected

Method	Brief description
Burn technologies	
Incineration	High-temperature, dry oxidation (1,200 °C [2,192 °F]) process that reduces organic and combustible waste to inorganic and incombustible material using combustion, pyrolysis, or gasification
Other methods	
Encapsulation	Filling containers (e.g., high-density polyethylene or metallic drums) with three-quarters waste and then one-quarter medium substance (e.g., plastic foam, bituminous sand, cement mortar, or clay material) and sealing container to be disposed of in landfill site
Inertization	Mixing of waste (e.g., pharmaceutical and high-metal content ashes) with cement and other substances before disposal to reduce the risk of toxic substances leaching into surface and groundwater
Land disposal	Removal of healthcare waste materials after minimization or treatment to land sites (e.g., controlled landfills) for final disposal
Municipal and other external disposal sites	Landfill or waste site operated in a controlled manner for municipal waste, whether treated or untreated waste, based on municipal guidelines

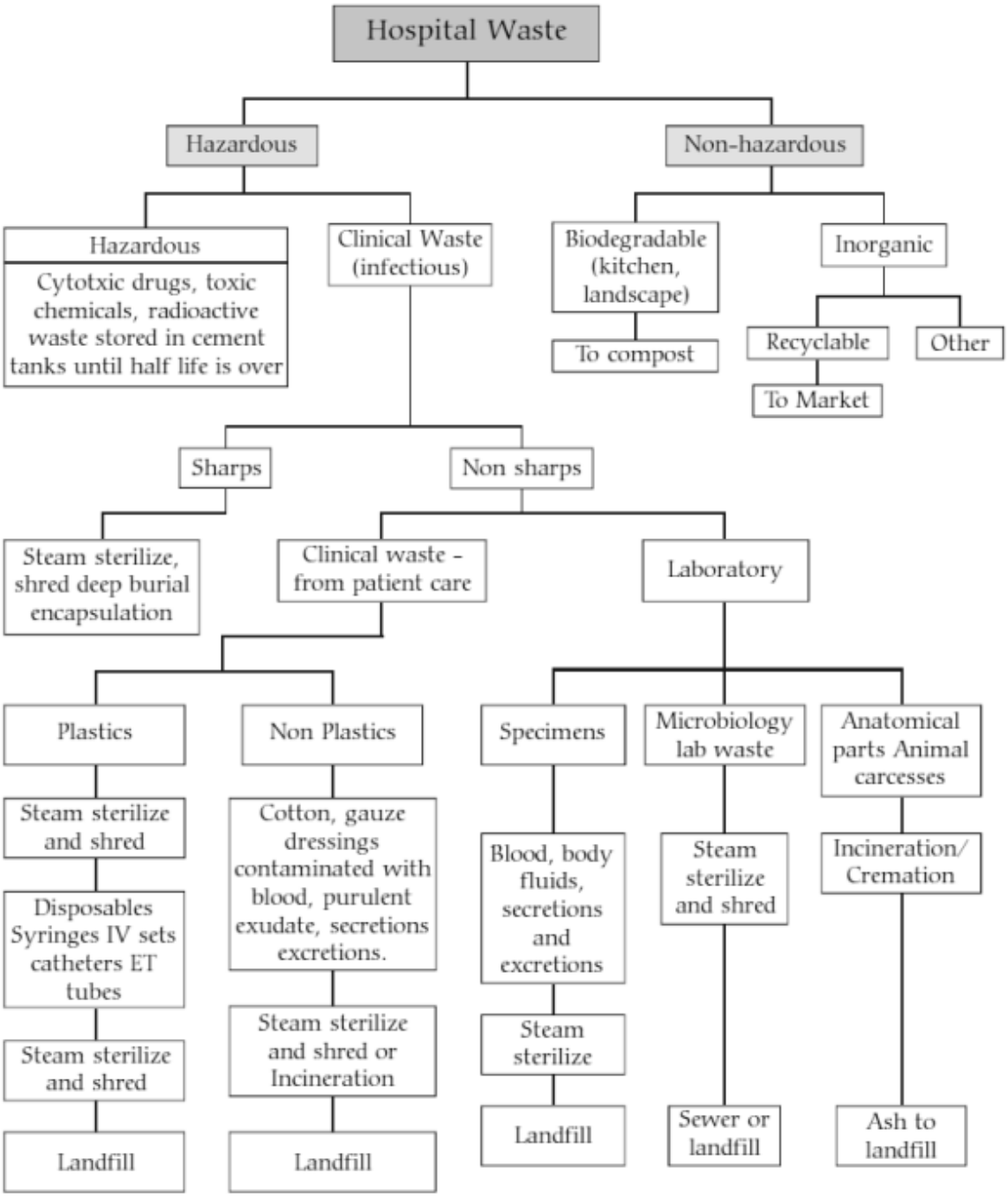
Adapted from: WHO 2014

The following waste treatment methods are not recommended and should be avoided:

- Open piles of waste because they:
    - Are a risk to those who scavenge and unknowingly reuse contaminated items.
    - Allow people to accidentally step on sharp items and injure themselves.
    - Produce foul odors.
    - Attract insects and animals.
    - Can scatter in the wind and rain.
- Open burning because:
    - It is dangerous.
    - Temperatures reached are not adequate to treat healthcare waste.
    - It is unsightly.
    - The smoke is a pollutant.
    - The wind can scatter the waste.

Specific steps are required for disposing of different categories of waste. Infectious and hazardous waste should be treated before final disposal. Figure 10.2 shows the acceptable methods of waste disposal.

Figure 10.2. Practical classification of hospital wastes and methods of disposal



Source: WHO 2004

Disposal of Solid Infectious Waste

Solid infectious waste consists of those items defined in national guidelines. Items, such as surgical specimens and those soaked with blood or body fluids, are included. The method of disposal for these items depends on the type of material from which they are constructed. See the sections on incineration, autoclaving, or burying in the section titled

Autoclaves

Autoclaves use low-heat, high-pressure steam to treat infectious wastes. They can treat a wide range of healthcare wastes. They consist of a metal vessel designed to withstand high pressures, with a sealed door and pipes and valves through which steam is brought in and removed (figure 10.3). Removal of air from the vessel is essential to ensure the penetration of steam into the waste. Because they must withstand repeated buildup and release of steam pressures, their construction materials, engineering design, fabrication, accuracy of pressure and temperature sensors, and testing must meet requirements to operate safely.

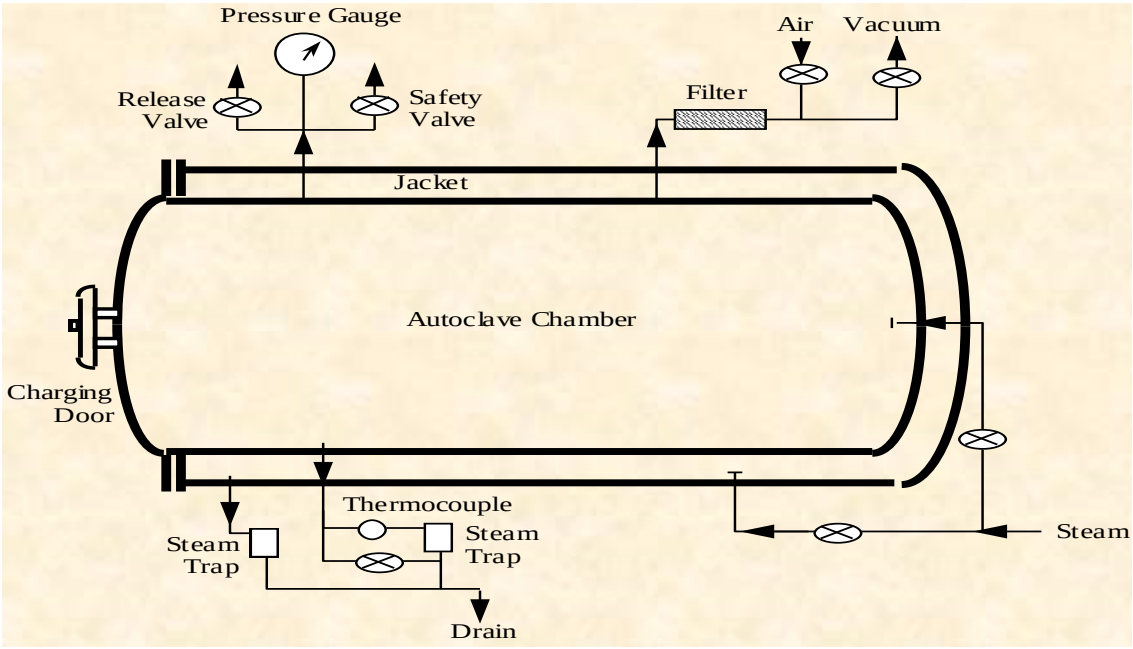
Autoclaves generate significantly fewer air pollutants than incinerators and other high-heat thermal processes. However, waste must be properly segregated to prevent hazardous chemicals from being autoclaved. Poorly segregated waste may emit low levels of alcohols, phenols, formaldehyde, and other organic compounds in the air and pose health risks to the autoclave operators and waste workers. Volatile and semi-volatile organic compounds, cytotoxic waste, mercury, other hazardous chemical waste, and radioactive waste should not be treated in an autoclave. Odors can also be a problem if ventilation is insufficient. The air that is removed must be treated to prevent the release of pathogenic aerosols; this is usually done with a high-efficiency particulate air filter or steam.

Treated waste from an autoclave will retain its physical appearance; shredders (though prone to breakdowns) may reduce the volume 60%–80%. Glass, plastic, and metal waste can be recycled after it is sterilized.

The three common types of autoclaves are:

- Gravity-displacement autoclaves
- Prevacuum or high-vacuum autoclaves
- Pressure pulse autoclaves

Figure 10.3. Diagram of an autoclave



Source: United Nations Development Programme, Global Environment Facility n.d.

Incineration of Waste

Incinerators can range from extremely sophisticated, high-temperature models to basic units that operate at much lower temperatures. Properly maintained and operated incinerators eliminate microorganisms from waste and reduce the waste completely to ashes. When selecting an incinerator, first analyze the needs of the healthcare facility and municipal or regional disposal requirements. Factors to consider include infrastructure of the area, local resources to support construction and operation, cost estimates, and environmental policies (PATH 2010).

This section focuses on the selection, operation, and management of small-scale incinerators.

Design and Types of Incinerators

When performed properly, incineration is efficient and affordable. Important factors in an incinerator design with regard to oxygen supplies are:

- Air inlets must be the right size and in the correct location to allow for a good mixture of air (oxygen) with the waste gases.
- The chimney diameter and length (minimum of 4 meters [13.1 feet]) must be carefully designed (not too short and not too long) to control the air draft.
- The incinerator should be located away from objects, such as buildings and trees.
- Ashes and other residues that build up and block the free passage of air (oxygen) must be removed routinely (PATH 2010).

There are four basic types of incinerators that are commonly used for treating waste:

- Double-chamber, high-temperature incinerators designed to burn infectious waste.
- Single-chamber, high-temperature incinerators that are less expensive and are used when double-chamber incinerators are not affordable.
- Rotary kilns that operate at high temperatures and are used for destroying toxic, organic constituents of hazardous waste and heat-resistant chemicals.
- Drum or brick (clay) incinerators that operate at lower temperatures and are less effective but can be made locally out of readily available materials.

Note: Incinerators that meet specifications and are properly maintained and operated eliminate microorganisms from waste and reduce the waste to ash.

Precautions

If resources are limited, the following precautions should be taken when considering incineration:

- Provide an effective system for waste reduction and segregation (separate by type of waste).
- Use an engineer-designed incinerator with sufficient residence time and temperatures to minimize incomplete combustion of products and premature failures.
- Place incinerators away from healthcare buildings, residential areas, or where food is grown.
- Describe methods of operation clearly to achieve the desired combustion conditions and emissions.
- Plan periodic maintenance to replace or repair defective components.

Certain chemicals and waste products are highly combustible and should not be incinerated (box 10.1).

Box 10.1. Types of wastes that should not be incinerated

- Plastics at low temperatures
- Large amounts of reactive chemical waste
- Pressurized gas containers (e.g., aerosol cans)
- Silver salts and photographic or radiographic wastes
- Plastics containing polyvinyl chloride (e.g., blood bags, IV tubing, or disposable syringes)
- Waste with high mercury or cadmium content (e.g., broken thermometers, used batteries, and lead-lined wooden panels)
- Radioactive materials
- Pharmaceuticals thermally stable in conditions below 1,200 °C (2,192 °F) (e.g., 5 fluorouracil)

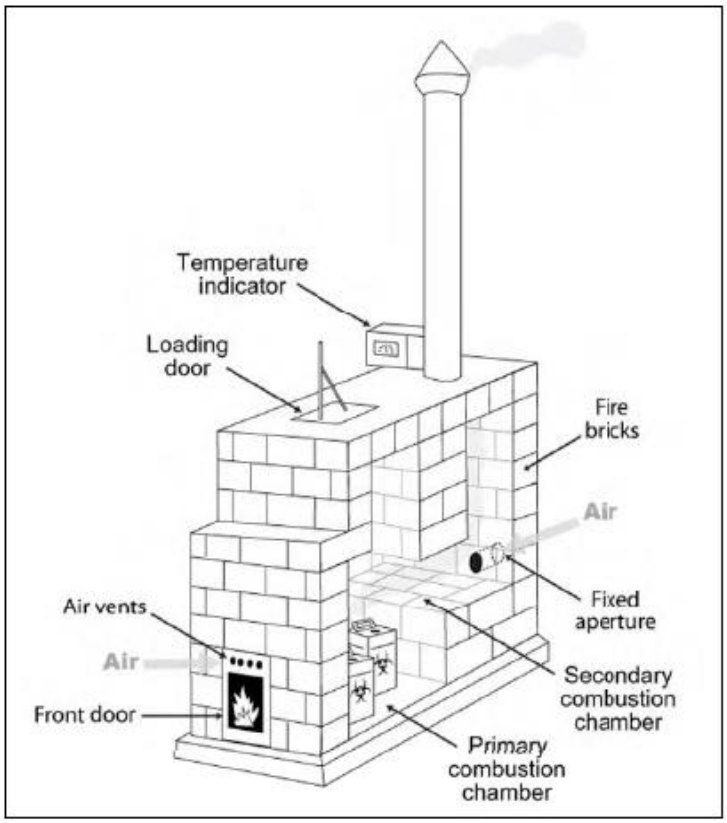
Source: WHO 2014

Small-Scale Incinerator for Waste Disposal

Ideally, a small-scale incinerator (figure 10.4) should have the following characteristics:

- Has a minimum of two chambers.
- Operates within a temperature range of 650–1,000 °C (1,202–1,832 °F).
- Has a minimum of 1-second smoke-residence time (i.e., amount of time that the gases take to travel through the incinerator).
- Is corrosion-resistant.

Figure 10.4. Standard components of a small-scale incinerator



Source: PATH 2010

Encapsulation of Waste

Encapsulation is the process of mixing waste with cement or other substances before disposal. This process is used to reduce the risk of injury to people, reduce access to scavengers, and minimize the risk of toxic waste migrating into surface water or groundwater. Encapsulation is primarily designed for the safe disposal of sharps, but can also be used for disposal of solid residues from wastewater treatment, incinerator ash, or small quantities of heavy metals (e.g., mercury), chemicals, and cytotoxic pharmaceuticals when they cannot be returned to the manufacturer. Hard plastic boxes or

metallic drums can be filled to three-quarters full and then topped with wet cement or clay. After hardening, the containers can be sealed and disposed of safely in a landfill. For waste containing small quantities of heavy metal, create a mixture of 65% waste material, 15% lime, 15% cement, and 5% water. This mixture is then poured into a container (e.g., plastic or metal) and allowed to settle. Once it has completely dried, the container can be disposed of in a landfill (WHO 2014).

Burying of Waste in Sanitary Landfills

In healthcare facilities with limited resources, short-term safe burial of wastes on or near the facility may be the only option available for waste disposal. Safe onsite burial is practical for only limited periods of time (one to two years) and for relatively small quantities of waste. Burial can be used as a method of waste disposal only where the water table is more than four meters (13.1 feet) below the surface. During this interval, the healthcare facility should continue to look for better, permanent methods for waste disposal.

Note: Large quantities (over 1 kg [2.2 pounds]) of chemical (liquid) wastes should not be buried at the same time, and burning of chemical waste should be spread over several days.

Limit health risks and environmental pollution from burying healthcare waste by:

- Restricting access to the disposal site: build a fence around the site to keep animals and children away.
- Lining the burial site with a material of low permeability (e.g., clay), if available.
- Selecting a site at least 50 meters (164 feet) away from any water source to prevent contamination of the water table.

The site should:

- Have proper drainage
- Be located downhill from any wells
- Be free of standing water
- Not be in an area prone to flooding

How to Make and Use a Small Burial Site for Waste Disposal

STEP 1 Find an appropriate location.

STEP 2 Dig a pit 1 meter (3.2 feet) square and 2 meters (6.5 feet) deep. The bottom of the pit should be 2 meters (6.5 feet) above the water table. Line the pit with clay or other low-permeable material.

STEP 3 Dispose of the infectious waste in the pit and cover the waste with 10–15 cm (4–6 inches) of dirt each day. The final layer of dirt should be 50–60 cm (20–24 inches) and compacted to prevent odors and attraction of insects, and to keep animals from digging

up the buried waste. Depending on the volume of waste, this pit should last 30 to 60 days (figure 10.5) (WHO 2014).

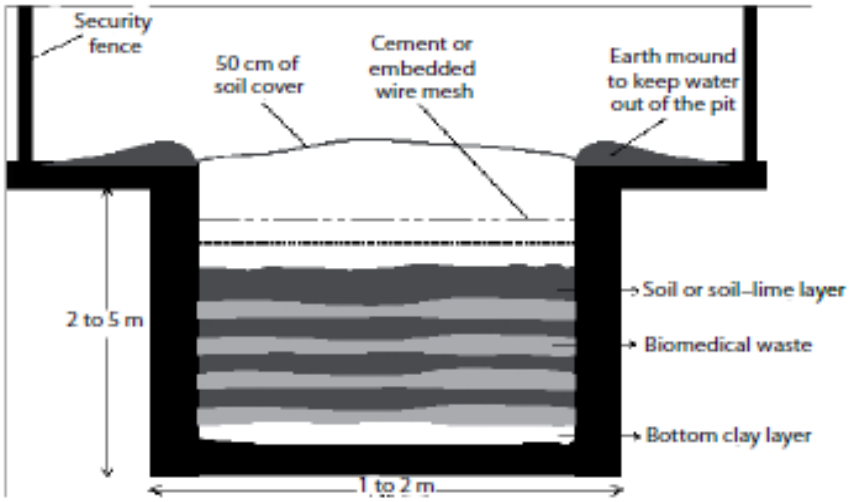


Figure 10.5. Plan for a small burial pit

Source: WHO 2014

Disposable Sharps

Sharps (e.g., hypodermic needles, suture needles, razors, and scalpel blades) require special handling because they are the items most likely to injure the HCWs who use them and people in the community if these items go to the municipal landfill without proper treatment methods.

Treatment and disposal methods for sharps include:

- By autoclave, followed by shredding (mechanical), and then disposal in a landfill or sharps pit.
- By incineration (sharp objects may not be completely destroyed by incineration, but it does make them less likely to be reused or repurposed and less risky to handle) and disposal in an ash pit.
- By shredding (mechanical) and disposal in a sharps pit. (There is a risk of exposure to staff handling non-decontaminated sharps.)
- If other treatment options are not available, small quantities of sharps waste can be encapsulated and disposed of in a landfill.

Disposal of Liquid Infectious Waste

Liquid infectious waste includes liquid culture media, blood, body fluids, and human excreta. Products that can be added to liquid waste to solidify it for safer handling may be available.

Steps for the proper handling of liquid infectious waste in volumes greater than 20 mL:

STEP 1 Put on PPE (utility gloves, face protection, long-sleeved, fluid-resistant gown, and plastic apron, protective shoes) when handling liquid wastes. (See Volume 1, Chapter 5, Personal Protective Equipment.)

STEP 2 Determine if the wastes require pretreatment before disposal. Blood and other infectious agents from laboratory work should be sterilized by steam sterilization at the earliest stage (i.e., inside the healthcare facility) before disposal, if possible.

STEP 3 Carefully pour liquid wastes down a utility sink drain or into a flushable toilet and thoroughly rinse with water to remove residual wastes. Clean and disinfect the surfaces (e.g., toilet or sink) to remove residual wastes using 1.0% chlorine solution and **avoid splashing the chlorine solution**. If a sewerage system does not exist, dispose of liquids using incineration or burial and not into open drains.

STEP 4 Wash the container that held the waste with detergent and water, disinfect using intermediate- or low-level disinfectant, and dry completely before storing and using. (See Volume 1, Chapter 9 Environmental Cleaning; Volume 2, Section 3, Chapter 3: Clinical Laboratory Biosafety.)

STEP 5 Remove PPE.

STEP 6 Perform hand hygiene.

(WHO 2014)

Disposal of Liquid Waste from Highly Infectious Diseases

During outbreaks of cholera and VHF, such as EVD, healthcare facility sewage must be treated and disinfected. *Vibrio cholerae*, the causative agent of cholera, and Ebola are easily killed and do not require the use of strong disinfectants. Chlorine solutions are not effective in disinfecting liquids with high organic content, such as blood and stool. Therefore, in situations such as a cholera and outbreaks of VHF, feces and vomit should be mixed with lime milk (calcium oxide) dry powder in a ratio of 1:2 for a minimum of six hours of contact before disposing. Urine can be mixed with a 1:1 ratio with two hours of minimum contact before disposing (WHO 2014).

Disposal of Pathological Waste

Pathological waste consists of tissues, organs, body parts, placentas, blood, body fluids, and other waste from surgery and autopsy. It also includes human fetuses. It is sometimes referred to as anatomical waste. Containers with pathological waste should be appropriately labeled using recommended labeling for infectious waste.

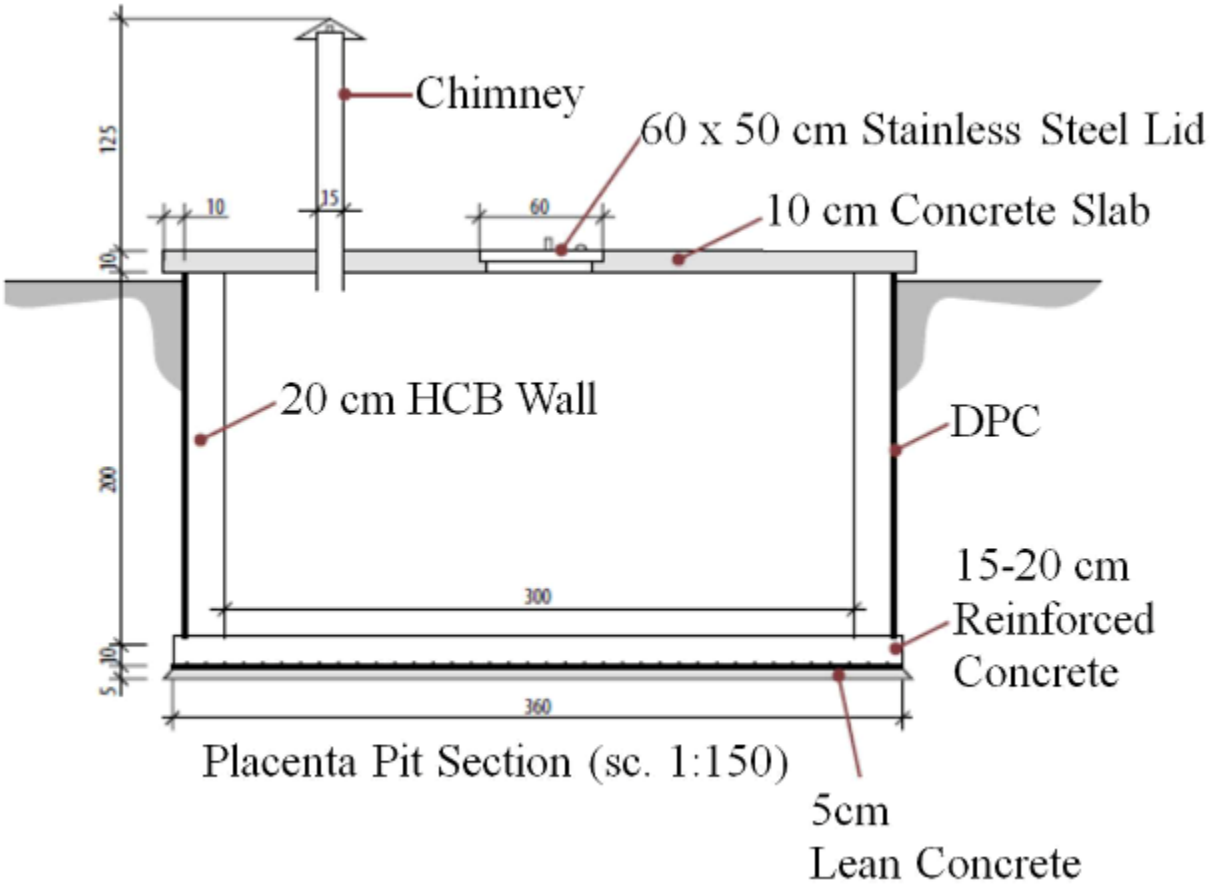
In many cultures, burying placentas is an important custom. In low-resource settings, a placenta pit is an effective option for safe disposal. The site for a placenta pit should minimize public accessibility and the size will depend on the number of daily childbirths in a facility. On average, one placenta and associated fluids require 5 liters (1.5 gallons) of pit capacity. Natural degradation and draining of liquid into the subsoil greatly reduce the volume of waste in the pit and facilitate the inactivation of pathogens. Small quantities of anatomical waste (e.g., body parts) may also be

disposed of in placenta pits, if other treatment options are not available or if sociocultural or religious norms prohibit other forms of treatment.

The pit should be designed to prevent the contents from contaminating the groundwater (figure 10.6). The bottom of the pit should be at least 1.5 meters (5 feet) above the level of the groundwater. Placenta pits are not recommended for sites where the water table is near the surface or in flood-prone areas (WHO 2014).

Placenta pit

Figure 10.6. Placenta pit plan



Source: Ali and Ahmed 2016

Traditional options for disposal of pathological wastes:

- Burying in cemeteries or special burial sites
- Burning in crematoria or specially designed incinerators
- Placenta pit

Steps for Using a Placenta Pit

Construct a placenta pit and dispose of placentas in the pit. (See figure 10.6 in the section titled placenta pit plan.)

- Open the cover of the pit and dispose of placentas and other organic waste into the pit as soon as possible without adding any disinfection to allow appropriate biodegradation to kill microorganisms and other cells.
- Keep the opening of the pit covered with a heavy lid or a concrete slab.
- Close the pit once it is filled up to 0.5 meter below the underneath slab. Keep it closed for two years.

The contents of the pit can be safely removed and disposed of in a sanitary landfill and the pit can be used again.

If a placenta pit is not available, for example, in areas with high water table, the option is to incinerate or bury the pathological waste in a burial pit. Never leave pathological waste out in the open.

Other Hazardous Wastes

Chemical Waste

Chemical waste includes residues of chemicals in their packaging, outdated or decomposed chemicals, or chemicals that are no longer required. Small quantities of chemical waste are generally collected in containers with infectious waste and can be incinerated, encapsulated, or buried. Large quantities of chemical waste should not be collected with infectious waste. Because there is no safe and inexpensive method for the disposal of chemical waste, the following options are recommended:

- Return the chemical waste to the original supplier. This is the best option for the disposal of specific chemical waste.
- Incinerate at a high temperature.

Because these chemical waste disposal methods can be expensive and may be impractical, it is important to keep chemical waste to a minimum. (See the Reduction of Healthcare Waste section above in this chapter.)

Note: Different types of chemical waste should never be mixed. Chemical waste should not be disposed of in a sewer system.

Chemical Containers

For plastic containers that held toxic substances, such as glutaraldehyde (e.g., Cidex) or formaldehyde, rinse three times (dispose of the rinse water as chemical waste) with water and dispose of by burning, encapsulating, or burying. Do not reuse these containers for other purposes.

Wear proper PPE to protect the eyes and skin from splashes, and rinse glass containers thoroughly with water. Glass containers may be washed with soap, rinsed, and reused.

Pharmaceutical Waste

Small quantities of non-hazardous pharmaceutical (drugs or medicines) waste are usually incinerated, encapsulated, or safely buried. Examples of non-hazardous pharmaceutical waste include vitamins, salts, and amino acids (ampoules and fluids), solid or semi-solid tablets, granules, powders, creams, gels, lotions and suppositories, and aerosols (e.g., sprays and inhalers). All controlled substances, cytotoxic/genotoxic drugs, anti-infective/antibiotic drugs, and disinfectants and antiseptics are considered hazardous waste (WHO 2014). It should be noted that temperatures reached in a single-chamber drum or brick incinerator may be insufficient to totally destroy pharmaceuticals and they can therefore remain hazardous.

Options for disposal of small quantities of pharmaceutical waste, such as outdated drugs (except cytotoxic drugs and antibiotics), include the following:

- Return of expired pharmaceuticals to the donor or manufacturer
- Encapsulation and burial in a sanitary landfill
- Chemical decomposition as per the manufacturer's recommendations

For moderate quantities of relatively mild liquid (e.g., vitamin solutions, cough syrups, intravenous solutions, eye drops), dilute in large amounts of water and discharge into a sewer. Antibiotics or cytotoxic drugs should not be discharged into municipal sewers or watercourses.

Large quantities of pharmaceutical waste may be disposed of by the following methods:

- Water-soluble, relatively mild pharmaceutical mixtures (e.g., vitamin solutions, cough syrups, intravenous solutions, eye drops) may be diluted in large amounts of water and then discharged into sanitation systems.
- Pharmaceutical waste can be returned to the original supplier, if possible.
- Cytotoxic drugs and antibiotics may be incinerated; the residues (i.e., what is left over after the wastes have been incinerated) can go into a landfill. An incinerator that is capable of reaching a combustion temperature of at least 1,200 °C (2,192 °F) should be used. Temperatures below 1,200 °C may release cytotoxic vapors.
- Residues from cytotoxic drugs or other cytotoxic waste should never be mixed with other pharmaceutical waste.
- Cytotoxic waste should never be discharged into natural water sources (rivers, lakes, etc.) or landfills.
- If the above options are not available, cytotoxic substances may be encapsulated.

Waste with a High Content of Heavy Metals

Examples of wastes with heavy metal content include batteries that contain cadmium, thermometers, and blood pressure machines containing mercury. Mercury is a potent neurotoxin, especially during fetal and infant development. When released into water or air, mercury will enter the environment and contaminate lakes, rivers, and streams. To minimize the risk of mercury

pollution, mercury-containing products (e.g., thermometers and blood pressure equipment) should be replaced with those that do not contain mercury.

Waste with high content of heavy metals should not be incinerated because of the toxic metallic vapors released into the air nor should it be buried without encapsulation (i.e., placed in a closed, tight container) because it may pollute groundwater. Usually, healthcare facilities have small amounts of this type of waste. Disposal options include:

- Recycling—the best disposal solution, if available.
- Encapsulation, if recycling is not feasible—encapsulated waste may be disposed of in a landfill.

Note: Do not touch mercury droplets with your hands unless wearing non-sterile or utility gloves.

Steps for disposal of mercury:

STEP 1 Put non-sterile gloves on both hands.

STEP 2 Collect all droplets of mercury with a spoon.

STEP 3 Place mercury in a small, plastic container with a tight-fitting lid and send it to the manufacturer. If this is not possible, encapsulate mercury before final disposal in a landfill.

The procedure for final disposal of mercury is complex and requires expertise. Stabilization of mercury into an insoluble substance and use of an encapsulation approach are currently being recommended for disposal of mercury.

Non-Recyclable Aerosol Containers

Pressurized containers should never be burned or incinerated because of the risk of explosion. Before aerosol containers are buried, any residual pressure should be released.

In summary, avoid buying or using chemical products that create difficult or expensive disposal challenges, whenever possible. The ability of the healthcare facility to safely dispose of the product after it is finished should be one of the considerations during product selection.

SUMMARY

Healthcare waste is potentially hazardous. Healthcare facilities are responsible for managing the waste they produce and appropriate management requires the collective efforts of various HCWs. However, waste management is complex and managing waste is challenging for facilities in resource-limited settings. Guidelines for disposal of waste from healthcare facilities set out by WHO in 2014 may not be immediately attainable by many facilities. Waste minimization to limit the volume of hazardous waste produced and waste segregation to minimize the proportion of the total waste that is infectious or hazardous are key waste management measures in all settings. Choosing the best available waste disposal method and working toward safer waste disposal to protect the community and the environment is essential. Effective waste management will save resources, reduce costs, and prevent injuries and exposure to infectious disease.

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CHAPTER 11: FOOD AND WATER SAFETY

Key Topics

- Managing water and food services
- Water safety
- Water quality monitoring and surveillance
- Prevention of food and waterborne diseases occurrence among patients hospitalized in healthcare settings

BACKGROUND

Healthcare-associated diarrhea is a common problem in hospitals, children's care facilities, and nursing homes (Lynch et al. 2007). Outbreaks in healthcare facilities among hospitalized patients have mostly been associated with unsafe food and water. A variety of organisms, including *Salmonella*, *Shigella*, *C. difficile*, *V. Cholera*, *C. albicans*, *Staph. aureus*, *cryptosporidium*, *rotavirus*, and other *enteroviruses* are responsible for contamination of food and water. Factors that increase the risk of water- and foodborne diseases in healthcare facilities include the fact that they serve food for more hours, serve food for ill and immune-compromised patients, transport and distribute food at a greater distance, and prepare nasogastric feeding and special diets. In general, the staff are often transient, poorly trained in food handling, and engage in unsafe practices involving the storage, preparation, and handling of raw meat, chicken, fish, fresh eggs, and some vegetables. Moreover, the quality of drinking water in countries with limited resources is often poor and unsafe, again contributing to the poor quality of food services hygiene (scabies and trachoma).

Managing Food and Water Services

Planning, implementing, and monitoring food and water service in healthcare facilities are of great value in preventing food and water contamination, which at times leads to infection or outbreaks among the hospitalized patients from such causes.

Principles of Food Safety

All activities in the food service department should be monitored regularly to be sure that safety standards are being followed. They include:

- **Temperature** should be kept above $60^{o}C/140^{o}F$ or below $7^{o}C/45^{o}F$. The temperature pertinent for the right storage of food should be maintained and checked periodically. Warm and perishable foods should be cooled while stored.
- **Cooking** should be complete and standardized. Frozen food items should be thawed before cooking to avoid the presence of cold spots in the interior.
- **Personal health and hygiene of food service staff** is of great importance and staff engaging in food service should be supervised by a knowledgeable person. Hand hygiene plays a crucial role in preventing healthcare-associated diarrhea and other

related health problems. The staff should report any gastrointestinal problems or skin lesions, especially on the hands. They need to know how to inspect properly; prepare and store the foods they handle; how to clean and operate equipment they use, such as slicers, blenders, and dishwashers, if they are available, and also the management of waste.

Food utensils should be washed using a three-compartment washing system. These are washing, cleansing, and sanitizing compartments.

Food Contamination

Food can be contaminated by the following three main hazard types:

- Physical hazards (foreign objects): metal, wood, glass, plastic, etc.
- Chemical hazards: bleach, caustic soda, detergents, pesticides, etc.
- Microbiological: bacteria, viruses, molds, and parasites

Food that is contaminated with any of these hazards is unsafe and unsuitable to eat.

Bacterial Food Poisoning

Bacteria are single-celled living microorganisms. The most common form of food poisoning is bacterial food poisoning. To survive and multiply, bacteria need water, food, correct temperatures, and time. Most, but not all, need oxygen. Under these conditions, bacteria will multiply by dividing into two every 10 to 20 minutes. After six hours, one bacterium can multiply into 262,144 bacteria, more than enough to cause food poisoning.

How Do Bacteria Enter a Food Premises?

- Food handlers (especially their hands)
- Raw foods, such as meat, poultry, shellfish, and vegetables
- Pests and animals
- Air and dust
- Dirt and food waste

Potentially Hazardous Foods

- Potentially hazardous foods support the growth of bacteria. They need to be kept at temperatures either below 5 °C or above 60 °C to prevent the growth of any food poisoning bacteria that may be present in the food.
- Examples of potentially hazardous foods include meat, poultry, seafood, eggs, dairy foods, gravies, and cooked rice.

Causes of Food Poisoning

1. Food at incorrect temperatures

Under ideal conditions, bacteria multiply rapidly between 5 °C and 60 °C (the danger zone for food). Below 5 °C, bacteria multiply slower. At freezing temperatures, bacteria stop multiplying and become dormant. Freezing does not kill bacteria; most bacteria are killed at temperatures above 60 °C.

2. Cross-contamination

Cross-contamination occurs when food becomes contaminated with bacteria from another sources. Bacteria can be transported by hands, utensils, surfaces, equipment, tea towels, raw food, and pests. Common examples of cross contamination include unclean hands; dirty knives; utensils; equipment and food contact surfaces (e.g., chopping boards); blood dripping from raw foods; storing raw food with cooked foods; storing food uncovered; and using dirty cleaning cloths and tea towels.

3. Poor personal hygiene

Examples of poor personal hygiene include: Dirty hands and clothing; uncovered cuts and wounds; long dirty fingernails; excess jewelry on hands and wrists; coughing and sneezing over food; handling food while ill; and not washing hands after going to the toilet.

4. Unclean food premises

Dirty kitchens increase the risk of cross-contamination from pests and particles of food, grease, and dirt.

5. Poor pest control. Common pests found in food premises include:

Flies, cockroaches, rats, and mice. These pests can carry food poisoning bacteria and may also cause physical contamination of food with their droppings, eggs, fur, and dead bodies.

Actions for the Prevention of Food Poisoning

1. Temperature control

Minimize the time that potentially hazardous foods spend in the danger zone; always remember to keep cold food cold at 5 °C or colder and hot food hot at 60 °C or hotter.

All food services at health facilities are required to obtain and use a probe thermometer, accurate to ±1 °C to monitor the temperature of potentially hazardous foods.

2. Avoid cross-contamination: To avoid cross-contamination do the following:

Keep food covered until used. Practice correct personal hygiene. Separate raw and cooked, and old and new food at all times. Use separate equipment and utensils when preparing raw meats, poultry, and seafood. Clean and sanitize all equipment, utensils, and food contact surfaces. Store chemicals separate from food.

3. Personal hygiene: the following should be considered:

Clean hands and clothing; minimize jewelry on hands and wrists; tie back or cover hair; clean and short fingernails; avoid unnecessary contact with food; cover all cuts and sores with a brightly colored waterproof dressing; do not eat over food or food surfaces; do not prepare food when you are ill; avoid touching your face and hair; do not cough or sneeze over food; do not taste food with your fingers or "double dip" with a spoon and if wearing gloves, change frequently.

Proper Handwashing

When should you wash your hands? Before starting or resuming work; after using the toilet; after smoking; after handling rubbish; after using a handkerchief or tissue; after touching your hair or face; before and after handling raw food; before handling cooked food; and after any cleaning task.

Handwashing facilities must be accessible to all food handlers, to be used only for the washing of hands, and should provide soap and warm portable water. Provide disposable towels for drying hands. Provide a bin for the disposable towels.

4. Cleaning

Must be continuous and ongoing; thoroughly clean and sanitize all food surfaces, equipment and utensils with hot water and detergent and chemicals (sanitizers). Remember that most detergents do not kill bacteria, but hot water and sanitizers do! Implement a cleaning schedule to ensure that cleaning is conducted on a regular basis (including hard-to-reach places).

Cleaning and Sanitizing With/Without a Dishwasher

- Wear rubber gloves to protect your hands from the hot water and chemicals.
- Remove food particles by scraping or soaking.
- Wash using hot water and detergent; change the water if it becomes cool or greasy.
- Rinse in hot water with chemical sanitizer or in very hot water (above 80 °C - only if sink has heating element and rinsing baskets) and leave to soak for 30 seconds.
- Either drip-dry or use a clean tea towel to reduce the risk of cross-contamination.

5. Pest Control

- Keep them out: seal the food premises.
- Starve them out: keep the food premises clean.
- Throw them out: conduct regular pest inspections or services.
- Don't give them a home: remove all unnecessary equipment and items.
- Report all pest sightings or evidence of pest activity to your supervisor.

6. Waste Management

- Place waste in plastic lined bins.

- Remove all waste from the premises as required.
- Empty and clean waste bins regularly.
- Ensure that all external bins are covered.
- Protect the external waste bin area from pests and birds.

Water Safety

The quality and quantity of drinking water is a major determinant of health. The most predominant waterborne disease—diarrhea—kills around 525,000 children under five each year. A significant proportion of diarrheal disease can be prevented through safe drinking water and adequate sanitation and hygiene. Diarrhea is a leading cause of malnutrition in children under five years old (WHO 2017).

There are several variants of the fecal-oral pathway of waterborne disease transmission. There are four categories of infectious diseases transmission pathways through the water supply:

- Waterborne diseases
- Water-washed diseases
- Water-based diseases
- Water-related diseases

Drinking Water Quality and Safety

Drinking water should be suitable for human consumption and for all usual domestic purposes. Drinking water contamination and chemical introduction can occur across the water supply chain. These include contamination at the catchment areas and water sources (by human and animal feces). Transmission can also result from contamination in the distribution system (through "leaking" pipes, obsolete infrastructure, and inadequate treatment and storage) and unhygienic handling of stored household water. Climate change can also affect the quality of drinking water.

Water Quality Parameters

There are three categories of parameters for drinking water: physical, chemical, and bacteriological. A national standard for drinking water quality was adapted from WHO recommendations (table 11.1).

Table 11.1. National standard for drinking water

Bacteriological levels

Organism	Maximum permissible level	Test method
Total viable organisms, colonies per ml	must not be detectable	ES ISO 4833
Faecal streptococci per 100ml	must not be detectable	ES ISO 7899-1 ES ISO 7899-2
Coliform organisms, number per 100 ml	must not be detectable	ES ISO 9308-1
E. Coli, number per 100 ml	must not be detectable	ES ISO 9308-1 ES ISO 9308-2

Source: Ethiopian Standards Agency 2013

Water Quality Monitoring and Surveillance

Drinking-water supply surveillance refers to "continuous and vigilant public health assessment and review of the safety and acceptability of drinking water supplies" (WHO 2011). It is the careful watching and protecting of drinking water from possible contamination risks.

Four Components of Drinking Water Quality Supply

- Sanitary inspection/survey: identify hazards
- Water quality monitoring/testing
- Data analysis, interpretation, and reporting
- Remedial action

It includes institutional inspection, sanitary survey, continuous monitoring of physicochemical and microbiological parameters (laboratory or spot testing of water samples collected at different locations, [i.e., at source, pipeline, reservoirs, and delivery points]) and time, data processing, and evaluation followed by remedial action and preventive measures.

Water Quality Monitoring

Improving and monitoring water quality require strong and consistent monitoring mechanisms to measure progress, and to direct efforts where the needs are greatest. Monitoring water quality at the facility level is important to detect contaminants early. Water containers and tankers should be cleaned and disinfected regularly, and the water should be tested regularly.

Water Sampling Methods

Basically, there are two types of sampling methods:

- Probability
- Non-probability

1. Probability Sampling Methods

Every unit of the population has an equal chance (probability) of being selected in the sample. Methods include:

- **Simple random sampling**: A subset of a statistical population in which each member of the subset has an equal probability of being chosen.
- **Systematic random sampling:** Systematic sampling is a statistical method involving the selection of elements from an ordered sampling frame.
- **Cluster sampling** is a sampling technique used when "natural" but relatively homogeneous groupings are evident in a statistical population.
- **Stratified random sampling** is the process of dividing members of the population into homogeneous subgroups before sampling.

2. Non-probability sampling does not use random selection. The generalization of the findings is not possible because the sample is not representative of the population.

- **Convenience sampling:** a sample population is selected because it is readily available and convenient**.**
- **Quota sampling:** a population is first segmented into mutually exclusive subgroups**.**
- **Snowball sampling:** The first respondent refers a friend. The friend also refers a friend, and so on. Table 11.2 shows sample volume and transportation conditions.

Table 11.2. Sample volume and transportation conditions

Sample type	Amount required	Transport and storage	Stability
Chlorinated water sample	100 ml	Water should be collected to a sterile container with lid and transported in an insulated cold box as soon as possible to the laboratory	6 hours
Unchlorinated water sample	105 ml	Water should be placed in an insulated cold box for transport to a water testing site	

Sample Dechlorination

- When samples of chlorinated effluents are to be collected and tested, the sample must be dechlorinated.
- Chlorine remaining in the sample can further disinfect the sample during any holding time after sample collection.
- Because sterile sampling procedures must be followed for a valid bacteriological test, the dechlorination steps cannot be performed after the sample is collected.
- Procedure for dechlorination of bacteriological samples is as follows:
    - When the water to be examined is likely to contain chlorine or chloramines, sufficient sodium thiosulphate (Na_2SO_3*$5H_20$) to neutralize this substance must be added to each bottle as follows:
    - Add 2-3 drops of sodium thiosulphate to sample collection bottle.
    - Grams of chemicals required to neutralize residual chlorine concentrations in 378,500 L of water. Table 11.3. shows sample dechlorination.

Table 11.3. Sample dechlorination

Residual chlorine concentration (mg/L)	Sodium thiosulfate pentahydrate ($Na_2S_2O_3.5H_2O$)
0.3	181.44g
0.6	317.51g
0.9	498.95g
1	544.31g
1.3	725.75g

How to Collect Water Samples

- Samples should be collected in a non-reactive borosilicate glass plastic bottle or plastic bag that has been cleaned, rinsed, and sterilized.
- 105 ml for unchlorinated and 100 ml for chlorinated water sample are the minimum volumes that should be taken as a sample to obtain reliable results, especially for microbiological testing. More water should be collected than needed (i.e., 200–1000 ml) if multiple tests are required.

Labeling of Water Sampling

Every sample container should have a label. The sample label has information about:

- Sample location
- Sample description (e.g., inlet water, storage bucket water)
- ID number
- Date and time
- Name of the person collecting the sample
- Test to be performed (optional)

Sampling Tap Water

- Remove any external fitting from the tap; carefully clean and disinfect the inside and outside of the tap.
- Carefully cleaning the outside nozzle of the tap ensures that any deposits in the pipes are washed out.
- Turn the tap on full for one minute.
- Sterilize the tap using the flame of a blow lamp or by igniting a piece of cotton wool soaked in alcohol.
- Allow the tap to cool by running the water to flow for few seconds.
- Fill the sample bottle from the gentle flow of water, and replace the cap of bottle.
- Using a waterproof marker, number the bottle with a sample code.

How to Transport Water Samples

- Bacteria do not generally survive well in water due to a variety of factors. It is well known that the number of bacteria in a water sample rapidly decline 24 hours after it has been collected. Temperature can also affect the die off in the water sample, with higher temperatures leading to greater die offs.

- Samples should be collected and placed on ice in an insulated container if they cannot be tested immediately; preferably held at <10 °C during transit. Samples should be tested the same day and refrigerated overnight, if necessary.
- If the time between collection and test exceeds six hours, the final report should include information on the conditions and duration of sample transport. Samples exceeding 30 hours holding time (from collection to testing) should not be tested. The minimum sampling frequency for drinking water in a distribution system is given in table 11.4.

Table 11.4. Recommended minimum sample numbers per year for E. coli testing in piped distribution systems

Population	Total number of samples per year
<5 000	12
5 000–100 000	12 per 5 000 population
>100 000–500 000	12 per 10 000 population plus an additional 120 samples
>500 000	12 per 50 000 population plus an additional 600 samples

[a] Parameters such as chlorine, turbidity and pH should be tested more frequently as part of operational and verification monitoring.

Source: WHO (2011)

Prevention of Food and Waterborne Diseases Occurrence Among Patients Hospitalized in Healthcare Settings

Hospitalized patients and caretakers should be trained and assisted on handwashing during critical times (before preparing food, before eating, after using the toilet).

A medical checkup of food handlers should be done quarterly. The checkup for diseases transmitted through contaminated food, water, or air should be carried out on regular basis. Cleanliness of the kitchen has to be done on a daily basis; it should be monitored and verified to avoid contamination of food during cooking.

Transportation and storage of raw and cooked food: Purchased raw food has to be transported to the healthcare facilities with transportation free from biological and chemical contaminants. Storage of raw and cooked food should be separate and done in line with the recommended temperature for each type of food to be stored (for example, easily perishable and cereals). In brief, the whole process, including food handling, has to be monitored daily. Food items should not be shelved with toxic materials, such as detergents, disinfectants, fuel, etc. If there is no option other than to shelve together, shelve food items at the top and other materials at the bottom.

Water safety principles: Identify the quality of the water source used by the healthcare facility: biological quality of the source (total *Coliform* and *E. coli* count based on WHO guideline value or country water quality standard, if available). If it is feasible, also examine the chemical quality. Infected patients should be restricted from using communal baths.

- **Collection, transportation, storage, and handling of water:** Healthcare facilities have to collect, transport, store, and handle water with precaution to avoid the risk of contamination (i.e., use properly washed/sanitized container to collect and store water,

separate container for drinking and other purpose by clearly writing on the container which is for which).

- **Making water collected from unsafe sources safe for hospitalized patients**: Water boiled for one to five minutes is considered safe to drink, whereas water boiled for 20 minutes is labeled as high-level disinfected and is even safer. Alternatively, water can be disinfected and made safe for drinking by adding 3-5 parts per million (ppm) chlorine based on the water quality and the residual Cl should be 0.2-0.5 ppm. The formula for preparing 0.001% of chlorine solution is given in these guidelines.
- **Monitoring/inspection:** The quality of water used by healthcare facilities, including its sources, collection, and storage, should be inspected regularly. The microbial water quality of the sources should also be monitored quarterly.
    - There are two types of sampling methods: probability and non-probability. When the water to be examined is likely to contain chlorine or chloramines, sufficient sodium thiosulphate ($Na_2S_2O_3.5H_2O$) to neutralize this substance must be added.

SUMMARY

Factors that increase the risk of water- and foodborne diseases in healthcare facilities include the fact that they serve food for more hours, serve food for ill and immune-compromised patients, transport and distribute food at a greater distance, and prepare nasogastric feeding and special diets. In general, staff are often transient, poorly trained in food handling, and engage in unsafe practices involving the storage, preparation, and handling of raw meat, chicken, fish, fresh eggs, and some vegetables. The quality of drinking water in countries with limited resources is often poor and unsafe, again contributing to poor quality food services.

Healthcare-associated diarrhea is a common problem in hospitals, children's care facilities, and nursing homes. Outbreaks in healthcare facilities among patients hospitalized have mostly been associated with unsafe food and water.

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CHAPTER 12: FACILITY DESIGN AND PATIENT FLOW

Key Topics

- The significance of regulating traffic flow and defining activity patterns in health facilities.
- Designing traffic flow and activity patterns in procedure rooms, and in instrument processing and surgical areas.
- Traffic flow requirements for different areas.

BACKGROUND

Regulating the flow of visitors, patients, and staff plays a central role in preventing disease transmission in healthcare facilities. This is because the number of microorganisms in a designated area tends to be related to that of the number of people present and their activity. Microbial contamination is found to be high in such areas as waiting rooms and places where soiled surgical instruments and other equipment are initially processed. Microbial contamination is minimized by reducing the number of people coming to the area and defining the activities taking place at each place.

An important objective of IPC is to minimize the level of microbial contamination in areas where patient care and instrument processing take place. Areas for instrument processing include procedure areas, surgical units, and work areas (where instruments are processed). These include dirty and clean areas where soiled instruments, equipment, and other items are first cleaned and then processed and stored. It is important to direct activity patterns and traffic flow in the above-mentioned areas to keep contaminated areas separate from areas where procedures take place. The major areas are:

- **Procedure areas** are settings where patients are examined and procedures (e.g., pelvic examinations, wound care management, blood drawing, immunizations, IUD insertions and removals, and normal childbirth) are carried out.
- **Surgical units** are settings where major and minor operations are performed. The surgical unit also includes preoperative and recovery rooms and several other areas.
- **Work areas** are settings where instruments are being processed. These include dirty and clean areas where soiled instruments, equipment, and other items are first cleaned and either high-level disinfected or sterilized and then stored.

It is important to direct activity patterns and traffic flow in these areas to keep contaminated areas separate from areas where procedures take place. Activities, such as waste disposal, instrument processing, and cleaning procedure areas, should be carefully planned and organized to minimize the risk of infection to patients and HCWs. Equally important is designing and implementing traffic flow patterns that prevent soiled instruments and other items from coming across to the cleaned, high-level disinfected or sterilized items. Traffic flow is also related with separating people who have or are likely to have communicable diseases from those who are at risk (susceptible). These people pose a great risk to susceptible patients and HCWs simply by availing themselves in the same room; therefore, it is necessary to identify and remove them quickly.

Facility Design, Space, and Equipment Requirements

Healthcare facilities vary in the types of services they provide. For example, a rural clinic may offer only a few procedures (e.g., IUD insertion and removal, immunizations, antenatal care, and minor surgery for suturing wounds). Larger facilities (including district and referral hospitals) provide major and minor general surgical procedures, and child delivery services, in addition to ambulatory procedures. Regardless of the size of the facility, the specific space and equipment requirements to perform a particular procedure do not generally vary.

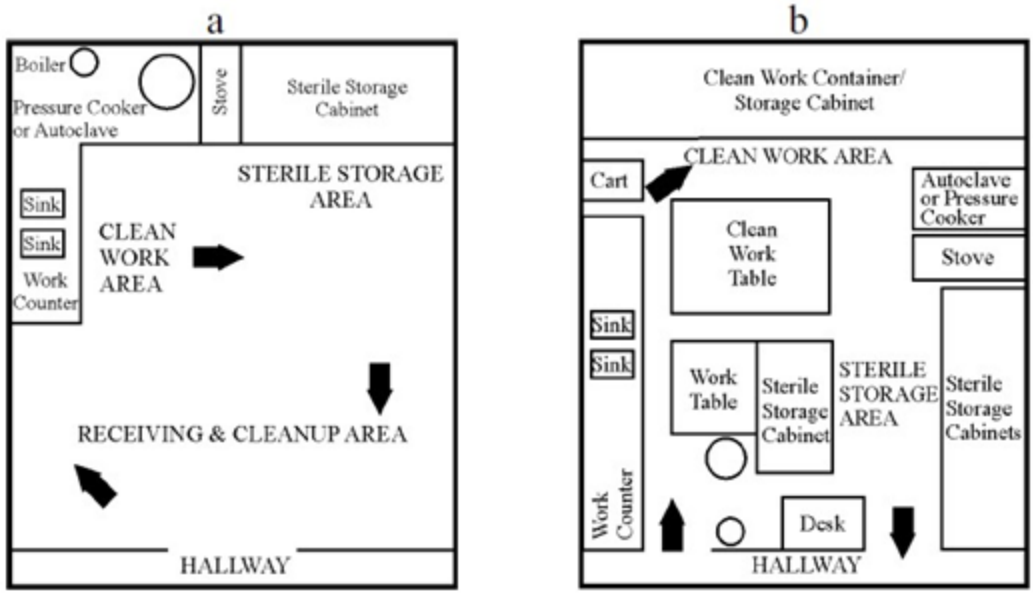
Microbial contamination can be substantial in highly trafficked areas and places where soiled surgical instruments and other equipment are initially processed. Basic principles of facility design, traffic flow, and work practices that can be applied to reduce microbial contamination include:

- Designating appropriate traffic flow for patients, HCWs, and equipment to ensure the safe separation between contaminated items and clean/sterile items.
- Developing policies and procedures that establish clear authority, responsibility, and accountability to ensure that these safe practices are adopted and practiced.
- Regulating the flow of visitors, patients, and staff using signs (e.g., authorized personnel only), reminders (e.g., red line on the floor), and physical barriers (e.g., closed doors). The amount of traffic and the number of individuals present in a designated area and their activities contribute to the number of microorganisms present in that area.
- Using work practices that prevent contaminated items from contacting clean items, such as working from dirty to clean. This is especially important if separate spaces for dirty and clean items are not available.
- Ensuring that all staff understand the policies and procedures, for example, through new staff orientation and ongoing training, to guarantee safe handling of clean and soiled items.
- Ensuring appropriate ventilation of operating rooms, procedure areas, Central Sterile Supply Department (CSSD), and instrument processing areas.
- Using fans in facilities without mechanical ventilation to optimize existing ventilation. The air should be drawn into the area and should be exhausted outside using one-way exhaust fans. Where mechanical ventilation or fans are not available, the only option is to use natural ventilation with open windows and doors fitted with mosquito nets.
- Designing new facilities and renovations with these principles in mind. For example, healthcare facilities should have a dedicated central location where soiled instruments can be reprocessed and that is physically separated from procedure areas.

In clinics where only minor procedures are performed, a procedure room with a handwashing sink is required for examining clients and performing procedures. A separate room with at least one sink for cleaning and an area for processing instruments and other items is also desirable (figure 12.1a). Ideally, the processing area should include more than one room (e.g., a dirty room for receiving dirty instruments and a clean room for final processing and storage). If only a single room is available (figure 12.1a), soiled equipment should be received and cleaned in an area of the room distant enough from areas where equipment is high-level disinfected or sterilized and then stored.

Although the space requirements for performing various minor surgical procedures may not be different, it may still be quite different to some extent depending on the classification of the procedure (semi-critical or critical), the instrument processing requirements (HLD or sterilization). Inserting or removing an IUD, for example, is classified as a semi-critical procedure not normally sterile, or can be made so if necessary (Spaulding 1968). By contrast, inserting a laparoscope into the abdomen is classified as a critical procedure because tissues that are normally sterile are being touched. For the former, either sterile or high-level disinfected instruments are acceptable, but for the latter, the preferred final processing is sterilization. To sum up, it should be noted that sterile metal instruments with laparoscopy call for an additional separate area for final processing (high-pressure sterilization by autoclaving) (figure 12.1b). This is especially important if the volume of services is high (five or more procedures per day).

Figure 12.1. a and b: Floor plans for instrument cleaning, high-level disinfecting, and sterilizing areas in a clinic and larger facility



Source: SEARO/WHO 1988.

The space, equipment, and need for well-defined traffic flow and activity patterns become progressively more complex as the type of surgical procedure changes from general surgery and obstetrics to open heart surgery.

As a guide, the space requirements for the types of surgery typically performed at district hospitals are roughly the same as that of a busy surgical center or polyclinic. They include**:**

- Changing room and scrub area for the clinic staff
- Preoperative area where clients are examined and evaluated before surgery
- Operating room

- Recovery area for the observation of patients after surgery (may be combined with the preoperative area)
- Processing area for cleaning and sterilizing or high-level disinfecting instruments and other items
- Space for storing sterile packs and/or high-level disinfected containers of instruments and other items

Traffic Flow and Activity Patterns

The recommended IP practices for minimizing microbial contamination of specific areas in healthcare facilities are briefly described below.

ICU and Isolation Room

- Limit traffic to authorized staff and patients at all times.
- Permit only the patient and staff (performing and assisting). Only two family members should be allowed at a time in one room for a limited period of time in a day (wearing clean attire and headcover).
- Patients can wear their own clean clothing.
- Staff should wear attire and PPE according to the procedures performed. Family members who are allowed to enter should wear a headcover, face mask, gown, and shoe cover above their clean clothes and shoes.
- Family member who reported to have acute upper respiratory tract infection should not be allowed to enter.

Procedure Area

- Limit traffic to authorized staff and patients at all times.
- Permit only the patient and staff (performing and assisting) in the procedure room (family members should be limited with obstetrical procedures).
- Staff should wear attire and PPE according to the procedures performed.
- Place a clean container filled with clean water mixed with enzymatic detergent solution (if available) for immediate immersing of instruments and other items once they are no longer needed.
- Have a leak-proof and covered waste container for disposal of contaminated waste items (cotton, gauze, dressings) right after use.
- Have a puncture-resistant container for the safe disposal of sharps (e.g., used suture needles, hypodermic needles and syringes, and disposable scalpel blades) right after use.

- Have storage space in procedure rooms for clean, high-level disinfected and sterile supplies. (Storage shelves should be enclosed to minimize dust and debris collecting on stored items.)

Surgical Unit

The surgical unit is often divided into four designated areas defined by the activities performed in each: **unrestricted, transition zone**, **semi-restricted,** and **restricted area**. Environmental controls and use of surgical attire increase as one moves from unrestricted to restricted areas. Staff with respiratory or skin infections and/uncovered open sores should not be allowed in the surgical unit.

Different Areas in Surgical Unit

Post signs in each area to clearly indicate the appropriate environmental control and surgical attire required.

A. Unrestricted Area

This area is the entrance from the main corridor and is isolated from other areas of the surgical unit. This is the point through which the staff, patients, and materials enter the surgical unit.

B. Transition Zone

This area consists primarily of dressing rooms and lockers. It is where the staff put on surgical attire that allows them to move from unrestricted to semi-restricted or restricted areas in the surgical unit. Therefore, only authorized staff should enter this area.

C. Semi-Restricted Area

This is the peripheral support area of the surgical unit. It includes preoperative and recovery rooms; storage space for sterile and high-level disinfected items; and corridors leading to the restricted area. This is an area where support activities (e.g., instrument processing and storage) for the operating room are carried out. Therefore, it is important to do the following:

- Limit traffic to authorized staff and patients every time.
- Have a work area for the processing of clean instruments.
- Have storage space for clean, sterile, or high-level disinfected supplies with enclosed shelves to minimize dust and debris collecting on stored items.

Flip flops or sandals should not be worn because they provide no protection from dropped sharps.

- Have doors limiting access to the restricted area of the surgical unit.
- Staff working in this area should wear surgical attire and a cap.
- Staff should wear clean and closed shoes that will protect their feet from fluids and dropped items.

D. Restricted Area

This designated area consists of the operating room(s) and scrub sink areas.

Never store instruments and other items in the operating room.

- Limit traffic to authorized staff and patients at all times.
- Keep the door closed at all times, except during movement of staff, patients, supplies, and equipment.
- Scrubbed staff must wear full surgical attire and cover their heads and facial hair with a cap and mask.
- Staff should wear clean and closed shoes that will protect their feet from fluids and dropped items.
- Masks are required when sterile supplies are open and when the scrubbed staff are operating.
- Patients entering the surgical unit should wear clean gowns or be covered with clean linen and have their hair covered.
- Patients do not need to wear masks during transport unless the patient is under airborne precautions.

E. Operating Room(s)

- The operating room should be enclosed to minimize dust and eliminate flies; however, central air conditioning is necessary. (If windows are the only ventilation, provide tight- fitting screens.)
- The operating room should be located away from areas of the hospital or healthcare facility that are heavily staffed with frequent movements of staff and patients.

F. Work Area

Depending on the size and type of healthcare facility, the work area for processing instruments (e.g., the CSSD) may be part of the surgical unit; or just connected to it; or an independent area somewhere away from it.

This is the area where instruments, surgical gloves, and equipment are processed, and where staff should be specially trained in handling, processing, and storing instruments, equipment, and other clean, sterile, or high-level disinfected items. The CSSD is considered a semi-restricted area; hence, all the recommendations for traffic patterns and proper attire described above should be followed.

Permit only authorized personnel to enter this area.

How to Conduct Activities in the Surgical Unit

A. Before Surgical Procedures

- Place a plastic bag or leak-proof covered waste container for contaminated waste items (cotton gauze and old dressings).
- Place a puncture-resistant container for the safe disposal of sharps (e.g., suture needles, hypodermic needles and syringes, and disposable scalpel blades) at the point of use but without contaminating the sterile field.
- Place a leak-proof and covered waste container for soiled linen away from sterile items.
- Organize tables, Mayo and ring stands side by side in an area away from the traffic patterns and at least 45 cm (18 inches) from walls, cabinets, and other non-sterile surfaces.
- Place a clean sheet, a lift sheet, and arm board covers on the operating room bed.
- Check and set up suction, oxygen, and anesthesia equipment.
- Place supplies and packages that are ready to open on the tables, not on the floor.
- Mayo stand and other non-sterile surfaces that are to be used during the procedure should be covered with a sterile towel or cloth.

B. During Surgical Procedures

- Limit the number of staff entering the operating room only to those necessary to perform procedures and to patients (family members, as deemed necessary). Make the surgical team self-sufficient so that outside help is not required.
- Keep the doors closed at all times, except during movement of staff, patients, supplies, and equipment.
- Keep the number of people and their movement to a minimum because the number of microorganisms is directly proportional to an increase in people's activity.
- Keep talking to a minimum in the presence of a sterile field.
- Scrubbed staff should wear full surgical attire, including:
    - A clean scrub suit covering the bare arm (one or two pieces); if a two-piece pantsuit is worn, the top of the scrub suit should be tucked into the pants.
    - A clean surgical cap that covers the head.
    - Clean, closed shoes that protect the feet from fluids or dropped items.
    - Sterile (or high-level disinfected) surgical gloves, protective eyewear, and a mask covering the mouth, nose, and any facial hair.
- Scrubbed staff should keep their arms and hands within the operative field at all times and touch only sterile items or areas. Non-scrubbed staff should wear surgical attire, including:
    - Long sleeved jackets banded at the wrist and that are closed during use.

  - A clean surgical cap that covers the head.
  - Clean, closed shoes that protect the feet from fluids or dropped items.
  - A mask covering the mouth, nose, and any facial hair.

- Non-scrubbed staff should stay at the periphery of the operating room, keeping their distance from sterile areas. They should not lean or reach over the operative field.
- Clean accidental spills or contaminated debris in areas outside the surgical field with a 0.5% chlorine solution as promptly as possible (a non-scrubbed staff member wearing utility gloves should do this).

C. After Surgical Procedures

Non-scrubbed staff wearing utility gloves should:

- Collect all waste and remove it from the room in closed leak-proof containers.
- Close and remove puncture-resistant containers when they are three-quarters full.
- Remove covered containers with a 0.5% chlorine solution with instruments and surgical gloves from the room.
- Remove soiled linen in closed leak-proof containers.
- Remove waste, soiled linen, soiled instruments, and equipment and supplies that have been opened but not used in an enclosed cart or in a leak-proof and covered waste container. (Be sure that these items do not reenter the restricted area.)

Description of Central Sterile Supply Department in a Hospital

A CSSD consists of four areas, as shown in figure 12.2. These areas are:

1. The “dirty” receiving/cleanup area
2. The “clean” work area
3. The cleaning equipment storage area
4. The sterile or high-level disinfected storage area

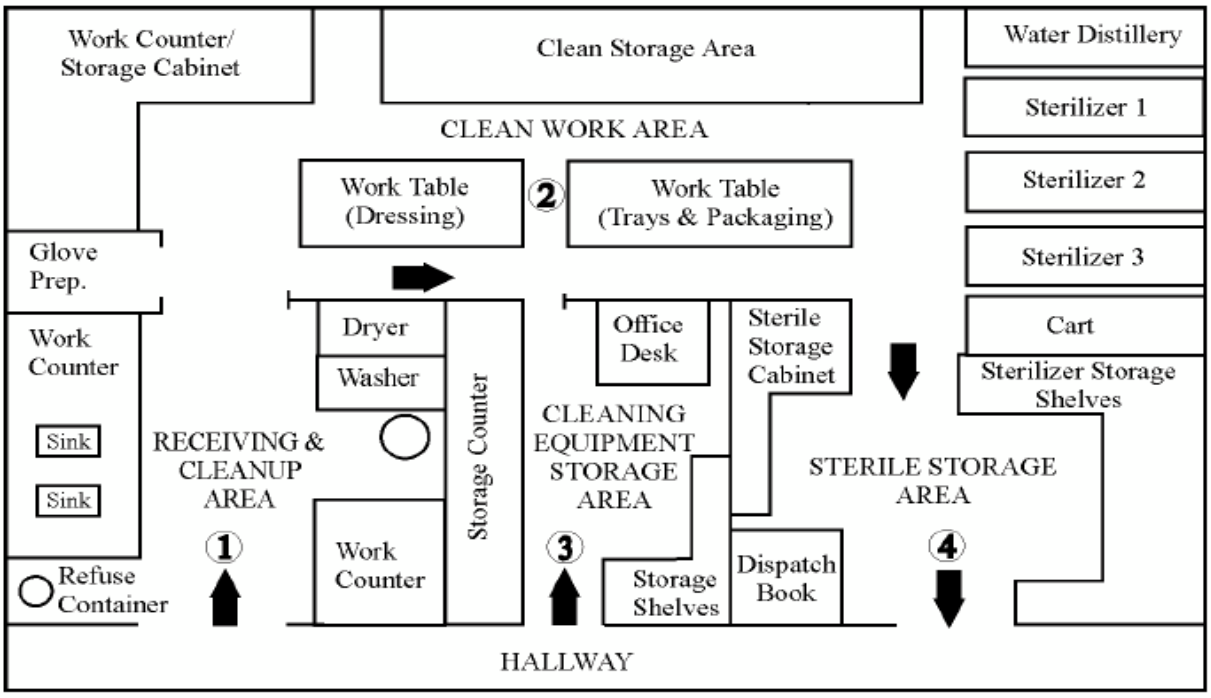
Following surgery, place soiled instruments in their original sterile wrap and transport them to the CSSD where they can be immediately cleaned before further processing.

Separate the “dirty” receiving/cleanup area (1) from the “clean” work area (2) with a physical barrier (wall and door). If this is not possible, use a screen or paint a red line on the floor to designate separation between the areas.

Note: Develop flow patterns to help ensure that contaminated items never come in contact with clean, disinfected, or sterile items.

The function and equipment requirements for the four areas of a typical CSSD are summarized below.

Figure 12.2. Floor plan for a CSSD in a hospital



Source: Tietjen, Bossemeyer, McIntosh 2003

"Dirty" Receiving/Cleanup Area (1)

In this area, soiled items are received, disassembled, washed, rinsed, and dried. Staff in the receiving/cleanup area should wear plastic aprons, utility gloves, and safety goggles or face shields to protect themselves from spills and splashes. The "dirty" receiving/cleanup area should have:

- Two sinks, if possible (one for cleaning with detergent and one for rinsing) with a clean water supply
- A clean equipment counter for drying

"Clean" Work Area (2)

In the clean work area, cleaned items are:

- Inspected for flaws or damage
- Packaged (if indicated) and either sterilized or high-level disinfected
- Sent for storage as packaged or air dried and placed in a sterile or high-level disinfected container

The clean work area should have:

- A large work table
- Shelves for holding clean and packaged items

- A high-pressure steam sterilizer, a dry-heat oven, a steamer, or a boiler

Staff entering the clean work area should wear clean cover gowns.

Clean Equipment Storage Area (3)

Store clean equipment in this area. The staff of the CSSD should enter the department through this area. Equip the area with:

- Shelves (preferably enclosed) for storing clean equipment
- An office or desk for record keeping

Sterile or High-Level Disinfected Storage Area (4)

Store sterilized packs and covered sterile or high-level disinfected containers in this area. This area should be separated from the central sterile supply area:

- Limit access to the storage area and/or store items in closed cabinets or shelves. (Shelves or cabinets should be closed because they protect packs and containers from dust and debris. Open shelves are acceptable only if the area has limited access and if housekeeping and ventilation practices are controlled.)
- Keep the storage area clean, dry, dust-free, and lint-free by following a regular housekeeping schedule.
- Packs and containers with sterile or high-level disinfected items should be stored 20 to 25 cm (8 to 10 inches) off the floor, 45 to 50 cm (18 to 20 inches) from the ceiling and 15 to 20 cm (6 to 8 inches) from an outside wall.
- Do not use cardboard boxes for storage. (Cardboard boxes shed dust and debris and may harbor insects.)
- Date and rotate the supplies (first in, first out). This process serves as a reminder that the package is susceptible to contamination and conserves storage space, but it does not guarantee sterility.
- Packs will remain sterile as long as the integrity of the package is maintained.
- Sterile or high-level disinfected containers remain so up until they are opened.
- Dispense sterile and high-level disinfected articles from this area.

Shelf Life of Sterile Items

The shelf life of a packaged sterile item is event-related and not time-related.

- An event can compromise the integrity and effectiveness of the package.
- Events that can compromise or destroy package sterility include multiple handling, loss of package integrity, moisture penetration, and airborne contamination.

- Sterility is lost when the package has tears in the wrapper, has become wet, has been dropped on the floor, has dust on it, or is not sealed.
- The shelf life of a sterile package will depend on the quality of packing; conditions during storage and transport; and the amount of handling before use.
- Sealing sterile packs in plastic bags can help prevent damage and contamination.
- Most contaminating events are related to excessive or improper handling of the packages.

  The ideal number of times an item should be handled is three:

  1. When removing it from the sterilizer cart and placing it on a storage shelf.
  2. When transporting it to the place where it is to be used.
  3. When selecting it to be opened for use.

Handling and Transporting Instruments and Other Items

- Keep clean and high-level disinfected or sterile instruments and other items separate from soiled equipment and waste items. Do not transport or store these items together.
- Transport high-level disinfected and sterile instruments and other items to the procedure or operating room in a closed cart or container with a cover to prevent contamination.
- Remove supplies from all shipping cartons and boxes before bringing such supplies into the procedure room, the operating room, or the clean work area of the CSSD. (Shipping boxes shed dust and harbor insects that may contaminate these areas.)
- Transport soiled supplies and instruments to the receiving/cleanup area of the CSSD in leak-proof and covered waste containers.
- Transport contaminated waste to the disposal site in leak-proof and covered waste containers.

Note: If supplies are being delivered to the surgical area, one person standing outside should pass them through the door to a person inside the operating room to reduce traffic.

SUMMARY

Irrespective of the existing layout of the facility, design traffic flow and work practices in such a way that keeps soiled/contaminated instruments, equipment, and textiles separate from the clean and sterile instruments, equipment, and textiles, whether in the operating rooms or in the CSSD. Appropriate traffic flow and work practices prevent accidental contamination of clean items and reduce the risk of infections to patients, HCWs, and visitors.

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CHAPTER 13: INFECTION PREVENTION AND CONTROL ASPECTS OF OCCUPATIONAL HEALTH IN HEALTHCARE SETTINGS

Key Topics

- Hazard identification, risk assessment, and risk control
- Occupational health activities for the prevention and management of infections in HCWs
- Occupational health activities for the management of job-related illnesses and occupational exposures
- Prevention strategies for infections relevant to occupational health in healthcare facilities
- Occupational health activities for specific groups of HCWs
- Post-exposure prophylaxis for HIV and HBV
- Monitoring occupational health activities

BACKGROUND

Healthcare facilities around the world employ more than 59 million workers who are routinely exposed to a variety of health and safety risks (WHO 2016a). These risks include exposure to infectious agents, such as bloodborne pathogens, TB, viral respiratory infections, vaccine-preventable diseases, bacterial infections, and gastrointestinal infections, among others. If an infection is contracted as a result of an exposure to risk factors arising from workplace activity, it is known as an occupational infection. In general, HCWs who have contact with patients, body fluids, or specimens have a higher risk of acquiring or transmitting infections than those who have casual contact with patients and the healthcare environment.

Occupational exposures to sharps injuries are an example of the substantial impact of occupational infections among HCWs. It is estimated that 39% of HCV, 37% of HBV, and 4.4% of HIV infections among HCWs worldwide are attributable to occupational exposure due to sharps injuries. This amounts to an estimate of 16,000 HCV, 66,000 HBV, and 1,000 HIV occupational infections annually (Prüss-Üstün Rapiti, Hutin 2005). It is thought that more than 90% of these are in limited-resource countries (IFIC 2011).

It is notable that infection with HBV is 95% preventable with immunization, and the HBV vaccine has contributed to a significant reduction of HBV in HCWs. However, fewer than 20% of HCWs in some regions of the world have received all three doses of the vaccine needed for immunity from HBV infection (APIC 2014a; IFIC 2003).

In general, occupational health deals with all aspects of work-related health and safety. It has a strong focus on prevention, especially for infectious (such as disease exposures) and non-infectious risks (such as injury). The goals of IPC intersect with those of occupational health in preventing and addressing infectious hazards at healthcare facilities. Therefore, a large portion of occupational health activities at a healthcare facility are also IPC activities (APIC 2014a).

Although the actual risk of infectious exposure for HCWs depends somewhat on the job description and the setting, attention to IPC helps protect staff and patients in all settings. Emerging infectious disease outbreaks, such as SARS in 2003, MERS-CoV in 2012, EVD in 2014, and COVID-19 have highlighted the importance of IPC in protecting HCWs because transmission of these viruses to

HCWs occurred when they cared for infected patients. These outbreaks have demonstrated that strategies to protect HCWs from exposure to infectious risks in the workplace are critically important and that facilities must have the infrastructure in place to be able to adapt to changes in emerging infectious threats. Healthcare facilities need staff knowledgeable in IPC to conduct and support sound occupational health activities to minimize the risk of occupational infection in HCWs and provide a safe environment for patients and staff (APIC 2014a; WHO 2016a; WHO 2016b) or a perpetrator, if it is a case of sexual assault.

Hazard Identification, Risk Assessment, and Risk Control

Workplace hazard identification, assessment, and control is an ongoing process. It should be undertaken at various times, including:

- If it has not been done before.
- When a hazard has been identified.
- When a change to the workplace may introduce or change a hazard, such as when changes occur to the work equipment, practices, procedures, or the environment.
- As part of responding to a workplace incident, even where an injury has not occurred.
- When new information about a risk becomes available or concerns about a risk are raised by workers.
- At regularly scheduled times appropriate to the workplace.

Hazard identification: This is the process of examining each work area and work task for the purpose of identifying all the hazards that are "inherent in the job." Work areas include but are not limited to machine workshops, laboratories, office areas, agricultural and horticultural environments, stores and transport, maintenance and grounds, reprographics, and lecture theaters and teaching spaces. Tasks can include (but may not be limited to) using screen-based equipment, audio and visual equipment, industrial equipment, hazardous substances and/or teaching/dealing with people, driving a vehicle, dealing with emergency situations, and construction. This process is about finding what could cause harm in a work task or area.

Risk assessment: Is defined as the process of assessing the risks associated with each hazard identified so that the nature of the risk can be understood. This includes the nature of the harm that may result from the hazard, the severity of that harm, and the likelihood of harm occurring.

Risk control: Taking actions to eliminate health and safety risks as is reasonably practicable. Where risks cannot be eliminated, implementation of control measures is required to minimize risks as is reasonably practicable. A hierarchy of controls has been developed and is described below to assist in the selection of the most appropriate risk control measure/s.

Monitoring and review: This involves ongoing monitoring of the hazards identified, risks assessed, and risk control processes, and reviewing them to make sure that they are working effectively.

Hazard identification, risk assessment, and risk control are an ongoing process. Therefore, regularly review the effectiveness of your hazard assessment and control measures. Make sure that you

undertake a hazard and risk assessment when there is a change to the workplace, including when work systems, tools, machinery, or equipment change. Provide additional supervision when new employees with reduced skill levels or knowledge are introduced to the workplace. The effectiveness of control measures can be checked through regular reviews and consultation with workers.

Occupational Health Activities for Preventing Infections among HCWs

The goal of occupational health activities is to protect HCWs—and thereby their patients—from acquiring an infection or any other hazard while working in a healthcare facility. This goal is achieved by:

- Identifying work-related infection risks and hazards and preventing them.
- Ensuring prompt and appropriate management of any occupational exposures to infections or other hazards.
- Training all HCWs on IPC and PS practices and how to protect themselves against the risks of occupational exposures to infections and other hazards.
- Monitoring and investigating potentially harmful exposures and outbreaks among HCWs.
- Preventing infections by carrying out occupational health activities (APIC 2014a; CDC 1998; WHO 2016b).

Protection from acquiring infections through occupational exposure is critical to maintaining and retaining an adequate workforce of trained and healthy HCWs. Protecting HCWs also helps contain costs associated with absenteeism, illness, and attrition as a result of incapacity, death, and fear. In addition, occupational health activities protect patients through prevention, early identification, and control of infections and other harms among staff. Therefore, protecting HCWs is integral to maintaining a safe environment for both patients and staff.

Aspects of occupational health should be included in any IPC/PS program. WHO's *Core Components of IPC* (2016b) emphasize the importance of collaboration between occupational health/employee safety activities and the IPC program (CDC 1998; WHO 2016a; WHO 2016b).

It is ideal to have an occupational health department and program in a larger healthcare facility, depending on the size of the facility and available staffing. In smaller healthcare facilities, the IPC team or other appropriate staff may carry out occupational health activities. All occupational health programs should be coordinated and overseen by a trained healthcare professional or team who are responsible for ensuring that all program activities, including IPC aspects, are conducted.

A responsible person from various departments, which could include human resources, IPC/PS, outpatient clinics, administration, and the laboratory, should work in a coordinated manner to implement occupational health activities, such as efficient and prompt screening, immunization, and follow-up of exposures and outbreaks among HCWs.

Major Occupational Health Activities

The priorities of occupational health activities at any facility will vary depending on such factors as the type of facility, organizational structure and services provided, geographic location, characteristics of the patients and HCWs, and diseases that are endemic in the community (APIC 2014a). This section provides a practical description of the implementation and integration of occupational health activities.

Activities that should be implemented by staff responsible for occupational health can be divided into the following categories:

- For newly employed HCWs (table 13.1)
- For all HCWs on an ongoing basis (table 13.2)
- Facility-wide activities (table 13.3)

Table 13.3. Occupational health activities for newly employed HCWs

Activity	Key occupational health activities for newly employed HCWs
Preemployment evaluation	• Although not recommended in many settings, a baseline medical history and physical examination, if done, can serve as a screening tool and establish a baseline to determine if any future diseases are work-related. • Review history of vaccination for HBV, in particular, and other vaccinations recommended as per the national guidelines for vaccination of HCWs. • Assess for immunity: In low-resource settings, documentation of routine immunization might be the only source to verify immunity if the records are available. Follow the national vaccination schedule for HCWs when vaccination status is not known. In some settings, blood titers to determine current immunity to vaccine preventable diseases may be available. • Assess for presence of chronic and acute infections, including screening for TB.

Education/ training on IPC	• Tailor training to the needs of specific job functions.
	• Conduct IPC training for newly employed HCWs following the national training curriculum. At a minimum, all new employees should receive training in:
	  ○ Standard precautions and transmission-based precautions
	  ○ Management of occupational exposure to bloodborne pathogens
	• Include such topics as risk and prevention of occupational infections, risk of infection after exposures, and management of exposures, including availability and effectiveness of PEP and potential consequences to family members of exposed HCWs. Also include updates on occupational health and pregnant HCWs.

Counseling for occupational exposure to infections	• Counsel for:
	  ○ The risk and prevention of occupational infection
	  ○ Risk of various infections following exposure
	  ○ Management of exposures, including testing and PEP (where indicated)
	  ○ Risks and benefits of PEP
	  ○ Long-term consequences of infections
	  ○ Potential risks for family members, colleagues, and other patients
	  ○ The need to be away from the job
	• Female HCWs of childbearing age and those who are pregnant should be counseled on the risks of infections and provided with information on appropriate transmission-based precautions needed for infections of concern during pregnancy.
	• Answer any other questions that the HCW might have.

Source: Curless et al. 2018

Table 13.2. Occupational health activities for all HCWs

Activity	Key occupational health activities for all HCWs
Monitoring employee health status	• Screen for TB using the WHO TB screening tool. • Ensure that the vaccination status of all HCWs is up to date. • Update employee health records. • Perform routine monitoring of HCWs with HBV, HCV, and HIV infection with the goal of assisting infected HCWs to continue to provide safe healthcare to patients.
Education/training on IPC	• Organize periodic refresher training for all HCWs in key IPC practices. • Provide updates on guidelines for monitoring and managing occupational exposures to bloodborne pathogens and other infections.
Determining work restrictions for employee illness and exposure	• Make decisions about work restrictions (the need to be away from the job) for ill HCWs. (See Appendix 13A and 13L for disease-specific work restrictions.)
Post-exposure follow-up	• Follow up immediately those HCWs with job-related exposures and make decisions about work restrictions and post-exposure care. (See Appendix 13 E, 13F, and 13G for disease-specific work restrictions.) See the Occupational Health Activities for Management of Job-Related Illnesses and Occupational Exposures section in this chapter.
Vaccination	• Organize vaccination sessions for those staff who need to complete vaccinations according to national/facility recommendations.

Source: Curless et al. 2018

Table 13.3. Facility-wide activities

Activity	Key occupational health facility-wide activities
Exposure reporting	• Conduct a regular review of occupational exposure reporting in the facility. • Ensure that round-the-clock services are available for post-exposure management as recommended in Volume 1, Chapter 6: Sharps Injuries and Management of Exposure to Bloodborne Pathogens. • Prepare and transmit documentation of occupational exposures to the authorities, as needed.
Occupational health program review	• Evaluate the effectiveness of occupational health activities for preventing occupational exposure to bloodborne pathogens and other risks. • Make changes in the selection and implementation of occupational health program activities, as needed.

Source: Curless et al. 2018

National guidelines, if available, should be followed to vaccinate HCWs against vaccine-preventable diseases. WHO has provided information on immunizations for the general population and HCWs (table 13.4) to help develop national policies for the vaccination of HCWs.

Table 13.4. WHO-recommended immunizations for HCWs

Vaccine	Recommendations
HBV	• Routine childhood immunization. No booster needed. • Incompletely vaccinated HCWs should receive additional doses to complete the vaccine series. The vaccine series does not need to be restarted; however, minimum dosing intervals should be followed: 4 weeks between the first and second dose, 8 weeks between the second and third dose, and 16 weeks between the first and third dose (CDC 2013). • HBV vaccine is affordable and available in many settings and is an appropriate place to begin when starting a staff immunization program (CDC 1998).
Polio	• Routine childhood immunization. • All HCWs should have completed a full course of primary vaccination against polio.
Diphtheria	• Routine childhood immunization. • Booster for HCWs every 10 years.
Measles	• Routine childhood immunization. • If required by the national policy, all HCWs should produce proof of immunity or documentation of immunization at the time of employment.
Rubella	• If rubella vaccine has been introduced in the national program, all HCWs should be immunized for rubella and produce proof of immunity or documentation of immunization at the time of employment.
Meningococcal	• One booster dose 3–5 years after the primary dose may be given to persons considered to be at continued risk of exposure, including HCWs.
Influenza	• Influenza virus changes regularly, therefore, annual immunization with a single dose is recommended if the vaccine is available for HCWs under the national immunization program.
Varicella (Chicken pox)	• Countries should consider vaccination of potentially susceptible HCWs (i.e., unvaccinated and with no history of varicella) with two doses of varicella vaccine.
Immunizations with NO current WHO recommendation for HCWs	
There are no specific recommendations for vaccination specifically for HCWs for TB, pertussis, tetanus, mumps, HAV, typhoid, or cholera. These vaccines should be offered as a part of routine vaccination programs and as overall strategies for preventing outbreaks (typhoid and cholera).	

Adapted from: WHO 2015

Occupational Health Activities for Management of Job-Related Illnesses and Occupational Exposures

The occupational health team should respond immediately to all potential and confirmed exposures to bloodborne pathogens and other infectious diseases, and collaborate with IPC staff for follow-up, as necessary. Healthcare facilities should have systems in place for HCWs to report sharps injuries and bloodborne pathogen exposures with prompt evaluation and follow-up (table 13.5).

Table 13.5. Occupational health activities for the management of job-related illnesses and exposures

Activity	Key occupational health activities: Job-related illnesses and exposures
Infectious disease in HCWs	• Identify infections in HCWs (whether community-acquired or job-related). • Make decisions about the length and type of work restrictions (related to patient care or food handling) and assignment to other duties (see Appendix 13L). • Report to public health authorities if it is a notifiable disease of public health interest.
Sentinel infections in HCWs	• Suspect a job-related infection in an HCW with an infectious disease known to spread in healthcare facilities. Certain occupational infections may be the result of caring for patients with an unidentified infection (such as meningococcal meningitis or novel influenza) or may indicate IPC lapses at the facility. (See Appendix 13L for disease-specific risk of transmission to and from HCWs.) • Ensure that infections are managed following clinical guidelines and make decisions about the length and type of work restrictions (as above). • Take necessary measures to prevent further spread of the infection through investigation of possible routes of transmission in the facility and correct any lapses in IPC. • Identify and facilitate clinical management and work restrictions of those exposed. • Monitor closely for additional cases (indicating a hospital or community outbreak).
Post-exposure follow-up	• Determine what is considered an exposure (exposure definition). • Obtain a list of those who have been exposed. • Counsel those exposed. • Offer PEP promptly when appropriate and available. • Determine any work restrictions. • Conduct medical surveillance for development of disease. • Determine when the HCW can return to work. • Maintain adequate and confidential documentation on the event. • Coordinate all of the above and any other activities, such as ongoing monitoring or follow-up lab testing. • (See Volume 1, Chapter 6: Sharps Injuries and Management of Exposure to Bloodborne Pathogens, for more information on post-exposure management for HBV, HCV, and HIV. See Appendix 13A for disease-specific guidance for management of exposed HCWs.)

Source: Curless et al. 2018

Summary of Key Elements of Occupational Health Activities

The following are the key elements for occupational health programs in healthcare facilities:

- Oversight by a qualified healthcare professional or team
- Coordination among multiple hospital departments
- Medical evaluation at the start of employment
- Health and safety education and training of all staff
- Immunization programs

- Management of work restrictions and post-exposure treatment for occupational illnesses and exposures
- Counseling on protection from and management of accidental exposure to bloodborne and other infectious pathogens
- Maintenance of personnel health records

(APIC 2014a; CDC 1998; WHO 2002)

Prevention Strategies for Infections Relevant To Occupational Health in Healthcare Facilities

Prevent occupational exposure of HCWs by the application of standard precautions for all patients, at all times, and disease- or syndrome-specific transmission-based precautions to prevent exposure to infectious agents.

Protect against vaccine-preventable diseases: Having a mandatory program that requires all HCWs to receive vaccines to protect themselves against vaccine-preventable diseases has been found to be more effective than a voluntary program in ensuring that all susceptible staff are vaccinated. In settings with limited resources, priority should be given to staff who are at high risk of exposure and those without any existing immunity. Select the vaccines that may provide the most protective effects, such as HBV or influenza.

Manage occupational exposures following the national guidelines (e.g., national guidelines for the management of occupational exposure to blood and body fluids) (Refer to Chapter 6, Sharps Injuries and Management of Exposure to Bloodborne Pathogens, in this volume for post-exposure management of HBV, HCV, and HIV, and to Appendix 13A for disease-specific guidance for the management of exposed HCWs.). Also refer to requirements for site level PEP service delivery in Appendix 13J.

Keep up to date by seeking additional information on specific diseases and local epidemiology.

Occupational Health Activities for Specific Groups of HCWs

Certain groups of workers at a healthcare facility may require special attention related to occupational health activities. They include pregnant staff, laboratory staff, emergency response staff, and HCWs infected with HIV, HBV, or HCV.

Pregnant HCWs

Pregnancy does not increase the risk of acquisition of infection for most occupationally-acquired infections, and clinical manifestations are no more severe in pregnant women than in others (APIC 2014b). However, pregnant HCWs may be anxious about potential infection and possible harm to their babies. The staff supporting occupational health activities should address any questions that pregnant HCWs may have about occupational exposures, how to avoid them, the management of exposures, and any implications for the baby. Full compliance with standard precautions, such as hand hygiene and appropriate PPE, and adherence to transmission-based precautions should be

adequate for pregnant HCWs in preventing most infectious diseases, and adherence to transmission-based precautions should be adequate for pregnant HCWs in preventing most infectious diseases (table 13.6).

However, as in the case of non-pregnant HCWs, non-immune pregnant HCWs should not care for patients with measles, rubella, and varicella (APIC 2014b). Table 13.7 provides information on occupational exposure to infection among pregnant HCWs, risks to their babies, and prevention strategies. The information provided in the table will guide the occupational health team members in making appropriate decisions. Table 13.7 also describes additional pertinent facts to assist with management of relevant occupational exposures in pregnant HCWs.

Table 13.6. Infectious agents of concern for pregnant HCWs according to the risk of transmission associated with providing healthcare services and available preventive measures

Healthcare-associated acquisition possible and prevented by vaccine	Healthcare-associated acquisition Is unlikely	HAIs for which standard and transmission-based precautions are the only preventive measures	HAIs for which PEP Is effective
Anthrax, HAV, HBV, influenza, Neisseria meningitis, pertussis, rubella, measles, varicella, tetanus, diphtheria	Herpes simplex virus, toxoplasmosis	Cytomegalovirus (CMV), VHF, HCV, parvovirus B19, TB	HIV, N. meningitis, syphilis

Source: Curless et al. 2018

In settings where adequate infection control precautions (including PPE) are available and immunizations for vaccine-preventable diseases are maintained, there are few instances in which pregnant HCWs cannot provide the same care as their non-pregnant colleagues; they should not routinely be restricted from duties on the basis of pregnancy status. However, pregnant HCWs should not care for patients with parvovirus B16 and certain vaccine-preventable diseases if they are non-immune. At times of PPE and vaccine shortage, assign pregnant HCWs to other tasks with no risk for exposure to infectious agents (APIC 2014b; CDC 2013).

Table 13.7. Management of occupational exposure to common infections for pregnant staff members

Agent	In-hospital source	Potential effect on the fetus	Rate of perinatal transmission	Maternal screening	Prevention
CMV	Urine, blood, semen, vaginal secretion, immunosuppressed transplant, dialysis, day care	Classic cytomegalic inclusion disease (5–10%)* Hearing loss (10–15%)	Primary infection (25–50%) Recurrent infants (52%) Symptomatic (< 5–15%)	Routine screening not recommended; antibody is incompletely protective	Efficacy of CMV immune globulin not established. No vaccine available Standard precautions
HAV	Feces (most common), blood (rare)	No fetal transmission described; transmission can occur at the time of delivery if the mother is still in the infectious phase and can cause hepatitis	None	Routine screening not recommended	Vaccine is a killed viral vaccine and can safely be used in pregnancy. Contact precautions during acute phase. The safety of HAV vaccination during pregnancy has not been determined; however, because the vaccine is produced from inactivated HAV, the theoretical risk to the developing fetus is expected to be low. The risk associated with vaccination, however, should be weighed against the risk for HAV in women who might be at high risk of exposure to HAV.
HBV	Blood, body fluids, vaginal secretions, semen	Hepatitis, early onset hepatocellular carcinoma	HBsAg + 10% HBeAg + 90%	Routine HbsAg testing advised	HBV vaccine during pregnancy Neonate: HBIG plus vaccine at birth Standard precautions

Agent	In-hospital source	Potential effect on the fetus	Rate of perinatal transmission	Maternal screening	Prevention
HCV	Blood, sexual	Hepatitis	5% (0–25%)	Routine screening not recommended	No vaccine or immunoglobulin available; post-exposure treatment with antiviral agents being investigated. Standard precautions
Herpes simplex virus	Vesicular fluid, oropharyngeal, and vaginal secretions	Sepsis, encephalitis, meningitis, mucocutaneous lesions, congenital malformation (rare)	Primary genital (33–50%) Recurrent genital (1–2%)	Antibody testing minimally useful, genital inspection for lesions if in labor	Chemoprophylaxis at 36 weeks decreases shedding Standard precautions
HIV	Blood, body fluids	No congenital syndrome; if fetus infected, AIDS in 2–4 years	Depends on HIV viral titer and use of ART If titer < 1,000 virus; rate 2% If titer ≥ 10,000; rate up to 25%	Routine maternal screening advised. If exposed, testing at 3, 6, and 12 months	Antiretroviral chemoprophylxis available for exposures, postnatal/breastfeeding chemoprophylaxis for HIV+ mothers and their infants. Standard precautions
Influenza	Sneezing and coughing, respiratory tract secretions	No congenital syndrome: influenza in mother could cause hypoxia in fetus	Rare	None	Non-live vaccine (such as trivalent inactivated) for all pregnant HCW during influenza season Droplet precautions
Measles (rubeola)	Respiratory secretion, coughing	Prematurity, spontaneous abortion, no congenital syndrome	Rare	Antibody test	Vaccine contraindicated during pregnancy. Vaccination recommended before conception. Airborne precautions

Agent	In-hospital source	Potential effect on the fetus	Rate of perinatal transmission	Maternal screening	Prevention
Neisseria meningitidis	Respiratory secretion of untreated patients or those patients who have received antimicrobials for < 24 hours	Sepsis No congenital syndrome	Unknown	None	Chemoprophylaxis with ceftriaxone or azithromycin. Vaccine if indicated for outbreak control. Droplet precautions, based on syndrome and for confirmed cases. Standard precautions, especially mask, face protection for all intubations.
Rubella	Respiratory secretions	Congenital syndrome	90% in first trimester 40–50% overall	Routine rubella IgG testing in pregnancy Preconception screening recommended	Vaccine contraindicated during pregnancy. Vaccine before conception. No congenital rubella syndrome described for vaccine. Droplet precautions; contact precautions for contact with congenital rubella patients.
Syphilis	Blood, lesion, fluid, amniotic fluid	Congenital syndrome	Variable 10%–90%, depends on stage of maternal disease and trimester of the infection	VDRL RPR FTA-ABS	PEP with penicillin Standard precautions, gloves until 24 hours of effective therapy completed for infants with congenital syphilis and all patients with skin and mucous membrane lesions.

Agent	In-hospital source	Potential effect on the fetus	Rate of perinatal transmission	Maternal screening	Prevention
Tuberculosis	Sputum, skin lesions	Neonatal TB; liver most frequently infected	Rare	TB skin test Interferon gamma-release assay blood test; if available. Chest radiograph	Post-exposure prevention recommendations vary with tuberculin skin test reaction size and chest radiograph result. Airborne precautions
Varicella-zoster	Droplet or airborne spread of vesicle fluid or secretions of the respiratory tract (scabs are not infective)	Malformations (skin, limb, central nervous system, eye); chicken pox	Total 25%: congenital syndrome (0–4%)	Antibody	Vaccine contraindicated during pregnancy. Vaccine before conception. Varicella-zoster immune globulin within 96 hours' exposure if susceptible. Airborne and contact precautions

*Congenital syndrome: varying combinations of jaundice, hepatosplenomegaly, microcephaly, thrombocytopenia, anemia, retinopathy, and skin and bone lesions.

FTA-ABS = fluorescent treponemal absorption test; HBsAg=hepatitis B surface antigen; HBeAg=hepatitis B e-antigen; HBIG=hepatitis B immune globulin; IgG=immunoglobulin G; RPR= apid plasma reagin test; VDRL=Venereal Disease Research Laboratory test

Adapted from : APIC 2014b

Laboratory Staff

HCWs in laboratories may be at increased risk of occupational exposure to the pathogens with which they work. Laboratory staff should receive specific training on the risks and how to avoid them (such as working under a biocontainment hood, using a closed centrifuge, avoiding mouth pipetting) and have access to PPE, as required, according to the procedures they perform and the pathogens with which they have contact. (Volume 2, Section 4, Chapter 3, Clinical Laboratory Services, provides details on preventing infection among laboratory staff.) In addition to the vaccines routinely recommended for all HCWs, further vaccinations may be appropriate for HCWs working in a clinical or research laboratory (CDC 1998). National recommendations should be consulted and followed, if available.

The following vaccines may be relevant for staff working with specific pathogens:

- BCG (Mycobacterium tuberculosis)
- HAV, Meningococcal (N. meningitidis)
- Polio, rabies
- Typhoid

(CDC 1998)

Emergency Response Staff

HCWs who respond to emergencies and transport patients should not be overlooked during occupational health activities. These HCWs are at a high risk of exposure to bloodborne pathogens and should have access to HBV vaccination, have adequate PPE and thorough instruction on proper PPE use, and be taught to apply standard precautions for all patients at all times. Moreover, they may transport patients before the infection status of a patient is known (e.g., meningococcal meningitis, influenza, novel respiratory viruses, VHF) and, therefore, should be aware of how to apply isolation precautions based on disease syndromes, be informed about patients who later develop infections of occupational health concern, and be included in exposure follow-up and relevant PEP and work restrictions.

HCWs Exposed to HIV and/or HBV or HCV

HIV, HBV, and HCV are the primary infectious agents that can be transmitted via exposure to body fluids. In addition to percutaneous injury, contact of mucous membranes or non-intact skin with blood, fluids containing blood, tissue, or other potentially infectious body fluids pose an infectious risk. Potentially infectious body fluids include semen, vaginal secretions, cerebrospinal fluid, synovial fluid, pleural fluid, peritoneal fluid, pericardial fluid, amniotic fluid, pus, etc. In this case, body fluids, such as feces, nasal secretions, saliva, sputum, sweat, tears, urine, and vomit, are not considered infectious unless they contain blood.

PEP is a preventive medical treatment that a person may take following exposure to potentially infectious bloodborne pathogens, such as HIV or HBV, to prevent becoming infected from the

exposure. PEP can also be taken following exposure to non-bloodborne pathogens, such as invasive Group A streptococcal infections, invasive meningococcal infections, and pertussis.

Occupational exposure is exposure of individuals to HIV and other bloodborne pathogens occurring in the course of their work. This exposure should not be assumed to be directed solely to HCWs but also to other workers, such as emergency rescue staff, waste-disposal workers, law enforcement personnel, and firefighters because these staff are also likely to be exposed to health risks from pathogens in blood and other potentially infectious body fluids while doing their work.

Occupational exposure to blood and body fluids is the exposure of an HCW to blood or other potentially infectious materials during the performance of an employee's duties. Exposure to bloodborne pathogens involves the skin, eyes, mucous membranes, or parenteral contact (e.g., a needle stick).

Non-occupational exposure is an exposure to HIV and other bloodborne pathogens outside the work setting. This term predominantly refers to potential exposure through sexual assault. Other forms of potential non-occupational exposure include those arising from needle sharing among injecting drug users, consensual sex, needle sticks in the community, fights or playground incidents resulting in bleeding by an HIV-infected child, and mass causalities, such as road traffic accidents, etc.

PEP for HIV

Occupational Exposure to HIV

Each day, thousands of people around the world experience accidental exposure to blood and other body fluids or tissues while performing their work duties. It could therefore be said that HCWs are especially vulnerable for infections. The risk of acquiring HIV after a mucous membrane exposure to blood is approximately 0.09%, whereas acquisition through a percutaneous exposure is approximately 0.3% (Cardo et al. 1997). The risk of acquiring HIV percutaneous is associated with deeper injuries, visibly bloody devices, and more advanced disease (likely due to a higher viral load) in the source patient. Hollow bore needle exposures have higher risk of transmission than that of solid bore needle exposures.

The use of PEP against HIV infection dates back to the early 1990s when both direct and indirect evidence suggested that treatment with antiretrovirals (ARVs) soon after exposure to HIV decreases the risk of transmission (WHO, 2014a).

A retrospective case-control study demonstrated that PEP with zidovudine (AZT) for four weeks was associated with an 81% reduction in the transmission of HIV in humans. In that study, approximately 70% of patients received AZT within four hours of the exposure (Cardo 1997). It is not known how long after an exposure PEP would be ineffective. However, the data from the animal studies mentioned above suggest that PEP is effective when initiated within 72 hours of exposure. Taking the evidence mentioned above into consideration, most international guidelines recommend PEP drugs be started for exposed persons (based on the indication) as early as possible, preferably within two hours of exposure; however, giving PEP drugs after 72 hours of exposure is not generally advisable. Measures that should be taken on initial management of exposure exposed persons are put in **Appendix 13A.**

The PEP drug recommendations for percutaneous injury and mucous membrane or non-intact skin exposure are found in tables 13.8 and 13.9.

Table 13.8. Recommended HIV PEP for percutaneous injuries

Status code (SC)	Exposure code (EC)	
	EC 2	EC 3
SC 1	Recommend basic 2-drug PEP	Recommend expanded 3-drug PEP
SC 2	Recommend expanded 3-drug PEP	Recommend expanded 3-drug PEP
SC unknown	Generally, no PEP is warranted; however, consider basic 2-drug PEP for source with HIV risk factors.	Generally, no PEP is warranted; however, consider basic 2-drug PEP for source with HIV risk factors
HIV-negative	No PEP warranted	No PEP warranted

Table 13.9. Recommended HIV PEP for mucous membrane exposures and non-intact skin exposures

Status code (SC)	Exposure code (EC)	
	EC 2	EC 3
SC 1	Consider basic 2-drug PEP	Recommend basic 2-drug PEP
SC 2	Recommend basic 2-drug PEP	Recommend expanded 3-drug PEP
SC unknown	Generally, no PEP warranted; if PEP is offered and administered and the source is later determined to be HIV-negative, PEP should be discontinued	Generally, no PEP warranted; however, consider basic 2-drug PEP for source with HIV risk factors
HIV-negative	No PEP warranted	No PEP warranted

Adapted from: CDC 2005a

Adherence

Compliance rates of 95% or greater are required to actually maximize the benefits of ART. Although parallel data are not available for PEP, the magnitude of the positive effects of high levels of adherence to prescribed practices is generally assumed to be similar.

Non-Occupational Exposure to HIV

The risk of HIV transmission per-contact from sexual exposure varies according to the nature of the exposure. The estimated risk is 1% to 30% with receptive anal intercourse; 0.1% to 10.0% with insertive anal intercourse and receptive vaginal intercourse; and 0.1% to 1.0% with insertive vaginal intercourse (Boily et al. 2009). Compared with other forms of intercourse, oral intercourse is considered to pose a lower risk of HIV transmission, although good risk estimates are lacking and there are case reports of HIV infections in people in whom the only reported risk factor was oral intercourse (Lifson et al. 1990).

Evaluation of Persons Seeking Care after Potential Non-Occupational Exposure to HIV

When deciding whether to recommend the initiation of PEP, the clinician should assess and carefully weigh the factors shown in box 13.1.

Box 13.1: Elements of assessment to determine whether PEP is indicated

Risk Behavior*:

Did exposure to potentially HIV-infected blood or body fluid occur?

If yes, was the exposure an isolated or episodic event, or the result of habitual behavior?

Degree of Transmission Risk Based on Type of Exposure:

What was the route of exposure?

Are factors present that are known to further increase transmission risk?

Exposure Source:

Is the source known to be HIV infected? **

If HIV status of the source is unknown, what is the likelihood of the source being HIV infected?

* Assessment of the behavioral factors and circumstances that led to HIV exposure includes emotional, psychological, and social factors that contribute to risk behavior, such as depression, history of sexual abuse, and drug and alcohol use.

**If the source is known to be HIV infected, information about his/her CD4 count, viral load, ARV medication history, and history of ARV drug resistance should be obtained, when possible, to assist in the selection of a PEP regimen.

Table 13.10. Considerations of non-occupational PEP according to the type of risk exposure

Types of exposures that do not warrant PEP	Types of exposures that should prompt considerations of PEP
• Human bites not involved with blood • Exposure to sharps and needles not in contact with an HIV infected or at risk person • Mutual masturbation without skin break. Oral-anal contact • Receptive penile–oral contact without ejaculation • Insertive penile-oral contact • Oral-vaginal contact without blood exposure	• Unprotected receptive and insertive vaginal or anal intercourse with a source that is HIV infected or at risk for HIV infection • Unprotected receptive penile-oral contact with ejaculation with a source that is HIV infected or at risk of HIV infection • Oral-vaginal contact with blood exposure • Needle sharing with a source known to be HIV infected or at risk for HIV infection • Injuries with exposure to blood from a source known to be HIV infected or at risk for HIV infection (including needle sticks, human bites, and accidents)
This risk estimate considers many factors, including source viral load, presence of sexually transmitted infections, and presence of ejaculates. It is prudent to recommend PEP for receptive oral sex with ejaculation, although discussion about the conflicting data should occur.	

Source: CDC 2018

Exposure to Hepatitis B Virus

HBV infection is a well-recognized occupational risk for HCP (CDC 2018). The risk of HBV infection is primarily related to the degree of contact with blood in the workplace and also to *hepatitis B e antigen* (HBeAg) status of the source person. In studies of health care providers (HCPs)

who sustained injuries from needles contaminated with blood containing HBV, the risk of developing clinical hepatitis, if the blood was both hepatitis B surface antigen (HBsAg) and HBeAg-positive was 22% to 31%; the risk of developing serologic evidence of HBV infection was 37% to 62%. By comparison, the risk of developing clinical hepatitis from a needle contaminated with HBsAg-positive, HBeAg-negative blood was 1% to 6%, whereas the risk of developing serologic evidence of HBV infection was 23% to 37% (Werner et al. 2013).

Table 13.11. Recommended PEP for exposure to HBV

Vaccination and antibody response status of exposed workers*	Treatment		
	Source HBsAg positive	Source HBsAg negative	Source unknown not available for testing
Unvaccinated	HBIG§ x 1 and initiate HB vaccine series	Initiate HB vaccine series	Initiate HB vaccine series
Previously vaccinated			
Known responder**	No treatment	No treatment	No treatment
Non responder†	HBIG x 1 and initiate revaccination source, or HBIG x 2 §§	No treatment	If known high risk, treat as if source were HBsAg positive
Antibody response unknown	Test exposed person for HBsab 1. If adequate**, no treatment is necessary 2. If inadequate, administer HBIG x 1 vaccine booster	No treatment	Test exposed person for HBsab 1. If adequate**, no treatment is necessary 2. If inadequate†, administer vaccine and booster and recheck titer in 1 to 2 months

* Persons who have previously been infected with HBV are immune to reinfection and do not require PEP.

† Hepatitis B surface antigen.

§ Hepatitis B immune globulin; dose is 0.06 ml”kg intramuscularly.

¶ Antibody to HBsAg.

**A responder is a person with adequate levels of serum antibody to HBsAg (i.e., anti-HBs >10 mlU/ml).

†† A non-responder is a person with inadequate response to vaccination (i.e., serum anti-HBs < lO mlU/ml).

§§ The option of giving one dose of HBIG and reinitiating the vaccine series are preferred for non-responders who have not completed a second 3-dose vaccine series. For persons who previously completed a second vaccine series but failed to respond, two doses of HBIG are preferred.

Source: CDC 2001

It is recommended that HCWs should be vaccinated for HBV.

Exposure to Hepatitis C Virus

The risk of HCV transmission from a percutaneous exposure is approximately 1.8% (Lanphear et al. 1994). HCV is rarely transmitted from mucous membrane exposure to blood and it has never been documented as occurring as a consequence of a blood exposure to intact or non-intact skin. Therefore, there is no known PEP to HCV exposure. Nevertheless, a 2001 *New England Journal of Medicine* study found that treatment of patients with acute HCV with interferon alpha-2b led to resolution of HCV viremia in 98% of patients (Jaeckel et al. 2001).

The CDC recommends follow-up testing for an exposure to HCV with anti-HCV antibody testing within four to six months. A positive antibody test should prompt HCV viral load and liver function tests. Once exposure is confirmed, the management and follow-up of non-occupational HCV exposure is similar to that of the occupational exposure.

Post-Exposure Management Steps (HBV, HCV, and HIV)

The aim of post-exposure reporting and follow-up is to start PEP as soon as possible, within 72 hours of exposure, if indicated. The key components of managing occupational exposure to bloodborne pathogens are described below.

STEP 1 Time frame – immediately, within 30 minutes. Person responsible: Exposed HCW.

Provide immediate care to the exposure site:

- Wash the exposed skin and any wound with soap and water.
- Mucous membranes with water for 15 minutes.
- DO NOT use any antiseptic or caustic agents, such as bleach.

After washing, immediately report the event to the person in charge of PEP management. The information reported should include identification of the exposed person, date and time of exposure, type of fluid and nature of exposure, and details about the source person as recommended by national PEP guidelines.

STEP 2 Time frame – immediately after reporting. Person responsible: Physician, in-Charge of PEP management determines the risk associated with exposure (-) by:

- Type of fluid (e.g., blood, visibly bloody fluid, other potentially infectious fluid or tissue)
- Type of exposure (e.g., sharps injury, mucous membrane or non-intact skin exposure, bites resulting in direct contact with infected blood) (CDC 2001).
- Infectious status of source (presence of HB_SAg, HCV antibody, or HIV antibody)
- Susceptibility of exposed person (hepatitis B vaccine and vaccine response status, HBV, HCV immune status)

Table 13.12. HIV exposure risk and type of exposure

Risk	Type of Exposure
Low-risk exposure	• Exposure to a small volume of blood or blood-contaminated fluids from asymptomatic HIV-positive patients • Following an injury with a solid needle • Any superficial injury or mucocutaneous exposure
High-risk exposure	• Exposure to a large volume of blood or potentially infectious fluids or blood-contaminated fluid • Exposure to blood or body fluid from a patient with clinical AIDS or early seroconversion phase of HIV • Injury with a hollow needle and/or deep and extensive injuries

Source: Curless 2018

STEP 3 Time frames – as soon as possible, preferably within 24 hours. Person responsible: Physician, in-Charge of PEP management, HCW.

Evaluate the exposed HCW:

- Check history of hepatitis B vaccination (currently there is no vaccine for hepatitis C or HIV).
- Determine immune and infection status of the exposed HCW.

For HBV, if not conducted previously, measure total HBV core antibodies (anti-HBc) and HBV surface antibodies (anti-HBs)

For HCV, test for HCV antibodies (anti-HCV—a positive test means current or past infection) and ALT (alanine aminotransferase).

If test is positive, test for viremia to confirm current infections.

For HIV, check status and history of previous HIV testing:

- Provide HIV pretest counseling.
- Offer HIV testing if the exposed HCW provides informed consent.
- Offer HIV post-test counseling per the national counseling and testing guidelines.
- Refer to HIV care and treatment for those who test positive.

STEP 4 Time frame – as soon as possible, preferably within 24 hours, simultaneously with Step 3 above. Person responsible: In-Charge of PEP management, patient's treating physician.

Evaluate the exposure source:

- Obtain detailed information on clinical status of the source person.
- Determine vaccination and immune status of the source person:
  - Test known source person for HBsAg.
  - Test known source person for anti-HCV antibodies.

- Check known source person for HIV status and history of previous HIV testing.
- Conduct clinical assessment of known source person for HIV/AIDS.
- Provide HIV pretest counseling.
- Conduct HIV testing if the source person provides informed consent.
- Offer HIV post-test counseling per the national counseling and testing guidelines.
- Refer to HIV care and treatment for those who test positive.

Determinants of PEP for occupational exposure to HBV are described in table 13.13.

Table 13.13. Determinants of PEP for occupational exposure to HBV

Vaccination and antibody response status of exposed HCW	Treatment		
	Source HBsAg[a] positive	Source HBsAg negative	Source unknown or not available for testing
Previously vaccinated	No treatment	No treatment	No treatment
Unvaccinated	HBIG[b] single dose and full HB vaccination	Full HB vaccination	Full HB vaccination
Known responder[s]	No treatment	No treatment	No treatment
Known non-responder[d]	HBIG single dose and revaccination or second dose of HBIG	No treatment	If known high-risk source, manage as if source were HBsAg positive
Antibody response unknown	Test exposed person for anti-HBs[e]: If adequate level, no treatment is necessary; if inadequate level, HBIG single dose and HB vaccine booster	No treatment	Test exposed person for anti-HBs: If adequate, no treatment is necessary; if inadequate, vaccine booster and check titer in 1–2 months

[a] HBsAg: hepatitis B surface antigen

[b] HBIG: hepatitis B immunoglobulin

[c] Known responder: a person who has an adequate level of serum antibody (anti-HBs ≥ 10 mIU/mL)

[d] Known non-responder: a person with inadequate response to vaccination (anti-HBs < 10 mIU/mL)

[e] Anti-HBs: hepatitis B surface antibody

Source: CDC 2001

STEP 5 Time frame – as soon as test results return (if any), must be within 72 hours from exposure. Person responsible: Physician, In-Charge of PEP management, HCW.

Establish eligibility for PEP:

Refer to table 13.13 to determine the PEP required for HBV exposure.

Parenteral or mucous membrane exposure (e.g., sexual exposure, splashes to the eye, nose, or oral cavity).

Exposure to blood, blood-stained saliva, breast milk, genital secretions, or cerebrospinal, amniotic, peritoneal, synovial, pericardial, or pleural fluids.

PEP is not indicated if:

- The exposed HCW is known to be HIV-positive.
- The source person is HIV-negative.
- Exposure is limited to intact skin.

Testing the source person and the exposed HCW is helpful but it is not mandatory to have either test results to initiate HIV PEP. The decision is sometimes based on an individual's level of concern and the background HIV prevalence.

STEP 6 Prescribe PEP: Time frame: initiate PEP as early as possible but within 72 hours.

- Continue ARVs for HIV for 28 days.
- Continue HBV vaccine schedule over six months.
- Provide adherence counseling and address any drug interactions.
- Follow national guidelines or WHO recommendations for PEP

STEP 7 Time frame - 72 hours – 6 months after exposure. Person responsible: Physician, In Charge of PEP Management, HCW.

Follow-up:

- Provide follow-up for adherence and any side effects of ARVs and address questions that the individual may have.
- Arrange for an HIV test at three months after the exposure.
- Arrange for HBV vaccine at 1 and 6 months, if indicated.
- Link HIV care and treatment, including prevention measure for protecting others, in case the HIV test results are positive.
- Provide additional counseling and other preventive interventions, as needed, and if test results are negative.

Document all PEP provided, following facility and national guidelines.

Monitor PEP provision in the facility.

Exposed HCWs who have already started PEP but did not come to the ART clinic on the follow-up appointment date can be traced by giving a telephone call (or physically for those in the same health facility, if possible) to remind them to come to the follow-up visit. The service given at each follow-up visit should be documented on potential exposure, and PEP follow-up forms (Appendix 13E to 13G) which should be attached to the chart of every patient who reports exposure.

To facilitate counseling and informed decision making for HIV PEP, the list of information items to be given for clients on PEP service is summarized in Appendix 13C. Patients given PEP drugs should be counseled on the side effects of ARVs. The steps in the clinical management of HIV PEP are summarized in Appendix 13B.

Considerations for Pregnant Women and Women of Childbearing Potential

Because of its potential teratogenicity, efavirenz (EFV) should not be used in any non-occupational PEP (nPEP) regimen during pregnancy or among women of childbearing age at risk of becoming pregnant during the course of antiretroviral prophylaxis. A protease inhibitor or nucleoside reverse transcriptase inhibitor-based regimen should be considered in these circumstances.

Children

Potential HIV exposure in children occurs most often by accident (e.g., needle sticks, in the community, fights, or playground incidents resulting in bleeding by an HIV-infected child) or by sexual abuse or assaults (Nourse et al. 1999). Young children who cannot swallow capsules or tablets need to be given other alternative preparations appropriate for pediatric dosing (Appendix 13D). Adherence to the prescribed medications will depend on the involvement of parents or guardians, and support provided to them.

Documentation of PEP Service Given

Each person with occupational HIV exposure should report the incidence to his immediate supervisor. Initial PEP management should be given in the case team, and the exposed person should be referred to the ART clinic for further follow-up. Documentation of exposure and management given should be done by using the potential HIV exposure documentation and follow-up form (Appendix 13E to 13H), which would be attached with the patient chart. The person who gives PEP service should be trained on PEP service delivery (or a training with a PEP management component) for he/she is responsible for completing the potential HIV exposure documentation and follow-up form (Appendix 13E to 13G), attach it with the patient chart, use the PEP decision-making tools (job aid) to determine indications for PEP, and decide on the use of two or three drug regimens (Appendix 13M).

If PEP is not indicated, the PEP trained service provider (preferably the case team leader) will file the completed potential HIV exposure documentation and follow-up form (Appendix 13E to 13G) with the patient chart and indicate to the exposed person that no further follow-up is needed. The incident and the service given should also be documented in the service register in the service outlet.

In the ART clinic, the persons getting PEP service will have a minimum of six follow-up visits, and each time the patient comes for a visit, the HIV exposure documentation and follow-up form that is attached with the patient's chart and the PEP register (Appendix 13E to 13G) placed in the ART clinic are updated. Documentation and reporting of PEP service given for non-occupational exposure will be similar to that of occupational exposure.

HCWs Infected with HIV and/or HBV or HCV

HCWs infected with HIV and/or HBV or HCV should inform the facility manager of their status. The facility IPC team should strive to prevent transmission of infections to patients and, at the same time, maintain the livelihood and privacy of the infected staff members. These HCWs should not be prohibited from providing patient care if they are not performing invasive procedures, the infection is well-controlled, they fully comply with recommended IPC practices, and there are no other factors that would prevent them from safely carrying out patient care activities.

HCWs with these conditions should be closely followed up by a team of clinicians for periodic clinical monitoring, to assess treatment response and viral suppression, when appropriate, and to revise recommendations about duty restrictions accordingly. They should avoid performing procedures that may result in increased risk of contact with large amounts of blood and body fluids. There are no restrictions for those staff with viral loads less than designated levels (Henderson, Dembry, Fishman, et al. 2010).

The Society of Healthcare Epidemiology of America (SHEA) has classified patient care and clinical procedures into three different categories based on the risk of transmission of bloodborne pathogens.

Category I: Procedures with minimum risk of bloodborne virus transmission

Clinical procedures and patient care activities that either do not involve touching patients (e.g., history taking, counseling) or are limited to touching patients' intact skin (e.g., performing physical examinations) and mucous membranes (e.g., performing vaginal examinations, performing some dental procedures, phlebotomy). It also includes minor surgical procedures with very minimal exposure to patients' blood and body fluids (e.g., surface stitches, gastrointestinal endoscopy procedures).

Category II: Procedures for which bloodborne virus transmission is theoretically possible but unlikely

Several surgical procedures are examples of such procedures, including ophthalmic surgery, dental surgery that requires local anesthesia, minor oral surgical procedures, endoscopic and arthroscopic procedures, provision of contraceptive methods, minor gynecological procedures, starting of central lines, and medical male circumcisions.

Category III: Procedures for which there is definite risk of bloodborne transmission

Procedures for which there is definite risk of bloodborne transmission of viruses or that have previously been classified as "exposure-prone." All major surgical procedures that involve a high volume of blood and body fluids are Category III procedures with definite risk of exposure. Examples of Category III procedures are: general surgery; oral surgery with difficult access for suturing; emergency surgical procedures involving bleeding and exposure to a high volume of blood; obstetric procedures, including cesarean section; and orthopedic surgeries. Any major surgical procedure that goes beyond three hours and requires changing gloves should not include staff members infected with bloodborne pathogens.

Managing HCWs Infected with HIV and/or HBV or HCV

HCWs infected with bloodborne pathogens whose viral load is below the minimum designated level should follow a six-point plan described below to safely provide patient care and be productive.

The HCWs should:

- Not have transmitted infection to any patient.
- Obtain advice from a team of clinicians about continuing to care for patients.
- Undergo testing twice a year to demonstrate the maintenance of a viral burden below designated levels.
- Receive follow-up by a clinician with expertise in managing bloodborne pathogen infections and consent to share their results with the IPC/occupational health team at the facility.

Consult closely with experts on the use of optimal IPC procedures:

A. This may include guidance on double gloving, changing gloves during procedures, avoiding digital palpation of needle tips, and performing all procedures under direct view. It also includes promptly withdrawing from a procedure if they have any injury that bleeds and informing the IPC/occupational health team about any injuries.

B. Adhere strictly to recommended procedures, including the routine use of double gloving for Category II (such as minor surgery) and Category III (such as major surgery) procedures and frequent glove changes during procedures, particularly if performing technical tasks that have a potential to compromise glove integrity.

Agree in writing to comply with recommendations and guidance of the expert clinicians and the facility IPC/occupational health and management team.

Adapted from: Henderson, Dembry, Fishman, et al. 2010

Monitoring Prevention of Occupational Exposures and Injuries

Healthcare facilities should evaluate the effectiveness of occupational health interventions and practices on a routine basis. They should conduct surveillance to collect, analyze, and disseminate data on risks to HCWs. There should be a system to report any occupational exposure and injury, which should be supported by prompt management and PEP. The rates of injuries or exposures among HCWs should be routinely reviewed and reported back to the staff, and strategies and action plans to prevent future injuries should be developed and updated.

Surveillance activities can be conducted by staff organizing occupational health activities at the facility and/or with the assistance of IPC staff.

SUMMARY

In the course of their duties, millions of HCWs around the world are routinely exposed to a variety of health and safety hazards, including infectious agents. Infections can be transmitted to HCWs,

who can in turn transmit the infections to patients and others. The goals of IPC intersect with those of occupational health activities in preventing and addressing infectious hazards at healthcare facilities. Therefore, IPC staff should be involved in occupational health activities at the facility, and occupational health staff should be knowledgeable about IPC.

IPC elements of an occupational health program include surveillance, education, immunization, and exposure prevention and response. Protection of staff by the application of standard precautions to every patient, every time, and the use of disease- or syndrome-specific transmission-based precautions to prevent exposures to infectious agents, are essential to prevent occupational exposures. Recommendations for managing specific occupational exposures and infections in staff members are based on the epidemiology of infectious disease transmission in healthcare facilities, and they should target HCWs as potential sources or hosts. Special attention may be needed for specific groups of employees with potential increased risk of exposure (laboratory, pregnant, and emergency response personnel, and HCWs infected with HBV, HCV, and HIV). Last, the effectiveness of interventions to protect HCWs from occupational infection should be evaluated. Monitoring progress and identifying causes, with feedback to key persons, can enhance prevention activities.

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CHAPTER 14: CLIENT EDUCATION ON INFECTION PREVENTION AND CONTROL

Key Topics

- Significance of client education on IPC
- Components of effective client education program
- Good examples of a patient education program
- Steps in client's education on IPC
- Models of client education

BACKGROUND

Educating and empowering patients and clients to actively participate in their care help reduce a patient's risk of HAIs. However, creating an open dialogue can be a challenge in today's healthcare system. So how can hospitals improve their patient education programs and help patients become empowered and active in their treatment?

Four components have been reported as being fundamental to the process of patient/client empowerment:

1. Patient understands his/her own role
2. Patient's acquisition of sufficient knowledge of their ability to collaborate or be involved with their healthcare provider
3. Patient's knowledge and skills
4. The presence of facilitating environment

Based on these four components, empowerment can be defined as a process in which patients understand their role, and are given knowledge and skills by their healthcare providers to perform tasks cognizant of the community's sociocultural differences and which encourages patient participation.

First, hospitals need to understand what accreditation standards are required of hospitals. The Joint Commission established certain standards to protect patients' rights and assist hospitals in patient education. These standards, while broad, provide the framework for healthcare providers to establish patient education practices.

One of the Ethiopian Standard Agency hospital standards requires the hospital to provide patient education and training based on the patient's needs. This includes conducting a learning needs assessment and then administering training to the patient based on the assessment. The standard provides examples of what hospitals should train patients on, including basic health practices and safety.

The information given to the patient should be appropriate for the patient's age, literacy level, education, and language skills. Patient materials should be geared between sixth and eighth grade reading levels. Use of medical terminology or jargon should be avoided.

With shorter lengths of stay and limited time for teaching, print and audiovisual materials are important adjuncts for any discharge teaching plan. However, they are just adjuncts and should not replace individualized instruction. Printed materials are useful for reinforcing information provided to patients while in the hospital and also serve as a ready resource. Printed material is an important reminder of key points after patients return home.

Family members are the vital links in the transition from hospital to home care. Families must be included in discussions and demonstrations. Family is any person who plays an important role in the patient's life.

Every effort must be made to ensure that learning takes place in incremental steps and that patients are not overwhelmed with too much information at one time.

Significance of Client Education on IPC

Although there are many unanswered questions on how to approach patient involvement in this part of the guidelines, WHO and World Alliance for Patient Safety are actively highlighting the role that patients and their families could play in the improvement of healthcare. Actionable strategies are being developed with a strong emphasis on working in partnership with healthcare authorities, partners, and professionals.

They are the basis of infection control precautions that are to be used as a minimal expectation in the care of all patients. For example, hand hygiene is a major component of standard precautions and one of the most effective methods to prevent transmission of pathogens associated with healthcare. In addition to that, the use of PPE should be guided by risk assessment and the extent of contact anticipated with blood and body fluids, or pathogens. Supplementary to the practices carried out by health workers when providing care, all individuals (including patients and visitors) should comply with infection control practices in healthcare settings. The control of the spread of pathogens from the source is the key to avoid transmission. Among source control measures, those like respiratory hygiene/cough etiquette that developed during the SARS outbreak have now been considered part of standard precautions.

Worldwide escalation of the use of standard precautions would reduce unnecessary risks associated with healthcare. The promotion of an institutional safety climate helps improve conformity with recommended measures. Therefore, subsequent risk reduction, provision of adequate staff and supplies, together with leadership and education of health workers, patients, and visitors are critical for an enhanced safety climate in healthcare settings.

HAIs are a major issue in PS. Hand hygiene is one of the primary measures to prevent HAI and limit the spread of antimicrobial resistance. However, for hand hygiene to be promoted and practiced, patient participation is quite an important element of the strategy. Studies undertaken on the effects of patient education confirmed that health education is a dependable instrument to increase staff adherence with handwashing. Given that support from HCWs is crucial for success, the first and most important step is to enlist their full and enthusiastic support. A major educational campaign using expressive patients, when possible, may be needed to convince physicians and nurses of the value of patient participation.

The objective is to help HCWs recognize the contribution of patients and their families to the healing process and to be receptive to patient input. This campaign must be designed to take into account the numerous healthcare provider-related obstacles to patient participation (e.g., perception of a lack of time and their level of training in the patient-caregiver relationship). Once HCWs are "on board," educational programs for patients must be offered so that they have the knowledge required to participate.

The strategy also emphasizes that when educating patients, the healthcare provider needs to understand the legitimacy and relevance of patient involvement and be convinced of the effectiveness of involving patients. When involving patients, numerous patient-related factors known to influence patient participation must be addressed and overcome. Although they are not modifiable, socio-demographic factors (e.g., age, disease severity, and ethnicity) must also be taken into account. When both the HCW`s and the patient's support are secured, positive feedback will emerge from the patients and contribute to the safety of healthcare.

Components of Effective Client Education Program

1. Have clear policies and procedures in place that guide proper implementation of patient education and empowerment.
2. Have a clear assignment of roles and responsibilities for all steps in the patient education process to qualified individuals in a context of shared responsibility and accountability. The list is inclusive of the patient's primary care provider, other physicians, nurses, pharmacists, and other clinicians. The qualifications of the responsible individuals should be determined by the healthcare organization within the limits of applicable law and regulation.
3. Incorporate training on procedures and basic principles for patient education in the educational curricula, orientation, and continuing professional development activities for healthcare professionals.
4. Develop and have an evaluation component that includes using both qualitative and quantitative measures to determine not only what works, but under what conditions and within which organizational contexts the program works.
5. Background of evidence on effective patient/client education program.

A program in which there is some evidence of patient and HCW empowerment is usually part of the multifaceted approach. It includes one or all of the following: educational tools, motivation tools, and role modeling.

For example, education on hand hygiene on admission to the hospital could be designed in such a way that it encompasses the above four components. With respect to hand hygiene, an educational program for patient/staff empowerment and improvement can be categorized as: educational (can include Internet), motivational (reminders/posters), and role modeling in the context of a multimodal approach.

Good Examples of a Patient Education Program

Example 1

In addressing IP through hand hygiene, it is very important that the administration ensure that it has clear policies and procedures in place that require:

- Provision of education on hand hygiene on admission of the patient to the hospital.
- Display of reminders of hand hygiene in a consistent and conspicuous location (for example, the patient's sink) so that it is easily accessible to patients and their family caregivers.
- Information on hand hygiene for patients can be designed in the form of **printed matter**, **an oral demonstration, or audiovisual means.** Hand hygiene and other educational reminders should be displayed in a consistent and highly noticeable location.

Example 2

The steps of patient participation orientation in the hospital following surgery are:

- Wash your hands carefully after handling any type of soiled material. This is especially important after you have gone to the bathroom.
- Because you are part of your healthcare team, do not be afraid to remind doctors and nurses about washing their hands before working with you.
- If you have an intravenous catheter, keep the skin around the dressing clean and dry. Tell your nurse promptly if the dressing become loose or gets wet.
- Likewise, if you have a dressing on the wound, let your nurse know promptly if it became loose or gets wet.
- If you have any type of catheter or drainage tube, let your nurse know promptly if it becomes loose or dislodged.
- Carefully follow your doctor's instructions regarding breathing treatments and getting out of bed. Don't be afraid to ask for help, advice, or sufficient pain medications!
- If possible, ask your friends and relatives not to visit you if they themselves feel ill.

Six key points that allow patients to be more actively involved in their own care

1. Share vital information with all caregivers, including all medicines, allergies, and ailments.
2. Ask questions about health problems and care.
3. Ask for help from family and friends.
4. Express your concerns.
5. Alert caregivers if your symptoms change.
6. Pay close attention to instructions.

Recommended techniques for patient educators (HCWs/community workers)

1. **Slow down:** Communication can be improved by speaking slowly and by spending just a small amount of additional time with each patient. This will help foster a patient-centered approach to the clinician-patient interaction.
2. **Use plain, non-medical language to explain things to patients** as you would explain them to your grandmother.
3. **Show or draw pictures** because visual images can improve the patient's recall of ideas.
4. **Limit the amount of information provided and repeat it**. Information is best remembered when it is given in small pieces that are pertinent to the tasks at hand. Repetition further enhances recall.
5. **Use of the "teach-back" technique** reconfirms that the patients really understood learning items taught before by asking them to repeat back your instructions.
6. **Create a shame-free environment** to make patients feel comfortable asking questions. Include other supporters of patients (patient's family or friends) to promote understanding. Despite the fact that a great deal of attention focuses on written materials suitable for low literacy audiences, non-written materials can also be effective patient education tools. The non-written materials include graphic illustrations, such as pictures, pictographs, and models, along with audiotapes, videotapes, and various forms of computer-assisted learning applications. Studies in the area tend to be supportive of the use of this alternative, stress the effectiveness of these non-written modalities, and their supremacy over written materials for patients with limited literacy.

Steps in Clients Education

1. Make the patient comfortable

The general standard on patient education also requires that the hospital provide the patient with education on how to communicate concerns about PS issues. Patients may feel cautious or apprehensive about asking questions because they do not want to be considered a tough patient, but encouraging them to speak up can go a long way in preventing infections.

Healthcare providers can help ease some of the apprehension by routinely asking patients if they have any questions or concerns they want to discuss. By asking them first, you open a whole new line of communication, making the patient more willing to come forward if he or she notices a change.

It is difficult for the patient to have the courage to speak up unless they are invited to speak up by the system. When patients do speak up, thank them for raising a concern even if it leads to nothing. Once again this will help them feel more at ease and comfortable bringing up issues in the future.

Encourage patients to also advocate for either a family member or someone else to help look out for potential risks. These advocates can also look out for variations in practice, and may notice changes in the patient before healthcare providers see a difference.

Very often the patient is not only reluctant to speak up but they are not feeling well, or they may have trouble communicating for a variety of reasons; therefore, a third party is vital.

2. Help the patient become an active participant

Talk to the patient about what he or she can do to optimize care, instead of focusing solely on what the healthcare provider is going to do for the patient. Patients want to be involved in their care. They want to be an active participant. And family members want to be involved in any way they can.

Encourage the patient to ask questions about his or her treatment. Urinary tract infections and central line infections are common in hospitals and can be costly to the patient. When it comes to certain things like catheters, assure patients that they can ask doctors and nurses, for example: “Is it essential for my care?” Educating the patient on these practices may reduce the risk of infection by eliminating a potential threat.

3. Let patients know what their care should look like

A lot of bad things in healthcare happen because of the variation in practice. If we can encourage patients to know what to expect, then they can identify a variation in practice that is exposing them to a potential risk.

Educate the patient on what dressings or catheters need to be changed on a daily basis and what the process looks like. Showing the patient what to expect and what techniques help prevent infections empowers him or her to look out for potential risks when shifts change and someone else begins changing his or her dressings.

4. Don't forget about high-risk patients

Hospitals need to improve their patient education and infection control training with high risk patients.

There are a number of patients out there who have diabetes. Significant changes in their blood sugar can increase their chances of infection, whether they are in the hospital or not.

For patients at a higher risk of infection, such as those who are diabetic, taking immune suppressive drugs, overweight, or smokers, healthcare providers need to discuss how these issues heighten their risk for infection. Patients in the ICU are also considered high risk. Healthcare providers should encourage ICU patients to get up and out of bed.

5. Understand the patient's rights to education

According to Ethiopian Food and Drug Administration (EFDA) standards, the patient possesses the right to receive information in a manner in which the patient understands. In certain cases, the hospital may need to provide interpreting or translation services to accommodate the patient's communication needs. These needs should be determined during the initial learning needs assessment.

Models of Client Education

Reminders and Motivational Messages

Patient empowerment models often include visual reminders for both the HCW and the patient. These visual reminders usually include small badges or stickers worn by patients with a message, such as "did you wash/sanitize your hands?" If the message is framed correctly, posters can serve as a visual reminder and encouragement for both the patient and the HCW to participate in hygiene practices of the hands. Educational videos, posters, brochures, and visual reminders targeting the education of HCWs and patients were evaluated in three long-term care facilities as part of a comprehensive program of hand hygiene. This combination of HCW education and patient empowerment resulted in an aggregate increase in compliance with hand hygiene to bring about 52% and 32% reduction in infections (WHO 2009).

Role Modeling

Role modeling, in which the HCW's behavior toward hand hygiene or other positive behavior is influenced by either peers or superiors, has been observed to influence compliance with and motivation of the patient to be empowered.

Graphic Illustrations (pictures, pictographs, models)

Research has shown that using pictures, including cartoons or pictographs, with verbal explanations, and the use of models can greatly increase patient's understanding and retention of information. In a recent study, the mean correct recall of information was found to be 85% with pictographs and 14% without it. Another study found that patients receiving wound care instructions with cartoons were able to answer questions correctly 46% of the time when tested three days later compared with only 6% of patients who received only written instructions and answered questions correctly (Delp & Jones 1996).

Topics for IPC Client Education

Patients and their families play an important role in infection prevention. Educating them on the infection prevention basics and helping them feel comfortable asking questions, voicing concerns to healthcare professionals in health facility will help alleviate HAIs. There are IPC-related areas to be addressed by hospitals in day-to-day patient and their families' health education program.

Table 14.1 Topics for IPC client education

Client education topics (area of concern for IPC)	Description	Case
Healthcare-associated infections (HAIs)	HAIs are infections that patients can get in a healthcare facility while receiving medical care. These infections are often preventable.	• Surgical site infections • Catheter-associated infections • Bloodstream infection • Pneumonia

Client education topics (area of concern for IPC)	Description	Case
Hand hygiene	Hand hygiene is the most important way to help prevent infection.	• Hand washing • Alcohol-based hand sanitizer
Safe injection practices	Teach your patients to recognize unsafe injection practices—and to speak up if they have a concern.	• Safe injection practices matter and speaking about the unsafe practices
Monitor the cleanliness of their area	Keeping the patient's environment and equipment clean is extremely important—especially frequently touched items.	• How to clean the patient's environment • Health care waste management • Food and water
Medications	Patients need to understand what medicines they are taking, and why—especially if antibiotics are being prescribed. Taking antibiotics the wrong way can promote antibiotic resistance.	• Use only physicians ordered antibiotics • Finish a course of antibiotics
Post-surgical care	Preventing infections after surgery is essential. Teach your patients how to care for their wound after leaving the healthcare facility and to verify that any person that inspects their wounds or changes their dressings uses appropriate hand hygiene.	• Cleaning of post-operative wound
Care for their devices	Advise your patients to ask if their device (catheter, etc.) is necessary.	• IV cannula • Catheters

Source: Infection prevention and you.org 2022

SUMMARY

Educating and empowering patients and clients to actively participate in their care help reduce a patient's risk of hospital acquired infections. Actionable strategies are being developed with a strong emphasis on working in partnership with healthcare authorities, partners, and professionals.

They are the basis of infection control precautions that are to be used as a minimal expectation in the care of all patients. For example, hand hygiene is a major component of standard precautions and one of the most effective methods to prevent transmission of pathogens associated with healthcare. In addition, the use of PPE should be guided by risk assessment and the extent of contact anticipated with blood and body fluids, or pathogens. Supplementary to the practices carried out by health workers when providing care, all individuals (including patients and visitors) should comply with infection control practices in healthcare settings.

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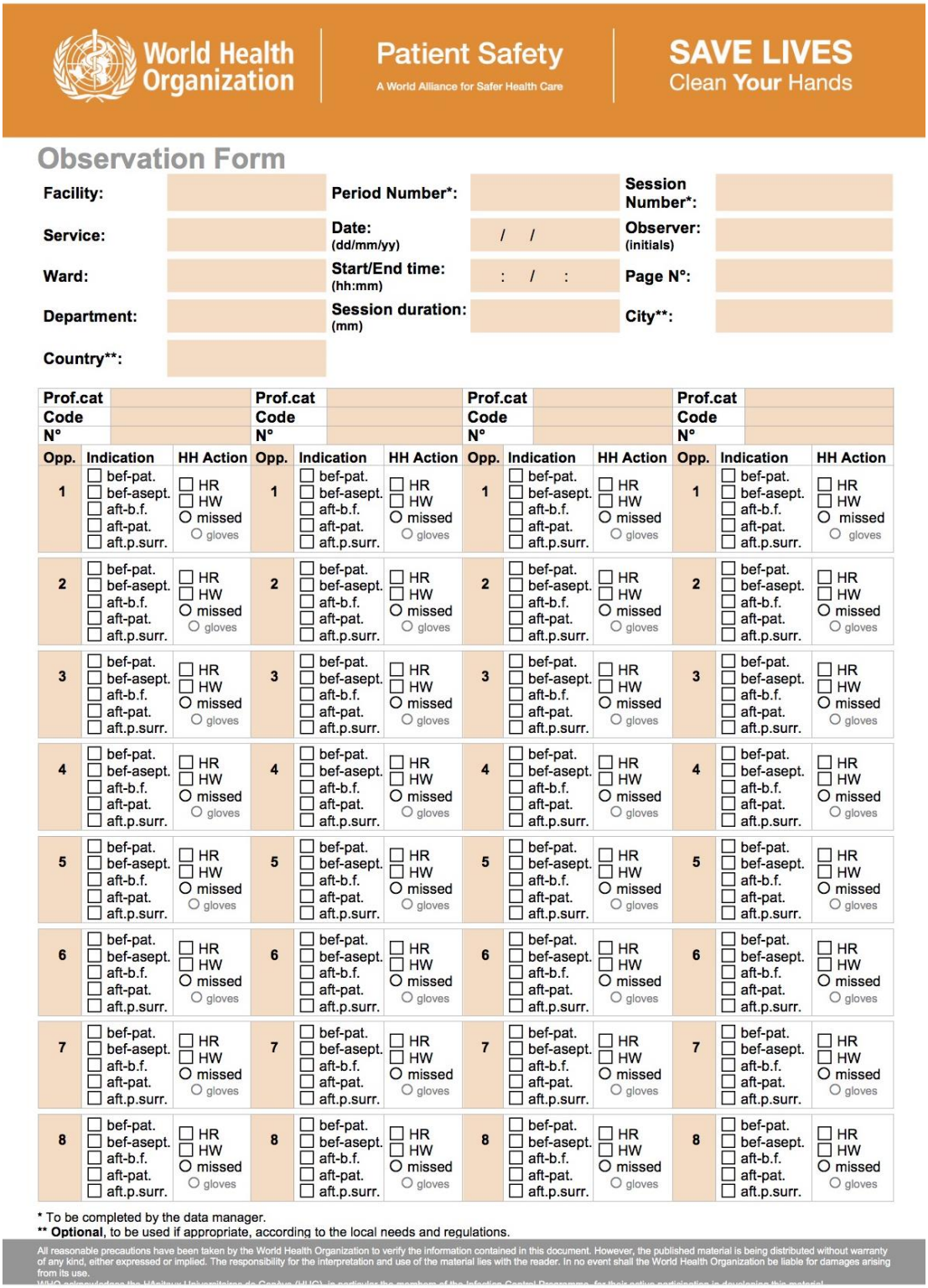
APPENDICES

APPENDIX 4A. SAMPLE HAND HYGIENE OBSERVATION FORM: WORLD HEALTH ORGANIZATION



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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**:**	
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* To be completed by the data manager.
** **Optional**, to be used if appropriate, according to the local needs and regulations.

Source: WHO 2009e. (https://cdn.who.int/media/docs/default-source/integrated-health-services-(ihs)/hand-hygiene/monitoring/surveyform/observation-form.doc?sfvrsn=39b780c9_6)

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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 (± 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(ortunity):	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 HW: hand hygiene action by handwashing with soap and water	Missed: no hand hygiene action performed

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Observation Form – Basic Compliance Calculation

	Facility:						Period:			Setting:					
	Prof.cat.			Prof.cat.			Prof.cat.			Prof.cat.			Total per session		
Session N°	Opp (n)	HW (n)	HR (n)	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															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
16															
17															
18															
19															
20															
Total															
Calculation	Act (n) = / Opp (n) =			Act (n) = / Opp (n) =			Act (n) = / Opp (n) =			Act (n) = / Opp (n) =			Act (n) = / Opp (n) =		
Compliance															

Compliance (%) = $\frac{\text{Actions}}{\text{Opportunities}}$ x 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.

Source: WHO 2009e

APPENDIX 4B. SAMPLE HAND HYGIENE OBSERVATION FORM MODIFIED FOR ROOM ENTRY AND EXIT

FOUR rules for conducting Hand Hygiene Observations

1. Observe for hand hygiene upon ENTRY and EXIT from *Patient Environment*

   Patient Environment definition:

   Private or semi-private room: Crossing room door

   Between patients and multi-patient rooms setting: Crossing the "curtain line"

2. A provider may use the Alcohol-Based Hand Rub (ABHR) dispenser just outside the room door, inside the room, at the sink, or the healthcare worker's personal ABHR bottle.
3. DO NOT GUESS. If your view is blocked and you cannot confirm if provider performed hand hygiene, simply check "Unsure" box.
4. Do not exceed 3 observations per provider in one session.

UNIT:_____	DATE:____/_____/____	DAY OF WEEK: _____
TIME: _____ TO _____	OBSERVER NAME: _____	

	Role of Observed Person								Hand Hygiene	Observed Behavior				
Obs #	**Nurse***	**Midwife**	**Physicians (all doctors)**	**CO/PA/Dentist****	**Pharmacist/Laboratory Technician**	**Support Staff**	**Other Providers (nursing, medical and other students, and residents)**	**Other 1=Unknown 2=Clinical procedure 3=Transport 4=Nursing care 5=Blood sample collection 6= Nutrition 7= Admin**	**Circle ONE**	**Not observed**	**Hand cleaning with ABHR**	**Hand wash with soap and water**	**No hand hygiene**	**Area location**
									ENTRY EXIT					
									ENTRY EXIT					
									ENTRY EXIT					

	Role of Observed Person								Hand Hygiene	Observed Behavior				
Obs #	**Nurse***	**Midwife**	**Physicians (all doctors)**	**CO/PA/Dentist****	**Pharmacist/Laboratory Technician**	**Support Staff**	**Other Providers (nursing, medical and other students, and residents)**	**Other 1=Unknown 2=Clinical procedure 3=Transport 4=Nursing care 5=Blood sample collection 6= Nutrition 7= Admin**	**Circle ONE**	**Not observed**	**Hand cleaning with ABHR**	**Hand wash with soap and water**	**No hand hygiene**	**Area location**
									ENTRY EXIT					
									ENTRY EXIT					
									ENTRY EXIT					
									ENTRY EXIT					

* All types of nursing staff including diploma, degree, post-graduate, supervisor, and assistant.

** CO=Clinical Officer, PA=Physician Assistant.

Adapted from: Johns Hopkins Medicine. Hospital Epidemiology and Infection Control. JHH Hand Hygiene Compliance Data Collection Form. http://www.hopkinsmedicine.org/heic/docs/HH_observation_form.pdf

APPENDIX 4C. IMPLEMENTATION OF A MULTIMODAL HAND HYGIENE IMPROVEMENT STRATEGY

As discussed in this hand hygiene chapter, the WHO Multimodal Hand Hygiene Improvement Strategy identifies five key steps to implement a hand hygiene improvement strategy (see Steps 1–5 below). The implementation strategy was developed based on a literature review of the implementation science, behavioral change, spread methodology, diffusion of innovation, and impact evaluation (WHO 2009a). For detailed information on assessing the economic impact of hand hygiene promotion, refer to *WHO Guidelines on Hand Hygiene in Health Care*.

It is important to note that although each step in the process builds on activities occurring in previous steps, it should be considered a cyclical process rather than a linear one. Each step of the cycle should be repeated, refined, and enhanced at least every five years to maximize the impact of the hand hygiene program (WHO 2009a; WHO 2009f).

Step 1: Facility Preparedness

Suggested duration: 3 months

Step 1 in the hand hygiene improvement strategy is to evaluate and prepare the facility for the program. To have a successful hand hygiene program, careful planning is required from the start of the program. During Step 1, it is imperative to map out a clear strategy for the entire program.

Key Activities in Facility Preparedness

Key Activities
Identify coordinator.
Identify key individuals/groups.
Undertake a situation analysis of hand hygiene practices at the facility.
Complete ABHR production, planning, and costing tool.
Train observers/trainers.
Procure raw materials for ABHR (if necessary).
Collect data on costs/benefits of hand hygiene improvement program: costs of program versus reductions in costs of managing hospital acquired infections.
Undertake training on data entry and analysis.

Steps 1–5 Reproduced from: WHO 2009a.

Step 2: Baseline Evaluation

Suggested duration: 2–3 months

Step 2 includes the baseline evaluation of hand hygiene practices, perceptions, knowledge, and available infrastructure in the healthcare facility.

Hand hygiene is the most effective way of preventing the transmission of infections and it is imperative to collect data on the HCWs' perceptions of the importance of hand hygiene. These

perceptions, and other factors influencing compliance, will provide valuable information for strategy development. Changing perceptions can be the means by which improvements in hand hygiene practices are achieved. Similarly, assessing the infrastructure of the healthcare facility may help explain current hand hygiene practices and will guide improvement efforts. Lack of access to sinks, running water, and ABHR may all contribute to low hand hygiene compliance and should be addressed during the implementation planning step.

Key Activities in Baseline Evaluation

Key Activities
Undertake baseline assessments: Senior manager perception survey HCW perceptions survey Ward structure survey HCW knowledge survey
Begin local production or market procurement of ABHR.
Conduct hand hygiene observations.
Monitor use of soap and ABHR.
Perform data entry and analysis.

Step 3: Implementation

Suggested duration: 3–4 months

Step 3 is implementation of the planned program. The availability of ABHR at the point of care, and the education and training of HCWs are crucial to the success of this step. Healthcare facilities may choose to hold a high-profile launch event to coincide with the start of the program's implementation. Publicizing leadership endorsement and support also helps foster a successful implementation stage (WHO 2009a). During implementation, it is also important to evaluate HCWs' tolerance and acceptance of ABHR. Monthly collection of hand hygiene observations should continue during implementation, if possible. If time and resources are limited, observations should occur only during Step 2 and Step 4.

Key Activities in Implementation

Key Activities
Launch the strategy.
Provide feedback on baseline data.
Distribute posters.
Distribute ABHR.
Distribute other WHO materials from the Pilot Implementation Pack.
Educate HCWs.
Undertake practical training of HCWs.
Undertake ABHR tolerance tests.
Complete monthly monitoring of usage of products.

Step 4: Follow-Up Evaluation

Suggested duration: 2–3 months

Step 4 is the evaluation of the short-term impact of the hand hygiene improvement strategy. By performing a follow-up evaluation, facilities will gain information they can use to make future decisions and take actions related to the hand hygiene program. Compliance with hand hygiene practices among HCWs is the main indicator that should be evaluated. It is important to note that hand hygiene improvement activities should continue in the healthcare facility according to the local action plan, even during this evaluation step.

WHO has identified the following as key success indicators in the evaluation of the short-term impact of a hand hygiene program:

- Increase in hand hygiene compliance
- Improvement in infection control/hand hygiene structures
- Increase in usage of hand hygiene products
- Improved perception of hand hygiene
- Improved knowledge of hand hygiene

The data collected during this evaluation will help shape future actions and the steps the healthcare facility may take to maintain high hand hygiene compliance rates over time.

Key Activities in Follow-Up Evaluation

Key Activities
Undertake follow-up assessments: HCW knowledge survey Senior executive manager perception survey HCW perception and campaign evaluation survey Facility situation analysis
Conduct data entry and analysis.
Conduct hand hygiene observations.
Continue monthly monitoring of use of products.

Step 5: Developing Ongoing Action Plan and Review Cycle

Suggested duration: 2–3 months

Step 5 is to develop an ongoing action plan and review cycle. The goal of the hand hygiene program is to create an environment in which performing appropriate hand hygiene is central to the facility's culture. Reviewing the results of the data and creating a final report detailing the results of the improvement program will help condense the findings and will aid in creating a future action plan. Enthusiasm and motivation for the program must remain high to have long-term impact.

Key Activities in Developing an Ongoing Action Plan and Review Cycle

Key Activities
Study all results carefully.
Provide follow-up data.
Develop a 5-year action plan.
Consider scale-up of the strategy.

APPENDIX 13A. INITIAL MANAGEMENT OF A PERSON REPORTING EXPOSURE TO POTENTIALLY INFECTIOUS BODY FLUIDS

The initial management should aim to reduce the time of contact with the source person's blood, body fluids, or tissues, and to clean and decontaminate the site of the exposure.

If the skin is broken following an injury with a used needle or sharp instrument, the following is recommended**:**

- Do not squeeze or rub the injury site.
- Wash the site immediately using soap or a mild disinfectant solution (like chlorhexidine gluconate solution or 70% to 80% alcohol solution) not irritating to the skin. If running water is not available, clean the site with a gel or other hand-cleaning solution or whatever is customarily available.
- Do not use strong solutions, such as bleach or iodine, to clean the site because they may irritate the wound and make the injury worse.

After a splash of blood or body fluids, the following is recommended. After a splash contacts with unbroken skin, do the following:

- Wash the area immediately.
- If, running water is not available, clean the area with a gel or other handrub solution or whatever is customarily available.
- Do not use strong disinfectants.

After a splash contacts with the eye, do the following:

- Irrigate the exposed eye immediately with water or normal saline.
- Sit in a chair, tilt the head back and have a colleague gently pour water or normal saline over the eye pulling the eyelids up and down to make sure the eye is cleaned thoroughly.
- If contact lenses are worn, leave these in place while irrigating the eye because they form a barrier over the eye and will help protect it. Once the eye has been cleaned, remove the contact lenses, and clean them in the normal manner. This will make them safe to wear again.
- Do not use soap or disinfectant on the eye.

After a splash contacts with the mouth, do the following:

- Spit the fluid out immediately.
- Rinse the mouth thoroughly using water or saline, and spit again. Repeat this process several times.
- Do not use soap or disinfectant in the mouth.

APPENDIX 13B. SUMMARY OF STEPS IN CLINICAL MANAGEMENT OF HIV POST- EXPOSURE PROPHYLAXIS

Item	Recommended action and notes
Person reports exposure	• First aid, assess the type and severity of exposure, use decision making tools to assess the exposure and decide eligibility for PEP • Fill the potential HIV exposure documentation and PEP follow-up form (Appendix 13G) • This form should be filled for every exposure despite the eligibility for PEP
Eligibility	• Eligible if the following four criteria are fulfilled: o Exposure within 72 hours o Exposed individual not known to be infected with HIV o Significant exposure o Person who was the source of exposure is HIV infected or has unknown HIV status
Informed consent for PEP	• Information about risks and benefits of PEP • Health education and counseling on adherence; side effects; risk reduction; trauma or mental health problems; and social support and safety (both occupational and non-occupational) • Consent may be given verbally • Baseline HIV testing of the exposed person • Give IEC materials in local language
Additional laboratory evaluations	• Rapid HIV test of the source person, if feasible and based on informed consent and standard operating procedures; also consider testing the source patient for HBV and HCV (if available) • Pregnancy testing of exposed person if the person is female and in the reproductive age group • Hemoglobin (for zidovudine-containing PEP regimens) HBV and HCV screening, if available
Medicine	• Medicine Two nucleoside-analogue reverse-transcriptase inhibitors + /- boosted protease inhibitor • Give doses of ARVs enough for 3 to 5 days (starter packs)
Time to initiation	• The initial dose of antiretroviral medicines should be given as soon as possible but not later than 72 hours after exposure
Duration of therapy	• 28 days
Link to ART clinic and subsequent follow-up there	• The person started on PEP needs to be informed/report to the ART clinic the next workday for further follow-up. • The exposed person should have a minimum of 6 visits to the ART clinic up to the sixth month HIV testing. • In the ART clinic: Assess and manage side effects; assess and support adherence. • Give continued health education and counseling on side effects; on the importance of treatment completion with good adherence, risk reduction; trauma or mental health problems; and social support and safety (both occupational and non-occupational) in the first ART clinic visit, at 2 weeks and at 4 weeks. • Do follow-up HIV testing 6 weeks, 3 months, and 6 months after exposure.
Referral	• Intra facility and inter facility referrals, as appropriate
Recordkeeping	• Maintain accurate and confidential records

APPENDIX 13C. FACILITATING INFORMED PATIENT DECISION MAKING FOR HIV POST- EXPOSURE PROPHYLAXIS

In the process of giving health education and counseling for HIV PEP, people who have been exposed to HIV must be made fully aware of the following:

- The risk of acquiring HIV infection from the specific exposure
- About the efficacy of PEP
- The importance of taking an HIV test and of receiving appropriate post-test counseling before starting PEP drugs
- The possibility that they might already be infected with HIV will need to be assessed if they have not already had an HIV test
- People already living with HIV should be referred to the ART clinic for treatment of their infection, and if they had started PEP, the medicine should be stopped when the diagnosis is confirmed
- The importance of adhering to medicine
- The duration of the course of medicine (four weeks)
- The common side effects that may be experienced while taking PEP medicine and possible drug interactions
- Exposed persons should be advised to avoid blood or tissue donations, breastfeeding, or pregnancy to prevent secondary transmission, especially during the first six to 12 weeks post- exposure.
- PEP medicine can be taken during pregnancy and may protect the mother from getting HIV infection after exposure.
- That continuing to breastfeed while taking PEP is safe, although the risk of transmitting HIV through breastfeeding is higher in the early stage of infection if women get infected by HIV while breastfeeding; appropriate counseling.
- Discuss safe alternatives to breastfeeding if they are acceptable, feasible, affordable, and sustainable.
- Exclusive breastfeeding is strongly recommended whenever alternatives are not possible.
- Information provided as part of the informed consent process should be appropriate to the person’s age, literacy skills, and level of education, and should take into account the context of the exposure.
- The consenting person must be able to understand the risks and benefits of the proposed intervention (PEP).

APPENDIX 13D. PEDIATRICS PEP DOSES

Regimen	Pediatrics PEP Doses	
1. Two drug PEP:		
A	AZT + 3TC	
B	D4T + 3TC (if HB is < 7gm/dl)	
2. Three drug PEP:		
A	AZT + 3TC + LVP/r	
B	D4T + 3TC + LPV/r (if HB < & 7 gm/dl)	
	Dose	**Formulation**
1. AZT	0-4 wks: 4 mg/kg/dose PO BID	Syrup: 10mg/ml Capsules: 100mg Tablet: 300mg Combvir (AZT/3TC): 300mg/150mg
	4wks-12yrs: 180-240mg/m2/dose PO BID	
	>/=13yrs: 300mg PO BID	
2. 3TC	0-4wks: 2mg/kg/dose PO BID	Syrup: 10mg/ml Tablet: 150mg Combvir (AZT/3TC): 300mg/150mg
	>/=4wks: 4mg/kg/dose PO BID	
	≥13 yrs: 150 mg PO BID	
3. D4T	< 30 Kg: 1mg/kg/dose PO BID	Syrup: 1mg/ml Capsules: 15mg, 30mg
	>/= 30mg: 30mg PO BID	
4. LPV/r	LPV:m230mg/m2/dose	Syrup: LPV/r=400mg/100mg in 5ml LPV/r = 80mg/ml/2omg/ml
	r: 57.5mg/m2/dose PO BID	Capsule: LPV/r=133.3/33.3

APPENDIX 13E. POST EXPOSURE PROPHYLAXIS FOLLOW-UP CARD LEGEND

Facility Name: Write the name of the hospital or health center. Date: Date clients' exposure reported in Ethiopian calendar (dd/mm/yyyy). Medical Record Number/Card Number: A number given by the facility main chart room. For HMIS sites, this number is medical record number and for the other sites it is card number. Patient Name: Write patient full name. Age: Write age of the client in years. Sex: Put a check mark on F for female and on M for Male. Occupation: Occupation of the exposed client (e.g., nurse, physician, teacher). Address: This information is helpful for tracking patients. Write the full address of the client in the spaces provided. Visits: A follow-up visit in the ART clinic. First the baseline information on the heading portion will be completed by the health worker who first encountered the exposed cases. The visits days/weeks are estimated from the first date the exposed person appears to the health facility, e.g., first visit is 1-3 days after initial presentation of the exposed case to the health facility. Write the number of hours elapsed between time of exposure and time of reporting in hours.

Date of Visit

Enter date of visit in Ethiopian Calendar in dd/mm/yyyy format

HIV status of source case

Put a check mark on **Reactive** or **Non- Reactive** if the HIV status of the source case is known. If Unknown select **Unknown.**

Exposure status

a) Hollow needle deep prick
b) Hollow needle superficial prick c) Solid needle deep prick
d) Solid needle scratch
e) Splash to the conjunctivae
f) Splash to the oral cavity
g) Splash to intact skin
h) Splash to broken skin
i) Other (specify) cut injury with a surgical blades etc.....

Circumstance of injury:

a) Trying to secure intravenous line
b) Needle stick injury during surgery
c) Needle stick while disposing of waste
d) Amniotic fluid splash during delivery
e) Splash with body cavity fluids during procedure
f) Other (specify): Cut injury with a surgical blade while doing a surgical procedure

Exposure code: Occupational Exposure Code Mucous Membrane

EC1= Few drops and short duration

Several drops /long duration/ major blood splash Percutaneous

EC2= Solid and Superficial scratch

EC3= Hollow needle deep puncture

Source code

SC negative: HIV negative

SC1: HIV positive; Asymptomatic/High CD4

SC2: HIV positive: Advanced disease/patient on antiretroviral therapy/primary infection/low CD4

SC unknown: HIV status unknown or source unknown

Exposure type: Non-Occupational

1. Sexual assault
2. Pediatric exposures
3. Non HCW caregivers
4. Unanticipated high-risk exposure (consensual sexual activity)
5. Condom tears
6. Road traffic accident
7. Other (specify) e.g., community fight, bite

Adherence grading

General counseling on PEP includes

- The risk of acquiring HIV infection due exposure
- The efficacy of PEP
- The importance of having a baseline and follow-up HIV test
- The importance of adherence to PEP drugs
- Advice to avoid secondary transmission to other people in case the exposed person becomes HIV positive due to exposure

Adherence	**% of missed/ month**	**# of missed dose per month**
G(good)	>95%	≤ 3 doses
F(fair)	85-94%	5-8 dose
P(poor)	<85%	≥ 9 doses

Counseling on:

- The risk of acquiring HIV infection due exposure
- The efficacy of PEP
- The importance of having a baseline and follow-up HIV test
- The importance of adherence to PEP drugs
- The duration of the course of medicine (four weeks)
- The common side effects of PEP drugs
- Advice to avoid secondary transmission to other people in case the exposed person becomes HIV positive due to exposure

Types of regimen given:

d4T/3TC *or*
AZT/3TC (CBV) *or*
TDF/3TC d4T/3TC/LPV/r AZT/3TC/LPV/r

TDF/3TC/LPV/r

AZT/3TC/EFV

Drug side effects

1. Nausea
2. Diarrhea
3. Fatigue
4. Headache
5. Numbness/tingling
6. Rash
7. Anemia
8. Abdominal pain
9. Jaundice
10. Fat changes
11. Dizzy, anxiety, nightmare
12. Other(specify)

Remark: one may use the table to show any other additional information (e.g., linkage to HIV care or other support, tracking, lost, dead)

Post Exposure Prophylaxis Follow-Up Card:

Patient Name: **Age:** **Sex:** □ M □ F **Occupation**

Address: Region: **Sub-city/Woreda**:
Kebele: **House #** **Tel:**

Exposure status: *Select a letter from the lists(a-i)* Other (specify):

Circumstance of injury: *Select a letter from the lists(a-e)* Other (specify): Number of hours elapsed after exposure: hrs

HIV status of source case: □ Reactive □Non-Reactive □ Unknown, **If Reactive, Source code** □ 1 □ 2 **Exposure code:** □ 1 □ 2 □ 3

Baseline HIV status of exposed person: □ Reactive □ Non-Reactive □ Not done **If female, pregnancy test:** □ Positive □ Negative

For Non-occupational exposure: □Sexual violence/rape □ Other(specify):

PEP Eligibility: □ Eligible □ Not Eligible **Type of PEP regimen provided :**

Visits		Follow-up				
			Fill the pt and service status as indicated	Measures taken *(e.g., in cases of poor adherence and drug side effect, additional PEP drugs prescribed for 2 weeks, linkages to other services)*	Next appointment date	Remark (tracking of clients lost to follow-up, etc.)
Visits in the ART Clinic	1st Visit (2-3 days)	Baseline info complete (Y/N)				
		General counseling on PEP(Y/N)				
		Adherence (G/F/P)				
		Drug side effects (1-12)				
	2nd visit (2 weeks)	Adherence (G/F/P)				
		Drug side effects (1-12)				
		General counseling on PEP				
	3rd visit (4 weeks)	Adherence (G/F/P)				
		Drug side effects (1-12)				
		Treatment completed(Yes/No)				
		Reinforce counseling on PEP				
	4th visit (6weeks)	General counseling on PEP				
		HIV test result(N/NR)				
	5th visit (3 month)	HIV test result(N/NR)				
		General counseling on PEP				
	6th visit (6 month)	HIV test result(N/NR)				
		General counseling on PEP				

APPENDIX 13H. OCCUPATIONAL AND NON-OCCUPATIONAL HIV POST EXPOSURE PROPHYLAXIS REGISTER

Instructions for PEP register:

Serial Number (SN): A number assigned to patients on the register (e.g., 1, 2, 3, etc.)

MRN/Card Number: A number given by the facility main chart room. For HMIS sites, this number is medical record number and for the other sites it is card number.

Date: Use Ethiopian Calendar and a format of DD/MM/YYYY to register when patient is enrolled in PEP service

Age: Enter client's age in year

Sex: Enter 'M' for male and 'F' for Female

Occupation: Enter client's current occupation (e.g., health worker, teacher, daily laborer, etc.)

Department/case team: Enter the Department or case team in which the client works (e.g., ANC, OPD, etc.) for occupational exposures

Non-occupational Exposure: Put a check mark "√" under the Non-Occup-sexual assault/rape column if the client is exposed due to sexual assault/rape. Specify if the client is exposed to other non-occupational reasons under 'other-Non-Occup' column.

Occupational exposure: Put a check mark "√" under the 'Occup column' if the patient is exposed occupationally

Exposure Code/type: Put the exposure code types among the lists provided under the foot note of the PEP register, e.g., If a client is exposed to few drops of blood for short duration of time, write "EC1" under the 'Exposure code/type' column.

Source patient HIV Status code: Put the source patient HIV status code listed under the foot note of the PEP register under 'source patient HIV status code' column, e.g., If a client is exposed to a patient whose HIV status is negative after testing then write 'SC negative' under the 'source patient HIV status code' column.

PEP Eligibility: If the client is eligible for PEP Write 'Eligible' otherwise write 'Not eligible'**.**

Drug regimen provided: Put the PEP drug regimen provided to the client among the drug regimen listed under the foot note of PEP register, e.g., if a client is prescribed "AZT/3TC (CBV)" put 'AZT/3TC (CBV' under the 'drug regimen column'.

Treatment completed: Put 'Yes' if completed, 'No' if not completed the treatment under 'treatment completed' column.

HIV status of exposed Person: Write 'R' for reactive or 'NR' for non-reactive depending or 'Unknown' for unknown status on the patient's HIV status at base line, 6 weeks, 3month, and 6 month

*** Remark:** Use the 'remark column' to document events like lost, stopped, linkage to HIV care, and other (specify) as applicable

SN	MRN/Card Number	Date	Age	Sex	Occu patio n	Case team/ Department	Non-occupational exposure		Occupat ional exposur e(√)	Exposure Code/ type	Source patient HIV status code	PEP Eligibility (Eligible/ Not Eligible)	Drug regimen Provided	Treatment complete d (Y/N)	HIV status of Exposed person (R or NR)				Remark
							Rape/ Sexual assault(√)	Other Non-occupation al (specify)							Base line	6w	3m	6m	

Occupational exposure code

Mucus membrane

EC1= Few drops and short duration

EC2= Several drops/long duration/major blood splash

Percutaneous

EC2= Solid and superficial scratches

EC3=Hollow needle deep puncture

Non-occupational exposure

Sexual assault

Pediatric exposure

Unanticipated high-risk exposure

Community fight

Road traffic accident

Other (specify

HIV status code of the source

SC negative: HIV Negative

SC1: HIV positive; Asymptomatic/High CD4

SC2: HIV positive: Advanced disease/patient on antiretroviral therapy/primary infection/low CD4

SC unknown: HIV status unknown or source unknown

Drug Regimen Code

d4T/3TC or AZT/3TC (CBV) or TDF/3TC

d4T/3TC/LPV/r or AZT/3TC/LPV/r or TDF/3TC/LPV/r or AZT/3TC/EFV

Remark

Lost

Dead

Stopped

Other (Specify)

APPENDIX 13I. PEP FACILITY ASSESSMENT FORM

Facility: _____
Date of Visit [Ethiopian Calendar] (dd/mm/yy) _____
Completed by: _____
Checked by: _____

A. Set up of PEP Service

1. Is there a PEP Service (both for occupational and non-occupational exposures) in the facility?
   ☐Yes ☐No

2. Is the PEP service in 24 hours available?
   ☐Yes ☐No

   Are PEP drugs accessible 24 hours where?
   Emergency case team L &D case team
   In Patient case team OPD case team
   Others specify _____

3. Is there follow-up of patients on PEP in the ART clinic
   ☐Yes ☐No

   Are the staffs in the health facility aware of PEP service?
   ☐Yes ☐No

B. Human Resource

1. Number of staff trained in trainings that includes PEP (ART, IMAI/IMNCI, IP, STI/PEP)
   MD___ Nurse___ HO___ HA/Junior Nurse___ Other
   _____

2. At least one PEP trained personnel assigned in each case team on duty hours to give PEP service (as an additional responsibility)
   MD___ Nurse___ HO____ Junior Nurse/HA_____

3. At least one PIHCT trained personnel assigned in each case team on duty hours to give CT service for PEP purpose (as additional responsibility)
   MD___ Nurse___ HO____ Junior Nurse/HA _____

4. Is there PEP Focal Person?
   ☐Yes ☐No

5. Is the PEP focal person a member of the MDT committee and IP committee?
   ☐Yes ☐No

6. Does PEP focal person regularly (weekly) follow, if the PEP service is given according to the standard management?
   ☐Yes ☐No

C. Materials available in the PEP service outlets:

1. Do the PEP service outlets have standard reference materials? (Check box when available)
   ☐ National infection prevention and patient safety
   ☐ Reference manual
   ☐ National PITC guideline
   ☐ PITC protocol
   ☐ PITC cue card
   ☐ Decision making tool for PEP wall charts
   ☐ Others specify _____
2. Standard IEC materials available in PEP service areas for
   ☐ HIV Yes No
   ☐ PITC Yes No
   ☐ ART Yes No
   ☐ PEP Yes No

D. Equipment/Supplies/Furniture available in the facility:

1. Is there adequate supply and appropriate use of personal protective equipment's in every service outlet of the hospital?
   ☐Yes
   ☐No, specify
   _____

2. Is there clean water supply in the rooms?
   ☐Yes ☐No

3. Are the recommended ARVs for PEP available in PEP service delivery areas at least one pack from each?
   ☐Yes ☐No

4. Are condoms available in the service outlets?
   ☐Yes ☐No

5. Is there a penile model to demonstrate about condom use?
   ☐Yes ☐No

7. Are HIV test kits available in the PEP service outlets?
   ☐Yes ☐No

8. Are pregnancy test kits available in the PEP service outlets?
   ☐Yes ☐No

9. Safety boxes available in every service outlet for safe disposal of sharps
   ☐Yes ☐No

10. In the pharmacy, are enough stock of recommended ARV drugs for PEP available?
    ☐Yes specify _____

E. Standard M&E Tools

Are the following formats available in the ART clinic?

1. Potential HIV exposure documentation and follow-up form
   ☐Yes ☐No
2. PEP register
   ☐Yes ☐No
3. Intra facility referral?
   ☐Yes ☐No
4. Service outlet HMIS register (in facilities that have not started the HMIS)
   ☐Yes ☐No

F. Service Practice

1. Do healthcare workers follow IP protocol (like using appropriate personal protective equipment's, safe disposal of sharps….)
   ☐Yes ☐No ☐Sometimes
2. Is HIV testing and counseling (base line and follow-up at 3 & 6 months) done for patients who take PEP?
   ☐Yes ☐No ☐Sometimes
3. Adherence counseling and follow-up of side effects done for PEP patients according to the standard
   ☐Yes ☐No ☐Sometimes
4. Completing of PEP drugs is followed and documented in the PEP register.
   ☐Yes ☐No ☐Sometimes
5. HIV testing of source patient (if required for decision making) done after taking consent.
   ☐Yes ☐No ☐Sometimes
6. Do the health facility MDT and IP committees use PEP data generated in hospital to improve PEP service delivery and IP practice of the facility in general?
   ☐Yes ☐No ☐Sometimes
7. Do health facility MDT and IP committees have monthly meetings and monitor the PEP service delivery and IP practice of health facilities
   ☐Yes ☐No ☐Sometimes
8. Does the Health facility have a mechanism for incorporating the IP and MDT reports (which includes PEP) into a final report that is given to the CEO and MD at least quarterly?
   ☐Yes ☐No

COMMENTS, RECOMMENDATIONS & FOLLOW-UP

Follow-up - Describe actions since last visit:

Comments about this visit

Recommended actions, persons responsible, time frame

APPENDIX 13J. CHECKLIST FOR PEP AT SITE LEVEL PEP SERVICE DELIVERY

The below mentioned human resources, materials, and supplies need to be 24 hours available in each case of health facilities

1. Healthcare provider who is trained on PEP service delivery
2. National infection prevention and patient safety reference manual
3. National PITC guideline
4. PITC protocol
5. PITC cue card
6. Decision making tool for PEP wall charts
7. IEC materials on HIV, PITC, ART and PEP
8. Potential HIV exposure documentation and follow-up form
9. PEP register
10. ARVs (recommended PEP drugs available in EOPD)
11. Condoms
12. Penile models
13. Gloves
14. Syringe with needle
15. Lancet
16. Safety box
17. Soap and water supply
18. HIV test kits
19. Pregnancy test kit
20. Post pill

APPENDIX 13K. RISK AND WORK RESTRICTIONS FOR HEALTHCARE WORKERS EXPOSED TO OR INFECTED WITH INFECTIOUS DISEASES OF IMPORTANCE IN HEALTHCARE SETTINGS

This information is to be used in the absence of local regulations.

Disease/ Infection/ Syndrome	Mode of Transmission	Transmission Risk		Incubation Period	Main Risk in Healthcare Facility	Prevention	Vaccine Available	Post-Exposure Prophylaxis (PEP) Available
		Staff to Patient	Patient to Staff					
Cholera	Fecal-oral contaminated water	Rare	Rare	Hours to 5 days, Shedding up to 10 days after cessation	Stool contact, unwashed hands	Hand hygiene, Contact Precautions, clean environment	Yes; No recommend-ation for HCWs	No
Work restrictions: No duty. Restrict from food handling. **Duration of restrictions: Until 48 hours after last episode of diarrhea except for food handlers: 2 consecutive negative fecal specimens at least 48 hours apart and at least 48 hours after stopping antibiotics are required.***								
Conjunctivitis due to adenovirus	Contact with eye secretions and contaminated surfaces and equipment	High	High	5–12 days, shedding from incubation period until 14 days after onset	Surfaces, equipment, unwashed hands	Hand hygiene, Contact Precautions, clean instruments, and equipment	No	No
Work restrictions: No contact with patient or patient environment. **Duration of restrictions: Until discharge from eye ceases.**								
Cytomegalovirus (CMV)[9]	Contact with urine, saliva, breast milk, cervical secretions, and semen from infected person who is actively shedding virus	Rare	Rare	Unknown	Contact with body fluids, especially saliva, blood, and urine, possibly unwashed hands	Hand hygiene, Standard Precautions	No	No

Disease/ Infection/ Syndrome	Mode of Transmission	Transmission Risk		Incubation Period	Main Risk in Healthcare Facility	Prevention	Vaccine Available	Post-Exposure Prophylaxis (PEP) Available
		Staff to Patient	Patient to Staff					
Work restrictions: No restriction. **Duration of restrictions: None.**								
Diarrheal diseases	Contact with infected person's stool, consumption of contaminated food or water, contact with objects or environment contaminated with stool	Varies	Varies	Varies by pathogen causing diarrhea	Stool contact, unwashed hands, contaminated environmental surfaces, contaminated food or water	Hand hygiene, Contact Precautions, clean environment	See specific disease	No
Work restrictions: Acute (diarrhea with or without other symptoms): No contact with patient or the patient environment, or food handling. **Duration of restrictions: Until symptoms resolve (check the need for negative stool cultures for specific diarrheal etiologies).***								
Diphtheria	By respiratory droplets, contact with skin lesions	No data	Rare	2–5 days, infectious for 2 weeks	Close contact, face-to-face exposure, cough	Hand hygiene, Droplet Precautions for pharyngeal lesions, Contact Precautions for skin lesions	Yes, and booster every 10 years†	PEP with antibiotic should be discussed, vaccination if none within 5 years
Work restrictions: Active disease: No duty; Asymptomatic carriers: No duty. **Duration of restrictions: Until antibiotic therapy completed and 2 negative cultures more than 24 hours apart.**								
Hemorrhagic fever (e.g., Ebola, Marburg, Lassa virus)	Bloodborne; possible contact transmission	Negligible	Moderate to high	5–21 days	Exposure of mucous membranes or respiratory tract, through broken skin or sharps injury	Hand hygiene, Barrier Precautions to achieve full skin coverage to be used with training and trainer observer to monitor	No	Antivirals should be discussed

Disease/ Infection/ Syndrome	Mode of Transmission	Transmission Risk		Incubation Period	Main Risk in Healthcare Facility	Prevention	Vaccine Available	Post-Exposure Prophylaxis (PEP) Available
		Staff to Patient	Patient to Staff					
Caring for EVD patients with adequate PPE and no known exposure: Active monitoring for fever and symptoms twice per day. Off duty if any symptoms. Work restrictions: Active suspected or confirmed: Off duty. Post-exposure: Off duty. With active monitoring for fever and symptoms twice per day. **Duration of restrictions: Active: Until cleared by medical staff. Post-exposure: Until 21 days after last exposure.**								
HAV	Person-to-person by fecal-oral route; infected food handlers with poor personal hygiene can contaminate food	Rare	Rare	15–50 days	Stool contact, unwashed hands, eating or drinking in patient care area	Hand hygiene, Contact Precautions, especially with babies and incontinent patients	Yes; HCWs are not considered at increased risk[ι]	Immune globulin
Work restrictions: No contact with patient or the patient environment, or food handling. **Duration of restrictions: Until 7 days after the onset of jaundice.**								
HBV[ο]	Via sharps, mucosal, and non-intact skin, contact with blood, semen, vaginal secretions, and bloody fluids	Low	Moderate, 2–40% after percutan-eous injury from infected patient	45–180 days (average 60–90 days)	Sharps injury, blood and serum-derived body fluid splashes to mucous membranes	Hand hygiene, Standard Precautions, including prevention of sharps injury, vaccination	Yes; Recom-mended for all HCWs†	Depends on HCW immune status and source patient's status;§ for non-immune HCWs with HBsAg, positive source HBIG and vaccination series§
Work restrictions: Acute or chronic HBV: Do not exclude from duty but restrictions apply depending on circulating viral levels and procedures performed by HCW. Requires review by occupational health/IPC personnel and possibly an expert review panel.[#] **Duration of restrictions: Different recommendations if HepB antigen is positive or negative and if HBV is < 10^4 GE/mL (genome equivalents/milliliter plasma) or ≥ 10^4 GE/mL.[#]**								

Disease/ Infection/ Syndrome	Mode of Transmission	Transmission Risk		Incubation Period	Main Risk in Healthcare Facility	Prevention	Vaccine Available	Post-Exposure Prophylaxis (PEP) Available
		Staff to Patient	Patient to Staff					
HCV[0]	Via sharps, mucosal, and non-intact skin contact with blood, semen, vaginal secretions, and bloody fluids	Low	Moderate, 0–10% (average 1.8%) after percutaneous injury from infected patient	6–7 weeks	Sharps injury, splash on mucous membranes or non-intact skin	Hand hygiene, Standard Precautions, including prevention of sharps injury	No	No
Work restrictions: Acute or chronic HCV: Do not exclude from duty but restrictions apply depending on circulating viral levels and procedures performed by HCW. Requires review by occupational health/IPC personnel and possibly an expert review panel.# Post-exposure:§ **Duration of restrictions: Different recommendations if HCV is < 104 GE/mL or > 104 GE/mL.#**								
Hepatitis E	Person to person by fecal-oral route, contaminated water, contaminate food	—	—	2–9 weeks	Contaminated food or water, unwashed hands	Hand hygiene, Standard Precautions	No	No
Work restrictions: Off duty. **Duration of restrictions: Duration of illness, viral shedding in stool occurs 7–30 days after onset of jaundice.**								
Herpes simplex[0]	Contact with virus in saliva of carriers, contact with vesicle fluid	Rare	Low	2–14 days	Contact with infected site or saliva, vaginal secretions, or amniotic fluid	Hand hygiene, Standard Precautions[0] (Contact Precautions in disseminated infection)	No	No
Work restrictions: Genital: No restriction. Hands (herpetic whitlow): No contact with patient or the patient environment. Orofacial: No contact with high-risk patients.[◊] **Duration of restrictions: Genital: None. Hands (herpetic whitlow): Until lesions heal.**								

Disease/ Infection/ Syndrome	Mode of Transmission	Transmission Risk		Incubation Period	Main Risk in Healthcare Facility	Prevention	Vaccine Available	Post-Exposure Prophylaxis (PEP) Available
		Staff to Patient	Patient to Staff					
Human immunodeficiency virus (HIV)[9]	Primarily via sharps contact with blood; mucosal or non-intact skin contact with blood; semen, vaginal secretions, and bloody body fluids less likely to transmit	Rare	Low, 0.2–0.4% after sharps exposure to infected person	Within 6 months	Sharps injury, splash on mucous membranes or non-intact skin	Hand hygiene, Standard Precautions including prevention of sharps injury	No	Depends on type of body fluid, type of exposure and source patient status;§ when indicated, initiate antiretroviral treatment as soon as possible (within 72 hours)§
Work restrictions: Acute or chronic HIV: Do not exclude from duty but restrictions apply depending on circulating viral levels and procedures performed by HCW. Requires review by occupational health/IPC personnel and possibly an expert review panel.[#] Post-exposure:§ **Duration of restrictions: Different recommendations if circulating HIV viral burden is < $5x10^2$ GE/mL or ≥ $5x10^2$ GE/mL.[#]**								
Influenza[9]	Droplet spread; direct droplet transmission or droplet-to-contact transmission of respiratory secretions of infected patients	Moderate	Moderate	1–5 days	Close contact with patient (within 1–2 meters from coughing/ sneezing)	Hand hygiene, Droplet Precautions, annual vaccine	Yes; annual immunization with a single dose recommended yearly for HCW[ǂ]	Antivirals may be recommended in certain situations
Work restrictions: No contact with high-risk patients[◊] during community outbreaks. **Duration of restrictions: Until acute symptoms resolve.**								

Disease/ Infection/ Syndrome	Mode of Transmission	Transmission Risk		Incubation Period	Main Risk in Healthcare Facility	Prevention	Vaccine Available	Post-Exposure Prophylaxis (PEP) Available
		Staff to Patient	Patient to Staff					
Measles[o]	Airborne; direct airborne transmission or airborne-to-contact transmission of respiratory secretions of infected person	High	High	5–21 days	Inhaling droplets and airborne virus or contact with the patient's respiratory secretions	Hand hygiene, Airborne and Contact Precautions, vaccine	Yes; all HCWs should be immune to measles, proof of immunity or immunization required pre patient contact†	Immune globulin
Work restrictions: Active: Off duty. Post-exposure in non-immune people: Off duty. **Duration of restrictions: Active: 7 days after rash appears. Post-exposure: From 5th day after first exposure through 21st day after last exposure and/or 4 days after rash appears.**								
Meningococcal infectious ***N. meningitides***	Droplet spread; direct droplet transmission or droplet-to-contact transmission of respiratory secretions of infected patients	—	Rare	2–10 days	Close contact (face to face) with respiratory secretions of patients with meningococcemia or meningococcal meningitis	Hand hygiene, Droplet Precautions	Yes; recom-mended for HCWs at risk of exposure† (tetravalent A, C, W135, and Y)	Antibiotic after close contact‡
Work restrictions: Active: No duty. Post-exposure: No restrictions. Recommended prophylaxis includes: rifampin (600 mg twice a day for 2 days), a single dose of ciprofloxacin (500 mg), or a single dose of ceftriaxone (250 mg) IM. **Duration of restrictions: Active: Until 24 hours after start of effective antibiotic therapy. Post-exposure: No restrictions.**								

Disease/ Infection/ Syndrome	Mode of Transmission	Transmission Risk		Incubation Period	Main Risk in Healthcare Facility	Prevention	Vaccine Available	Post-Exposure Prophylaxis (PEP) Available
		Staff to Patient	Patient to Staff					
Mumps	Droplet spread; direct droplet transmission or droplet-to-contact transmission of respiratory secretions and saliva of infected patients	Moderate	Moderate	12–25 days	Close contact with patient (within 1–2 meters from coughing/ sneezing)	Hand hygiene, Droplet Precautions	Yes; HCWs are not indicated as a group at increased risk†	No
Work restrictions: Active: Off duty. Post-exposure in non-immune people: Off duty. **Duration of restrictions: Active: 9 days after onset of parotitis. Post-exposure: From 12th day after first exposure through 26th day after last exposure or 9 days after onset of parotitis.**								
Methicillin-resistant *S. aureus* (MRSA) infection	Direct and indirect contact	Rare	Rare	Depends on the type of infection	Unwashed hands, contaminated surfaces, contaminated equipment	Hand hygiene, Contact Precautions	No	No
Work restrictions: Active, draining skin lesions: No contact with patient or the patient environment, or food handling. Carrier: No restriction unless epidemiologically linked with transmission of the organism. **Duration of restrictions: Until lesions have resolved.**								
Norovirus	Fecal-oral (direct or indirect contact with patient's stool or vomit), contaminated surfaces, contaminated food or water	High	High	12–48 hour	Stool or vomit contact, possibly aerosol transmission during vomiting	Hand hygiene, Contact Precautions, clean equipment, clean environment	No	No
Work restrictions: Acute: No contact with patient or the patient environment, or food handling. **Duration of restrictions: Until symptoms resolve, viral shedding in stool may occur.**								

Disease/ Infection/ Syndrome	Mode of Transmission	Transmission Risk		Incubation Period	Main Risk in Healthcare Facility	Prevention	Vaccine Available	Post-Exposure Prophylaxis (PEP) Available
		Staff to Patient	Patient to Staff					
Parvovirus B19 (erythema infectiosum or fifth disease)	Contact with infected persons, fomites, or respiratory secretions	—	Rare	6–10 days	Respiratory secretions	Droplet Precautions for patients with fever and anemia or aplastic crisis or chronic B19, others Standard Precautions	No	No
Work restrictions: Acute: Off duty. Exposed: no restriction. **Duration of restrictions: 7 days after onset of illness.**								
Pertussis (whooping cough)	Droplet spread; direct droplet transmission or droplet-to-contact transmission of respiratory secretions of infected patients	Moderate	Moderate	7–10 days	Respiratory secretions and respiratory droplets	Hand hygiene, Droplet Precautions	Yes; recom-mendation for HCWs currently under review†	Macrolides
Work restrictions: Active: Off duty. Post-exposure asymptomatic: No restriction if PEP received. Post-exposure symptomatic: Off duty. **Duration of restrictions: Active: from beginning of catarrhal stage through 3rd week after onset of paroxysms. Post-exposure: Until 5 days of effective antibiotic therapy.**								
Poliomyelitis	Contact with feces or urine of infected person, respiratory secretions and fomites	Rare	Rare	3–21 days, vaccine-associated polio (oral vaccine): 7–21 days after vaccination	Feces, respiratory secretions, lab specimens	Hand hygiene, Contact Precautions	Yes; all HCWs should have completed a full course of primary vaccination against polio†	No
Work restrictions: Active: Off duty. Post-exposure: Vaccination series or booster. **Duration of restrictions: Duration of illness.**								

Disease/ Infection/ Syndrome	Mode of Transmission	Transmission Risk		Incubation Period	Main Risk in Healthcare Facility	Prevention	Vaccine Available	Post-Exposure Prophylaxis (PEP) Available
		Staff to Patient	Patient to Staff					
Rabies	Animal bite, saliva, tissue and organ transplants	Rare	Rare	1–3 months	Lab samples, saliva of infected patients (theoretical)	Hand hygiene, Standard Precautions	Yes; HCWs are not at increased risk	Yes
Work restrictions: Active: Off duty. Post-exposure: No restriction, consider post-exposure treatment. **Duration of restrictions: Rabies is mostly fatal.**								
Respiratory syncytial virus (RSV)	Droplet contact or direct contact with respiratory secretions	Moderate	Moderate	2–8 days	Respiratory secretions, hands, and fomites	Hand hygiene, Contact Precautions	No	No
Work restrictions: No contact with high-risk patients◊ during community outbreaks. **Duration of restrictions: Until acute symptoms resolve.**								
Rotavirus	Person-to-person via fecal-oral route; food handlers may contaminate food	Moderate	Moderate	2–3 days	Stool contact, unwashed hands, environmental surfaces, fomites	Hand hygiene, Contact Precautions, clean environment, clean equipment	Yes; adults including HCWs are not at increased risk of severe disease†	No
Work restrictions: Acute: No contact with patient or the patient environment, or food handling. **Duration of restrictions: Until symptoms resolve.**								

Disease/ Infection/ Syndrome	Mode of Transmission	Transmission Risk		Incubation Period	Main Risk in Healthcare Facility	Prevention	Vaccine Available	Post-Exposure Prophylaxis (PEP) Available
		Staff to Patient	Patient to Staff					
Rubella[0]	Droplet contact or direct contact with respiratory secretions; airborne transmission not demonstrated	Moderate	Moderate	12–23 days	Respiratory droplets and secretions	Droplet Precautions (acute infection), Contact Precautions (congenital rubella)	Yes; all HCWs should be immune to rubella and proof of immunity or immunization required prepatient contact†	No
Work restrictions: Active: Off duty. Post-exposure in non-immune people: Off duty. **Duration of restrictions: Active: Until 5 days after rash appears. Post-exposure: From 7th day after first exposure through 21st day after last exposure.**								
Salmonella or shigella	Person-to-person via fecal-oral route, via contaminated food or water; food handlers with poor personal hygiene can contaminate food	Low	Low	1–3 days	Stool contact, unwashed hands	Hand hygiene, Contact Precautions for incontinent patients and babies	Yes (typhoid), currently no recommen-dation regarding HCWs†	No
Work restrictions: Acute: No contact with patient or the patient environment, or food handling. Carrier: No restriction from patient care unless staff member handles food* or is epidemiologically linked with transmission of the organism. **Duration of restrictions: Until symptoms resolve unless food handler,* in which case a specific number of negative cultures is required.**								
Novel respiratory viruses (SARS, bird flu, MERS-CoV, etc.)	Droplets, contact (possibly airborne)	Medium	Medium	Varies	Small droplets from respiratory secretions, possibility of airborne transmission	Hand hygiene, Droplet and Contact Precautions, use Airborne Precautions if possible	No	No
Work restrictions: Acute: No duty. **Duration of restrictions: Until acute symptoms resolve.**								

Disease/ Infection/ Syndrome	Mode of Transmission	Transmission Risk		Incubation Period	Main Risk in Healthcare Facility	Prevention	Vaccine Available	Post-Exposure Prophylaxis (PEP) Available
		Staff to Patient	Patient to Staff					
Staphylococcus aureus **infection (see also MRSA)**	Direct and indirect contact	Rare	Rare	Foodborne: 30 minutes–6 days Impetigo: 1–10 days Toxic shock syndrome: 2 days	Unwashed hands, contaminated surfaces, contaminated equipment	Hand hygiene, Contact Precautions	No	No
Work restrictions: Active, draining skin lesions: No contact with patient or the patient environment, or food handling. Carrier: No restriction unless epidemiologically linked with transmission of the organism. **Duration of restrictions: Until lesions have resolved.**								
Scabies	Direct skin-to-skin contact with infected person	Low (typical scabies) to moderate (crusted scabies)	Low (typical scabies), moderate (crusted scabies)	2–6 weeks	Prolonged skin-to-skin contact (typical scabies), skin-to-skin contact during daily care (crusted scabies), infrequently fomites	Hand hygiene, Contact Precautions, clean environment, clean equipment	No	No
Work restrictions: Active: No patient contact. Post-exposure: No restriction. **Duration of restrictions: Active: Until after 1st treatment and cleared by medical evaluation. Post-exposure: Prophylactic treatment not indicated except in outbreak situations.**								

Disease/ Infection/ Syndrome	Mode of Transmission	Transmission Risk		Incubation Period	Main Risk in Healthcare Facility	Prevention	Vaccine Available	Post-Exposure Prophylaxis (PEP) Available
		Staff to Patient	Patient to Staff					
Streptococcus, Group A (GAS)	Droplet contact or direct contact with oral secretions or drainage from infected wounds	Rare	No data	Pharyngitis 2–5 days, impetigo 7–10 days, other infections variable	Contact with infected secretions; HCWs are rarely carriers	Hand hygiene; precautions depend on type of infection – Minor skin and endometritis: Standard Precautions, Major skin: Contact Precautions, Respiratory tract, scarlet fever and invasive disease: Droplet Precautions	No	No
Work restrictions: Active: No contact with patient or the patient environment, or food handling. Carrier: No restriction unless linked with transmission. **Duration of restrictions: Until 24 hours after effective treatment is started.**								
Tuberculosis (TB)[o]	Airborne transmission from sources with active pulmonary or laryngeal TB; susceptible person must inhale airborne droplet nuclei to become infected	Low to high	Low to high	Weeks to years	Incomplete implementation of recommend control measures, including patient placement, facility ventilation, and personal respiratory protection	Airborne Precautions	Yes, BCG; There is no recommenda-tion for HCWs in routine circumstances	Isoniazid (INH) for treatment of latent TB infection; 4-drug regimen for active TB
Work restrictions: Active pulmonary or laryngeal: Off duty. Active extra-pulmonary: No restriction once pulmonary or laryngeal involvement is excluded. Latent: No restriction. PPD (tuberculin skin test) conversion (> 10 mm induration): No restriction; consider isoniazid prophylaxis depending on local recommendations. **Duration of restrictions: Active: Until proven non-infectious (by sputum acid-fast bacilli [AFB] culture culture).**								

Disease/ Infection/ Syndrome	Mode of Transmission	Transmission Risk		Incubation Period	Main Risk in Healthcare Facility	Prevention	Vaccine Available	Post-Exposure Prophylaxis (PEP) Available
		Staff to Patient	Patient to Staff					
Varicella, chicken pox, disseminated zoster[o]	Contact with vesicles; droplet or airborne spread from respiratory tract	High	High	10–21 days (up to 28 days in person who receives varicella-zoster immune globulin [VZIG])	Contact with lesions and aerosols even without direct contact with the infected patient	Airborne and Contact Precautions	Yes; consider vaccination of potentially susceptible HCWs (i.e., unvaccinated and with no history of varicella)[ι]	VZIG
Work restrictions: Active: Off duty. Post-exposure in non-immune people: Off duty. **Duration of restrictions: Active: Until all lesions are dry and crusted. Post-exposure: From 10th day after first exposure through 21st day (28th if VZIG is given) after last exposure.**								
Localized varicella-zoster (shingles)	Contact with vesicles; perhaps droplet or airborne spread from respiratory tract from disseminated zoster	Moderate	Moderate	Years after acute infection	Contact with lesions and perhaps aerosols from respiratory tract from disseminated zoster	Contact Precautions and Airborne Precautions for disseminated zoster	Yes; see above; shingles vaccine not recommend-ed specifically for HCWs	VZIG
Work restrictions: Localized in healthy person: Cover lesions, no contact with high-risk patients.[◊] Generalized or localized in immunosuppressed person: No patient contact. Post-exposure in non-immune people: No patient contact. **Duration of restrictions: Active and generalized: Until all lesions are dry and crusted. Post-exposure: From 10th day after first exposure through 21st day (28th if VZIG is given) after last exposure or if varicella occurs, until all lesions dry and crusted.**								

Disease/ Infection/ Syndrome	Mode of Transmission	Transmission Risk		Incubation Period	Main Risk in Healthcare Facility	Prevention	Vaccine Available	Post-Exposure Prophylaxis (PEP) Available
		Staff to Patient	Patient to Staff					
Viral respiratory infections, acute febrile	Respiratory secretions	Moderate	Moderate	1–7 days	Droplet contact or direct contact with respiratory secretions, close contact (1–2 meters) with patient	Respiratory etiquette, hand hygiene, Droplet Precautions, annual vaccine	Yes (influenza only)	No
Work restrictions: No contact with high-risk patients◊ during community outbreaks. **Duration of restrictions: Until acute symptoms resolve.**								

§ PPE—Post-exposure prophylaxis; see Chapter 3, Sharps Injuries and Management of Exposure to Bloodborne Pathogens, in this module for details about PEP for bloodborne pathogens.

See section above on Healthcare Workers Infected with HIV and/or HBV or HCV.

º For information relevant to exposure of pregnant personnel, see Table 2-7 in this chapter.

◊ Definition of high-risk patient: neonates and immunocompromised persons of any age. For influenza, also those > 65 years, residents of nursing homes, persons with chronic pulmonary or cardiac conditions, diabetes. (CDC 1998)

‡ Definition of close contact: Direct, mouth-to-mouth contact as in resuscitation attempts, endotracheal intubation, endotracheal tube management, or close examination of oropharynx of patients. (CDC 1998; WHO 2002)

† For vaccine recommendations for HCWs (WHO 2016b), see Table 2-4.

* For management of illness in food handlers, see Volume 1, Chapter 12: Food and Water Safety.

APPENDIX 13L. DECISION MAKING TOOLS FOR PEP

Interpretation of exposure code (Severity of Exposure)

	Exposure Code	Type of exposure
1	**EC 1**	Is a minor mucocutanous exposure to small volume of blood for short period (Few Seconds to minutes)
2	**EC 2**	Is a Major mucocutanous exposure to large volume of blood for longer duration (Several minutes) or Mild Percutaneous exposure (with Solid needle or superficial scratch or injury)
3	**EC 3**	Severe Percutaneous exposure (Large bore hollow needle , Deep puncture ,Visible blood on devise , Needle used in patient artery/vein)

Interpretation of the HIV status of the source patient

	HIV Source code (SC)	**The HIV Status and Severity of the illness in the source patients**
1	**HIV SC 1**	The Source patient is HIV Positive but is asymptomatic and has reasonably good immune status
2	**HIV SC 2**	The Source patient is HIV Positive and is symptomatic , may have AIDS or has other evidence of advanced illness (Low CD4 or High viral load)
3	**HIV SC unknown**	The HIV status of the source patients is unknown (either the patient has refused HIV testing or died or discharged before HIV testing) or The source patient is unknown (e/g Unlabeled blood sample in a laboratory)

Recommended HIV post-exposure prophylaxis for percutaneous injuries and Mucous membrane or non-intact skin exposure

Status code	**Exposure code**		
	EC 1	**EC 2**	**EC 3**
SC 1	basic 2 drug PEP	basic 2 drug PEP	expanded 3 drug PEP
SC 2	basic 2 drug PEP	expanded 3 drug PEP	expanded 3 drug PEP
SC unknown	No PEP is warranted.	No PEP is warranted	Generally no PEP is warranted
	consider basic 2-drugs PEP for source with HIV risk factors		
HIV negative	No PEP warranted	No PEP warranted	No PEP warranted

Source: Federal Ministry of Health. 2014. National guidelines for comprehensive HIV prevention, care and treatment. https://www.childrenandaids.org/sites/default/files/2017-05/Ethiopia-Consolidated-ART-Guideline-2014.pdf