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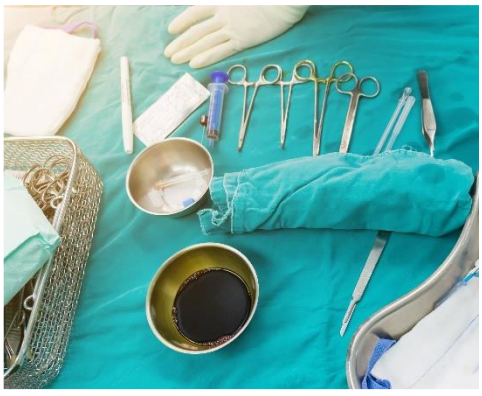
MINISTRY OF HEALTH - ETHIOPIA

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

## VOLUME 2: ADVANCED AND SPECIAL SETTINGS 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 shows 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 infection 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, 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 have been implementing and revising sets IPC guidelines to improve IPC practices in healthcare facilities over the 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 infection and the associated healthcare cost. 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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# 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: RATIONAL USE OF ANTIBIOTICS

**Key Topics**

- Consequences and magnitude of antibiotic resistance
- Causes of antibiotic resistance
- Rational use of antibiotics
- Promoting the rational use of antibiotics

## BACKGROUND

Critical aspects of the broader global response to AMR are efforts to minimize the emergence and transmission of resistance to drugs used to treat tuberculosis (TB), HIV, and malaria.

The use and misuse of antimicrobials have led to the persistent expansion of AMR, thereby lowering the effectiveness of some of these drugs (e.g., chloroquine and penicillin). Resistance to the most commonly available antimicrobials requires the use of more expensive alternative regimens. Unfortunately, although resistance has created a demand for new treatment options, there has been a significant drop in the development of new antimicrobial agents in recent decades. This has compromised the ability of healthcare workers (HCWs) to treat infectious diseases and has increased healthcare costs. It is critical that necessary measures to respond to the resistance crisis be taken at all levels (by institutions and by local and national governments). Measures should include the rational use of antimicrobials through the incorporation of careful antimicrobial stewardship (AMS) activities and programs. Ultimately, improving antimicrobial use involves actions at the national level to guide treatment decisions made by informed HCWs and by the awareness and cooperation of patients. Although this chapter focuses on antibiotics, its recommendations can be applied to all antimicrobials (World Health Organization [WHO] 2015; WHO 2021).

### Consequences of Antibiotic Resistance

Antibiotic resistance makes it harder to treat the infections that were effectively treated a few decades ago, leading to increased medical costs, extended hospital stays, increased toxicity, adverse effects, and mortality. Antibiotic resistance is present in all parts of the world and threatens the effective prevention and treatment of a long list of infections, including multidrug-resistant *Mycobacterium tuberculosis*, methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant *Enterococci* (VRE), and multidrug-resistant *Neisseria gonorrhoeae*. Mortality among patients infected with resistant microbes can be about twice that of patients with infections caused by the same species of bacteria that is sensitive to antibiotics (National Institute of Allergy and Infectious Diseases [NIAID] 2011).

The increased use and misuse of antibiotics accelerate the emergence of drug-resistant strains of microorganisms, which threatens our ability to treat common infectious diseases (WHO 2021). Infections, such as pneumonia, TB, bloodstream infections (BSIs) (sepsis), and sexually

transmitted infections, are becoming more difficult and, at times, impossible to treat due to antibiotic resistance.

## Magnitude of Antibiotic Resistance

WHO has classified priority pathogens into three categories for which new antibiotics should be developed (table 1.1-1).

Table 1.1-1. WHO priority pathogens list for research and development of new antibiotics

| Priority 1: Critical | Priority 2: High | Priority 3: Medium |
|---|---|---|
| • Acinetobacter baumannii, carbapenem-resistant<br>• *Pseudomonas aeruginosa*, carbapenem-resistant<br>• *Enterobacteriaceae*, carbapenem-resistant, Extended Spectrum Beta Lactamase-producing | • *Enterococcus faecium*, vancomycin-resistant<br>• *Staphylococcus aureus*, methicillin-resistant, vancomycin-intermediate and resistant<br>• *Helicobacter pylori*, clarithromycin-resistant<br>• *Campylobacter* spp., fluoroquinolone-resistant<br>• *Salmonellae*, fluoroquinolone-resistant<br>• *Neisseria gonorrhoeae*, cephalosporin-resistant, fluoroquinolone-resistant | • *Streptococcus pneumoniae*, penicillin-non-susceptible<br>• *Haemophilus influenzae*, ampicillin-resistant<br>• *Shigella* spp., fluoroquinolone-resistant |

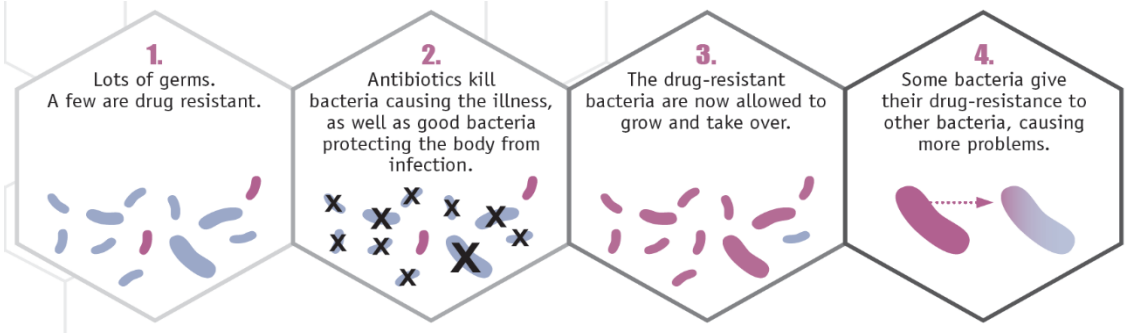
Adapted from: WHO 2017c

## Causes of Antibiotic Resistance

### Natural Causes

**Selective pressure:** Bacteria will die or stop multiplying in the presence of an antibiotic to which they are susceptible, but if they are resistant to the antibiotic, the bacteria will survive and continue to grow. Therefore, in the presence of an antibiotic, only the resistant microbes will continue to survive, grow, and become the dominant population. This phenomenon is called "selective pressure" and results in the growth of resistant bacteria that will replace the susceptible bacteria (figure 1.1-1).

Figure 1.1-1. Development of antibiotic-resistant bacteria




*Source*: US Centers for Disease Control and Prevention (CDC) 2013

## Societal Contributions

Some antibiotic use practices by HCWs and communities create pressure that allows resistant organisms to survive and grow. These "societal pressures" can accelerate the development of microbial resistance. Societal pressures include:

- Inappropriate selection, dosage, and duration of antibiotics prescribed by clinicians, including issuing prescriptions for viral diseases, such as diarrhea and seasonal influenza.
- Prescribers not complying with prescribing the right drug (only when indicated), in the right dose, for the right duration, and with the right route of administration.
- Prescription of broad-spectrum antibiotics rather than a specific antibiotic in situations where laboratory support is not available to identify specific causative organisms and their susceptibility to antibiotics.
- Admission to hospitals of critically ill patients who are more susceptible to infections and, therefore, are more likely to be on antibiotics. The heavier use of antibiotics in these patients can worsen the problem by promoting the selection of antibiotic-resistant microorganisms. The extensive use of antibiotics and close contacts among sick patients promote the spread of antibiotic-resistant microorganisms.
- Poor compliance with recommended IPC practices, such as standard precautions and transmission-based precautions, including respiratory IPC, contribute to the transmission of resistant microorganisms from one patient to another.
- Antibiotic use in agriculture and the poultry industry exposes animals and humans to unnecessary and inadequate doses of antibiotics that may lead to antibiotic resistance in humans.
- In some countries, policies and regulatory frameworks to control the misuse of antibiotics are not available. This results in antibiotics being available without a prescription from a clinician authorized to prescribe, which increases the inappropriate use of antibiotics (NIAID 2011; WHO 2015; WHO 2021).

## Commonly Available Antibiotics

Table 1.1-2 provides examples of the classes and the individual antibiotics in each class that are commonly available. When bacteria develop resistance to an antibiotic, resistance to other members in the same class is possible.

Table 1.1-2 Commonly available classes of antibiotics

| Class | Antibiotics |
|---|---|
| β-lactams | • Penicillins: **penicillin G*** <br>• Penicillin V, propicillin <br>• Aminopenicillins: **amoxicillin**, amoxicillin-clavulanate, **ampicillin**, ampicillin-sulbactam <br>• Anti-staphylococcal penicillins: methicillin, oxacillin, dicloxacillin, flucloxacillin <br>• Extended-spectrum penicillins: ticarcillin, ticarcillin-clavulanate, **piperacillin**, **piperacillin-tazobactam** <br>• Cephalosporins: <br>  ○ First generation: **cefazolin**, cefadroxil, **cephalexin**, cephalothin <br>  ○ Second generation: **cefoxitin**, cefotetan, cefuroxime <br>  ○ Third and fourth generation: cefdinir, cefpodoxime, **cefotaxime**, **ceftazidime**, **ceftriaxone**, **cefepime** <br>  ○ Fifth generation: **ceftaroline** <br>• Carbapenem: **imipenem-cilastatin**, ertapenem, doripenem, **meropenem** <br>• Monobactams: aztreonam |
| Glycopeptides | • **Vancomycin**, **teicoplanin**, dalbavancin, telavancin, oritavancin |
| Aminoglycosides | • Gentamicin, tobramycin, amikacin, streptomycin, neomycin, kanamycin, paromomycin |
| Chloramphenicol | • Chloramphenicol |
| Ansamycins | • Rifampicin, geldanamycin |
| Sulfonamides | • Sulfadiazine, sulfamethoxazole, sulfasalazine, sulfamethizole |
| Tetracyclines | • Tetracycline, oxytetracycline, doxycycline, minocycline |
| Macrolides | • Erythromycin, azithromycin, clarithromycin |
| Oxazolidinones | • Linezolid, tedizolid |
| Quinolones | • Norfloxacin, ciprofloxacin, ofloxacin, levofloxacin, moxifloxacin |
| Lipopeptides | • Daptomycin |
| Lincosamides | • Clindamycin |
| Azole derivatives | • Miconazole, ketoconazole, fluconazole, voriconazole, posaconazole, isavuconazonium sulfate |
| Nitroimidazole | • Metronidazole |
| Polymyxins | • **Colistin,** polymyxin B |

* Antibiotics in **bold** are on the WHO list of essential medicines.

*Source*: Frank & Tacconelli 2012

## Rational Use of Antibiotics

**Medications are used rationally when they are:**

- Clinically appropriate for the patient
- Prescribed in doses that meet the patient's requirements
- Taken for the recommended time period
- Taken at the recommended frequency
- The lowest cost option for the patient and the community

**Medications are not used rationally in the following circumstances:**

- Excessive use of multiple medicines for the same purpose in the same patient, also known as polypharmacy.
- Use of injections when oral formulations would be an equally appropriate or more preferred route of administration.
- Inappropriate use of antibiotics, such as failure to narrow the therapy when culture results are known, or use of antibiotics to treat viral infections.
- Antibiotic selection that differs from what is recommended in standard treatment guidelines.
- Self-medication with antibiotics, such as buying them without a prescription written by a healthcare provider.

**Determinants of Irrational Use of Antibiotics**

There are several determinants of irrational use of antibiotics:

- Lack of provider knowledge, especially with regard to prescribers who are insufficiently qualified, supervised, or supported
- Prescriber habits (prescribing without following the guidelines)
- Non-availability of standard treatment guidelines for prescribing antibiotics
- Non-availability of a specific drug to treat a clinical condition, resulting in prescribing a less effective or inappropriate alternative
- Lack of unbiased, independent, government-funded continuing medical education and supervision that include prescribing
- Excessive promotion and incentives for prescribing offered by the pharmaceutical industry
- Short consultations that do not provide time to explain to the patients that there is no need for antibiotics and that the condition will improve in a few days without antibiotics
- Following practices of senior practitioners

- Perceived patient demand
- Lack of diagnostic and laboratory support
- Inappropriate procurement of antibiotics by hospitals and the public sector supply chain

(Radyowijati, Haak 2003; Rowe, de Savigny, Lanata, et al. 2005; Sketris, Ingram, Lummis 2009; WHO 2002).

## Promoting the Rational Use of Antibiotics

Promoting the rational use of antibiotics and other medicines requires concerted efforts at all levels, starting from the Ministry of Health (MOH) at the national level and extending to the community.

WHO recommends the following core interventions to promote the rational use of medicines, including antibiotics, at the national level:

- A mandated multidisciplinary national body to coordinate the development of medicine use policies
- Up-to-date standard treatment guidelines for prescribing antibiotics
- An essential medicines list based on treatments of choice, consistent with the standard treatment guidelines
- Drugs and therapeutics committees to oversee antibiotic use in districts and healthcare facilities
- Strengthening of pre-service curricula to include problem-based pharmacotherapy
- Continuing in-service medical education as a regulatory requirement
- Supervision, audits, and feedback on antibiotic use
- Independent information on medicines
- Avoidance of any financial incentives to prevent over-prescribing
- Public education about the rational use of medicines
- Appropriate and enforced regulation
- Sufficient government expenditure to ensure the availability of medicines and trained staff

(WHO 2002)

### Facility-Level Recommendations and Strategies

Ideally, facility-level activities to promote the rational use of antibiotics in large hospitals are organized by a stewardship technical working group in collaboration with the IPC technical working group. Although IPC staff can contribute significantly to reducing AMR, other interventions to ensure the rational use of antibiotics should have the support of the management team at the healthcare facility and the quality improvement technical working group or other

clinical staff members interested in promoting the rational use of antibiotics. Small successes can be built on over time to reach the goal of having an antibiotic stewardship program. (For details, see the Antibiotic Stewardship Programs section in Chapter 2.) The recommendations and strategies mentioned in this section should be appropriately adjusted for smaller healthcare facilities.

- **Provide continuing education:** Education is a fundamental element of any program designed to improve prescribing behavior. Education can also provide a foundation of knowledge that will enhance and increase the acceptance of stewardship strategies. However, education alone, without the inclusion of active interventions, is not effective in changing antibiotic prescribing practices and will not produce a prolonged impact (Barlam, Cosgrove, Abbo, et al. 2016).
- **Improve the use of standard treatment guidelines:** Clinical practice guidelines are being produced with increasing frequency to improve the quality of care (box 1.1-1). Antibiotic stewardship programs should improve clinicians' access to and use of national, evidence-based practice guidelines that integrate local microbiology and resistance patterns. Guidelines implementation can be facilitated through provider education and feedback on antibiotic use and patient outcomes (Barlam, Cosgrove, Abbo, et al. 2016; MOH, Republic of Ghana 2010).
- **Streamline or de-escalate therapy:** Antibiotic streamlining or de-escalation should be based on culture results and the elimination of redundant combination therapies to effectively target the causative microorganisms. This will ultimately help to decrease antibiotic exposure and result in cost savings (Barlam, Cosgrove, Abbo, et al. 2016; Masterton 2011).
- **Convert parenteral therapy to oral therapy:** See details in the Pharmacy-Driven Interventions section of this chapter.
- **Practice good IPC:** Good IPC will reduce healthcare-associated infections (HAIs) and the resulting use of antibiotics.

Box 1.1-1. Reputable, evidence-based clinical practice guidelines on antimicrobial use

- The Infectious Diseases Society of America: http://www.idsociety.org/IDSA_Practice_Guidelines/
- The European Society of Clinical Microbiology and Infectious Diseases: https://www.escmid.org/escmid_publications/medical_guidelines/
- All guidelines are updated on a yearly basis. Always ensure that you are referring to the most up-to-date version.

## General Public/Community-Level Recommendations and Strategies

Steps should be taken at all levels of society to reduce antibiotic resistance. Patients and the community can be educated on the following actions to increase rational antibiotic use:

- Prevent the spread of infections through regular handwashing, good food preparation practices, respiratory etiquette, avoiding close contact with sick people, and keeping individual vaccinations up to date.

- Use antibiotics only when prescribed by a licensed healthcare professional.
- Take all antibiotics according to the clinician's advice—right dose, right duration (e.g., number of days), and at the right time of day.
- Do not use antibiotics left over from previous illnesses or from other people.
- Refrain from sharing antibiotics with others.
- Refrain from pressuring the doctor to prescribe antibiotics when it is determined that antibiotics are not indicated for the condition (such as for viral upper-respiratory illness).

There are a variety of ways to inform patients and the community in the facility (such as patient education and information material, posters in the clinics, direct reinforcement from HCWs) and through community outreach (TV/radio messages, involvement of informal leaders).

## SUMMARY

Antibiotics have been able to save many lives and their use has significantly contributed to the control of infectious diseases, which were once the leading causes of morbidity and mortality. However, the use and misuse of antibiotics have led to significant antibiotic resistance, thereby limiting their effectiveness. Therefore, the adoption of rational antibiotic use must be a global priority addressed at all levels: nations, facilities, individual clinicians, and the public. Measures at the facility level include activities to promote the rational use of antibiotics using broad interventions, pharmacy-driven interventions, and interventions targeted at effective treatment of specific infections or syndromes. Clinicians can increase the rational use of antibiotics in their practices by streamlining or de-escalating therapy, changing from parenteral to oral therapy, following standard treatment guidelines, and using good IPC practices.

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# CHAPTER 2: ANTIBIOTIC STEWARDSHIP PROGRAMS

**Key Topics**

- Antibiotic stewardship program
- Goal of antibiotic stewardship program
- Core elements of antibiotic stewardship program
- Intervention modalities for implementing an AMS program

## BACKGROUND

Antibiotic stewardship programs are coordinated interventions at the healthcare facility level intended to monitor and improve the appropriate use of antibiotics by encouraging the selection of the optimal drug regimen, dose, duration of therapy, and route of administration. Antibiotic stewardship programs are designed to:

- Achieve optimal clinical outcomes associated with antibiotic use
- Minimize adverse events
- Reduce infection-related healthcare costs
- Reduce antibiotic resistance
- Prevent the creation of antibiotic-resistant strains

(Barlam, Cosgrove, Abbo, et al. 2016; CDC 2015a).

### Goals of an Antibiotic Stewardship Program

- Optimization of clinical outcomes while minimizing unintended consequences of antibiotic use, such as toxicity and selection of pathogenic organisms (e.g., *Clostridium difficile*)
- Reduction of healthcare costs without an adverse impact on quality of care

### Core Elements of an Antibiotic Stewardship Program

The core elements for implementing an antibiotic stewardship program should include:

1. Leadership commitment
2. Accountability and drug expertise
3. Implementation of policies and interventions
4. Tracking and reporting antibiotic use and outcomes
5. Education

## 1. Leadership Commitment

Leadership support is an important component of successful stewardship programs. Leadership should support the creation of formal statements supporting antibiotic monitoring efforts, incorporating antibiotic stewardship-related components into job descriptions, supporting antibiotic stewardship-related training and education endeavors, and ensuring contributions from all groups that can support stewardship activities. Most of the time, facility administrative and management team members, clinicians, and pharmacy staff can play a leadership role at the facility level.

Financial support can enhance the capacity and impact of stewardship programs. Stewardship programs can often end up being self-supporting through the direct and indirect healthcare savings for the facilities at which they are implemented.

## 2. Accountability and drug expertise

Designated leadership of the program helps ensure accountability and provide drug expertise. The following are example of leaders and other staff members beneficial to a stewardship program:

- An antibiotic stewardship program leader who will be responsible for program outcomes. Clinicians with infectious disease expertise are ideally suited, but in settings where this specialty is not available, a clinician with an interest and willingness to seek out information on the topic and implement program activities can perform this role.
- A pharmacy leader who will co-lead the program. Pharmacists with infectious disease training are ideally suited, but in settings where this expertise is not available, pharmacy staff with an interest and willingness to work with the clinician leader can fulfill this role.
- Other individuals in the hospital or healthcare facility who can assist with and support the program activities. At large hospitals, they may include clinical microbiologists, laboratory staff, information system staff, quality improvement staff, IPC staff, hospital epidemiologists, department heads, clinicians, and nursing staff (table 1.2-1). At small clinics with staff shortages, the clinic nurse could be the only person who may prescribe/dispense antibiotics and, at the same time, ensure the rational use of antibiotics.

Table 1.2-1. Contributions of facility staff to an antibiotic stewardship program

| Staff member | Contribution to antibiotic stewardship program |
|---|---|
| Clinicians with authority to prescribe antibiotics | • Make day-to-day decisions about prescribing antibiotics. |
| IPC staff | • Coordinate facility-wide monitoring and prevention of HAIs.<br>• Provide skills, such as auditing, analyzing, and reporting data.<br>• Assist with resistance-trend monitoring and reporting.<br>• Include the importance of appropriate antibiotic use in staff education. |

| Staff member | Contribution to antibiotic stewardship program |
|---|---|
| Quality improvement staff | • Align goals of both the antibiotic stewardship and quality of care programs with patient safety programs. Improving antibiotic use is a medical quality and patient safety issue. |
| Laboratory staff | • Guide the proper use of tests and the flow of results.<br>• Create the hospital's antibiogram.<br>• Work with stewardship staff to ensure that lab reports present data in a way that supports optimal antibiotic use.<br>• (See Volume 1, Chapter 2, Basic Microbiology for IPC, for more information on the role of the clinical microbiology laboratory.) |
| Nurses (the role of nurses will vary based on the size of the facility and the country's policy and regulatory framework for prescribing antibiotics) | • Provide support by helping with integration of stewardship protocols into existing workflow.<br>• Operationalize prompts that trigger a review of antibiotic use in key situations, such as on the day culture results arrive (only applicable where facilities are available) or the number of days of empiric treatment, etc.<br>• In facilities where laboratory capacity is available, ensure that samples are collected for cultures before the start of antibiotics. |
| Pharmacy staff | • Change from parenteral (i.e., IV) to oral antibiotic therapy<br>• Adjust dosage and optimize dosage.<br>• Avoid therapeutic duplication.<br>• Issue time-sensitive automatic stop orders.<br>• Detect and prevent antibiotic-related drug interactions. |
| Information technology staff | • Facilitate the management and reporting of antibiotic use data. |

*Source*: CDC 2015a

## 3. Implementation of policies and interventions

Key activities under implementing policies that support optimal antibiotic use and identify interventions fall under three categories:

- Broad interventions
- Pharmacy-driven interventions
- Infection- and syndrome-specific interventions

Examples of policies that apply in all situations to support optimal antibiotic prescribing include:

- Document dose, duration, and indication for all courses of antibiotics in the patient's medical record. This helps ensure the timely discontinuation and/or modification of antibiotics by clear communication and thoughtful prescribing.
- Implement national standard treatment guidelines, which can optimize antibiotic selection and duration, especially for common indications for antibiotic use, such as community-acquired pneumonia (CAP), urinary tract infections (UTIs), and surgical prophylaxis. Adapt national guidelines to local conditions, if indicated.

- Implement broad, pharmacy-driven, infection- and syndrome-specific interventions. (See details in the Chapter 1 Facility-Level Recommendations and Strategies section above.)

## 4. Intervention Modalities for Implementing an Antibiotic Stewardship Program

**Antibiotic time-outs**: Antibiotics are frequently started empirically in hospitalized patients before diagnostic information is available. In places where laboratory tests, including culture results, are not available, the only option that the clinicians will have is to reassess each patient's situation more frequently and make a decision on continuing, stopping, and choosing an alternative antibiotic if the patient's condition does not improve. An antibiotic "time-out" prompts a reassessment of the continuing need for and choice of antibiotics when the clinical picture is clearer and more diagnostic information is available. Some important questions that should be asked by clinicians when performing a review of antibiotics 48 to 72 hours after they are initiated include the following:

- Does this patient have an infection that will respond to antibiotics?
- If so, is the patient on the right antibiotic, dose, frequency, and route of administration?
- Can a more targeted antibiotic be used to treat the infection?
- For how long should the patient receive the antibiotic?

**Prior authorization**: Although not common practice in the majority of healthcare facilities in low- and middle-income countries (LMIC), hospitals can restrict the use of specific antibiotics based on their effectiveness, cost, and associated toxicities, or to ensure that they are used only when indicated. Although effective, this intervention requires individuals (such as pharmacists or physicians) with expertise in infectious diseases and antibiotics to be readily available because authorization will likely need to be provided quickly.

**Prospective audits and feedback**: A prospective audit and feedback program allows the antibiotic stewardship staff to interact directly with the treating clinician to tailor antibiotic therapy for each patient. These strategies are employed after antibiotics have been initially prescribed and dispensed. Target patient populations, such as those receiving vancomycin for suspected MRSA infections, are audited for de-escalation (de-escalation includes starting a broad-spectrum antibiotic and then modifying the therapy—antibiotic agent, route, and duration—based on the identification of specific microorganisms and improvement in the patient's condition) or cessation of unnecessary antibiotic therapy. Unlike antibiotic "time-outs," antibiotic stewardship program staff conduct prospective audits of patients and provide feedback to the treating clinician; the clinician initiates therapy and the antibiotic stewardship staff intervene only in selected cases. These programs address both over- and under-treatment (Griffith, Postelnick, Scheetz 2012).

### Pharmacy-Driven Interventions

Involving pharmacists, when available, in ensuring the rational use of antibiotics at the healthcare facilities in a LMIC can be challenging because it requires a change in culture. However, efforts should be made to engage any staff performing the tasks of pharmacy technician and pharmacy assistant in active involvement in antibiotic stewardship programs to ensure the rational use of

antibiotics. The interventions that can be performed by the pharmacist or trained pharmacy staff include:

- **Changing from parenteral (i.e., IV) to oral antibiotic therapy:** A pharmacist can change antibiotic therapy from parenteral to oral in consultation with the clinician, based on a patient's ability to take an appropriate oral alternative. This change should improve patient safety (PS) and may decrease the length of hospital stay.
- **Adjusting the dosage:** A pharmacist, when available, can review the prescription before dispensing the antibiotic to ensure that the medication is prescribed at the right dose for the indication. The pharmacist can alert the clinician about dose adjustments for admitted patients in cases of organ dysfunction (e.g., renal or hepatic adjustment).
- **Optimizing dosage:** A pharmacy staff member, when available, can suggest an optimal dose of an antibiotic based on the causative microorganism, site of infection (for example, higher doses may be needed to penetrate the central nervous system), frequency of administration, and drug interactions.
- **Avoiding therapeutic duplication:** A pharmacy staff member can perform a daily assessment of antibiotic therapy, looking for duplication of same-spectrum antibiotics, including the use of multiple agents active against anaerobes or dual therapy with broad-spectrum antibiotics effective against gram-negative bacteria.
- **Issuing time-sensitive automatic stop orders:** The facility antibiotic stewardship team can work with the prescribing clinicians so that pharmacy staff can be authorized to stop antibiotics after a certain duration or doses. A member of the pharmacy staff can stop antibiotic use when prolonged therapy has not been effective. For example, antibiotic therapy used for the prevention of infections after surgical procedures should be limited to a single dose given preoperatively or for a maximum of up to 24 hours.
- **Detecting and preventing antibiotic-related drug interactions**: Pharmacy staff should be trained to review the prescription of antibiotics and other drugs to identify any drug-drug interactions. For example, simultaneous use of rifampicin and oral contraceptives reduces the effect of the oral contraceptive. Consuming alcohol while taking metronidazole or tinidazole can cause some unpleasant side effects. In settings where online resources are not available, textbooks, guidelines, and other job aids can be used.

### Infection- and Syndrome-Specific Interventions

Antibiotic stewardship interventions are intended to improve prescriptions for specific syndromes, but should not interfere with timely and effective treatment for severe infection or sepsis.

Standard treatment guidelines for prescribing antibiotics for a given infection help avoid the use of multiple antibiotics for managing an infection that can be treated with a single, specific antibiotic. Use of standard treatment guidelines can guide day-to-day prescription and use of antibiotics at the facility. Standard treatment guidelines include those for:

- Sexually transmitted infections

- CAP
- UTIs
- Skin and soft tissue infections
- Empiric treatment of MRSA infections
- *C. difficile* infections
- Maternal sepsis

Guidelines should include individual condition, diagnosis, treatment (first-line and second-line antibiotic agent, dose, route of administration, and duration), drug toxicity monitoring, and drug interactions. Conducting regular periodic reviews of the implementation of standard treatment guidelines and continuously improving the quality of implementation will allow the most appropriate use of antibiotics and help avoid unnecessary continuation and prescribing of inappropriate antibiotic therapy.

## 5. Tracking and reporting antibiotic use and outcomes

Data on antibiotic use can be collected to monitor antibiotic prescription, distribution, and resistance patterns and to evaluate the process and outcomes of antibiotic stewardship programs. This system is designed to serve as a tool for tracking drug use to improve the quality of drug use. For example, antibiotic use for a ward can be compared with use in different units in a facility and with other facilities (WHOCC 2009).

Monitoring antibiotic use and outcomes includes both process and outcome measures. Evaluation of the process may include monitoring the implementation of policies and guidelines about antibiotic use and the number of prescriptions issued, whereas outcome measures include monitoring patient outcomes.

**Antibiotic use process measure**: Process measures include qualitative assessment of antibiotic prescribing patterns in the healthcare facility. Examples of process measures include but are not limited to:

- Using accurately applied diagnostic criteria as per the standard treatment guidelines, if available.
- Prescribing the appropriate antibiotic, in the right dose, for the right duration, and using the right route of administration for the specific indication.
- Collecting samples for laboratory investigations before administration of antibiotics.
- Modifying treatment based on laboratory test results, if indicated.
- Conducting periodic assessments to review the effectiveness of treatment and potential changes.
- Although the process reviews can be carried out retrospectively by doing chart reviews, given the quality of documentation on antibiotic use, conducting prospective process monitoring is a better option.

**Antibiotic use measure**: Healthcare facilities implementing antibiotic stewardship programs measure antibiotic use either as days of therapy or defined daily dose. (See Appendix 1.2.A for more information about antibiotic use measures.)

Management of information on drug use requires dedicated training of pharmacy staff. Healthcare facilities embarking on such activities should ensure that pharmacy staff are appropriately trained.

## 6. Education

Stewardship programs should provide education and regular updates on antibiotic prescribing, antibiotic resistance, IPC measures, and infectious disease management to ensure behavior change to improve antibiotic prescribing among HCWs.

### Rational Use of Antibiotics

Medications are used rationally when they are:

- Clinically appropriate for the patient
- Prescribed in doses that meet the patient's requirements
- Taken for the recommended time period
- Taken at the recommended frequency
- The lowest cost option for the patient and the community

Medications are not used rationally in the following circumstances:

- Excessive use of multiple medicines for the same purpose in the same patient, also known as polypharmacy.
- Use of injections when oral formulations would be an equally appropriate or more preferred route of administration.
- Inappropriate use of antibiotics, such as failure to narrow the therapy when culture results are known, or use of antibiotics to treat viral infections.
- Antibiotic selection that differs from what is recommended in standard treatment guidelines.
- Self-medication with antibiotics, such as buying them without a prescription written by a healthcare provider (Holloway 2011).

### Determinants of Irrational Use of Antibiotics

There are several determinants of the irrational use of antibiotics:

- Lack of provider knowledge, especially prescribers who are insufficiently qualified, supervised, or supported
- Prescriber habits (prescribing without following the guidelines)

- Non-availability of standard treatment guidelines for prescribing antibiotics
- Non-availability of a specific drug to treat a clinical condition, resulting in prescribing a less effective or inappropriate alternative
- Lack of unbiased, independent, government-funded continuing medical education and supervision that include prescribing
- Excessive promotion and incentives for prescribing offered by the pharmaceutical industry
- Short consultations that do not provide time to explain to the patients that there is no need for antibiotics and that the condition will improve in a few days without antibiotics
- Following practices of senior practitioners
- Perceived patient demand
- Lack of diagnostic and laboratory support
- Inappropriate procurement of antibiotics by hospitals and the public sector supply chain

(Radyowijati, Haak 2003; Rowe, de Savigny, Lanata, et al. 2005; Sketris, Ingram, Lummis 2009; WHO 2002).

## SUMMARY

Everyone (countries, hospitals, physicians, and individuals) plays a part in the prevention of antibiotic resistance, but rational use cannot be achieved without knowledge of the problem. IPC staff can help prevent the irrational use of antibiotics and encourage the implementation of strategies that reduce the development of antibiotic resistance.

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# SECTION 2: PREVENTION OF COMMON HEALTHCARE-ASSOCIATED INFECTIONS

# CHAPTER 1: PREVENTING SURGICAL SITE INFECTION

### Key Topics

- Surgical site infection (SSI) basics: epidemiology and microbiology
- Major risk factors for SSIs
- Prevention of SSIs
- Identify the commonly used antiseptics in IPC
- Monitoring and surveillance of SSIs
- Quality improvement for prevention of SSIs

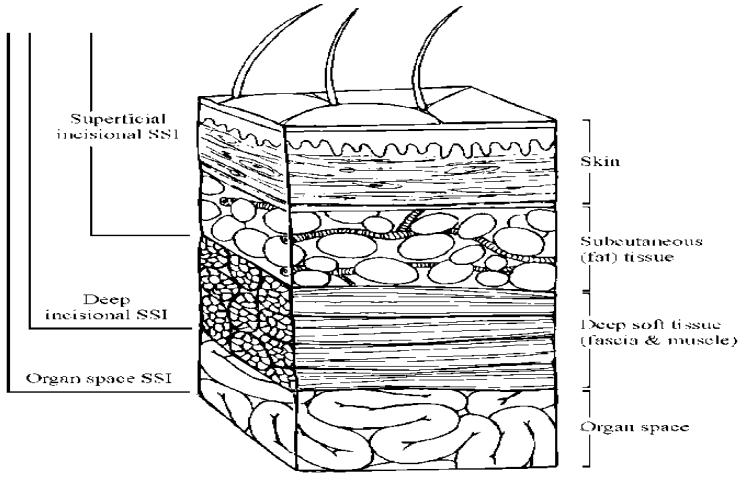
## BACKGROUND

Despite improvements in operating theater (OT) practices, instrument sterilization methods, and surgical techniques, and the efforts in IPC by HCWs, SSIs remain a major cause of HAIs. Moreover, in countries where resources are limited, even common procedures, such as appendectomies and cesarean sections (C-sections), are associated with high infection rates and mortality (Alvarado, Farr, McCormick 2000). These infections are often caused by multidrug-resistant microorganisms. However, by following evidence-based IPC practices before, during, and after surgery, HCWs can prevent SSIs in their patients.

As shown in figure 2.1-1, SSIs are divided into superficial incisional infections (i.e., involvement of the skin and subcutaneous tissue),[1] deep incisional infections (i.e., involvement of deeper soft tissue, including fascia and muscle layers), and organ space infections.[2]

[1] Superficial incisional infections do not include stitch abscess, infection of episiotomy (an incision made in the perineum during childbirth), newborn circumcision, or infected burn wounds. Specific criteria, separate from SSI, are used to identify these HAIs and to track them for the purposes of quality improvement.
[2] For confirmation of all SSIs, specific criteria of a SSI surveillance definition, including signs and symptoms and/or laboratory tests (e.g., organism isolated from aseptically obtained culture and imaging results), must be met.

Figure 2.1-1. Cross-section of abdominal wall showing CDC classifications of SSIs




*Source*: Mangram, Horan, Pearson, et al. 1999

It is important to use available resources wisely by focusing on preventing SSIs from procedures most frequently performed with the highest SSI rates or the most serious consequences to the patient. Reducing the risk of SSIs is relatively simple and inexpensive, especially compared with the cost of the infections themselves. Reducing the risk factors associated with SSIs requires commitment at all levels of the healthcare system.

## Epidemiology

Considerable progress has been made in understanding the cause and prevention of SSIs in the past 100 years. However, postoperative wound infections remain a leading cause of HAIs, especially in limited-resource settings, where SSIs are the most frequently diagnosed HAI, ranging from 1.2 to 23.6 per 100 surgical procedures, and increased hospital lengths of stay by up to 21 additional days (WHO 2011).

## Microbiology

Bacteria and other microorganisms are routinely introduced into the surgical incision during surgical procedures. However, only a small number of patients actually develop a clinical infection (Fry 2003). The development of postoperative infections following microorganism contamination depends on the following factors:

- Number of microorganisms entering the wound
- Type and virulence (i.e., ability to cause disease) of the bacteria
- Strength of the patient's defense mechanisms (e.g., status of the immune system)
- External factors, such as the patient's preoperative length of stay at the healthcare facility or the duration of the surgery (more than 4 hours)

Most SSIs are caused by microorganisms found on the patient's skin, mucous membranes adjacent to the surgical site, and other sites on the body (e.g., nose, mouth, or GI tract). Bacterial

contamination may also be caused by exogenous sources (i.e., a microorganism that is not part of the normal human flora introduced to a patient's body from an external environment) (WHO 2011). These sources include:

- The hands of the surgical HCWs
- Contaminated instruments, drapes, surgical gloves, or other equipment used in the surgery
- Contaminated surfaces and/or air in the OT

Microorganisms associated with SSIs vary with the type of procedure and the location of the operation on the patient's body. *Staphylococcus aureus*, coagulase-negative staphylococci, and *Enterococcus* species are associated with more than 50% of SSIs. *Escherichia coli* and *Pseudomonas aeruginosa* are also among the most frequently isolated pathogens from SSIs; an increasing number of SSIs are caused by antimicrobial-resistant pathogens and fungal infections. The number of these infections has risen significantly in the last decade. The array of microorganisms that cause SSIs is similar in many countries throughout the world (box 2.1-1) (Hidron, Edwards, Patel, et al. 2008).

Box 2.1-1. The most common pathogens associated with SSIs

*Staphylococcus aureus*

Coagulase-negative staphylococci

Enterococcus species

*Escherichia coli*

*Pseudomonas aeruginosa*

Enterobacter species

*Klebsiella pneumoniae*

Candida species

*Klebsiella oxytoca*

*Acinetobacter baumannii*

*Adapted from:* Hidron, Edwards, Patel, et al. 2008

## Risk Factors for SSI

Risk factors for developing a SSI can occur before, during, and after surgery. The risk factors can be patient-related or procedure-/practice-related (box 2.1-2). Of the many possible human conditions and surgical practices, few have been proven to independently influence the risk of infection. This is, in part, due to the complex nature of acquiring an SSI and the difficulty in designing and conducting studies that accurately isolate the effect of a single factor.

Box 2.1-2. Patient characteristics and perioperative practices that may influence the risk of developing an SSI

**Patient**

- Coexistent infections at a remote body site
- Colonization with microorganisms (i.e., *S. aureus* or MRSA)
- Age (e.g., elderly or < 5 years)
- Poor nutritional status
- Uncontrolled diabetes
- Smoking or use of other tobacco products
- Obesity (body mass index ≥ 30 kg/m$^2$)
- Altered immune response (e.g., HIV/AIDS and chronic corticosteroid use)
- Length of preoperative stay

**Preoperative**

- Lack of preoperative bathing
- Inappropriate preoperative patient hair removal
- Inappropriate preoperative patient skin preparation
- Inadequate preoperative HCW hand and forearm antiseptic surgical scrub

**Intraoperative**

- Deficiencies in OT environment (e.g., lack of appropriate ventilation, cleanliness)
- Failures in instrument processing (e.g., lapses in cleaning, high-level disinfection, and/or sterilization processes)
- Lapses in surgical attire of HCWs and draping of patients
- Long duration of surgery
- Lack of appropriate perioperative antimicrobial prophylaxis
- Foreign material in the surgical site
- Poor surgical technique
- Ineffective hemostasis
- Not maintaining normal body temperature (normothermia)
- Tissue trauma
- Entry into hollow viscus
- Presence of surgical drains and suture material
- Failure to obliterate dead space

**Postoperative**

- Lack of normal glucose levels
- Poor wound care practices

*Adapted from*: WHO 2009a

## Prevention of SSIs

The complete surgical process (preoperative, intraoperative, and postoperative) contains a multitude of complex steps that are performed by a large group of HCWs (including cleaning staff, sterilization personnel, laundry workers, nurses, doctors, anesthesia personnel, etc.). A breakdown in excellent IPC at any of these steps can cause or contribute to infection. For this reason, every

HCW has responsibility for ensuring that all evidence-based practices are implemented at every step to prevent SSIs.

## WHO Guidelines to Prevent SSI

In 2016, the WHO published the first global guidelines for SSI prevention (WHO 2016). The document should guide the practices of HCWs and the allocation of resources provided by healthcare facility leaders. Although all healthcare facilities in limited-resource settings should aspire to implement WHO's recommendations, some interim modifications may be needed based on what is currently practical and available at healthcare facilities, until resources and practices can be improved. Box 2.1-3 provides WHO's strongly recommended practices.

Box 2.1-3. WHO's strong recommendations for the prevention of SSIs

- Patients with known nasal carriage of *S. aureus* should receive intranasal applications of mupirocin 2% ointment with or without a combination of chlorhexidine gluconate (CHG) body wash.
- Mechanical bowel preparation alone (without the administration of oral antibiotics) should **not** be used in adult patients undergoing elective colorectal surgery.
- In patients undergoing any surgical procedure, hair should either **not** be removed or, if absolutely necessary, should be removed only with a clipper before entering the OT. Shaving is strongly discouraged at all times, whether preoperatively or in the OT.
- Surgical antibiotic prophylaxis (SAP) should be administered before surgical incision, when indicated.
- SAP should be administered within 120 minutes before incision, while considering the half-life of the antibiotic.
- Surgical hand preparation should be performed either by scrubbing with a suitable antimicrobial soap and water or using a suitable alcohol-based hand rub before donning sterile gloves.
- Alcohol-based antiseptic solutions based on CHG for surgical site skin preparation should be used in patients undergoing surgical procedures.
- Adult patients undergoing general anesthesia with endotracheal intubation for surgical procedures should receive 80% fraction of inspired oxygen intraoperatively and, if feasible, in the immediate postoperative period for 2 to 6 hours.
- SAP administration should not be prolonged after completion of the operation.

*Source*: WHO 2016

## General Measures To Prevent SSIs

### Patient Preparations

Complete preoperative evaluations for scheduled elective surgeries and identify underlying conditions that should be managed at least 30 days before scheduling surgery. They include:

- Controlling diabetes and high blood pressure before elective surgery.
- Target blood glucose levels should be ≤ 200 mg/dL in both diabetic and non-diabetic surgical patients. Maintain target blood glucose during the pre-, intra-, and postoperative periods (up to 36 hours).

- Advising and assisting patients to cease smoking or using other tobacco products at least 30 days before elective surgery.
- Advising and assisting patients to achieve a healthy weight:
    - Enhanced nutritional support: Consider administration of oral or enteral (i.e., via feeding tube) multiple nutrient-enhanced nutritional formula for the purpose of preventing SSIs in underweight patients undergoing major surgery.
    - Please note that enhanced nutritional formulas contain any combination of arginine, glutamine, omega-3 fatty acids, and nucleotides.
    - Weight loss guidance and support for overweight patients.
- Treating infections remote to the surgical site, if possible, or postponing the surgery until the infection has cleared.
- Recommending that patients undergo elective surgery, where feasible, in day-stay surgery centers (when available) rather than acute care hospitals to help decrease the risk of exposure to microorganisms in the hospital.
- Educate patients and relatives on the following topics to facilitate their involvement in SSI prevention:
    - Hand hygiene practices
    - Preoperative bathing or shower
    - Mechanical bowel preparation (when indicated)
    - Rational use of antibiotics following surgery and prevention of AMR

**Skin Preparation Before Surgical Procedures**

Applying an antiseptic solution minimizes the number of microorganisms around the surgical wound that may contaminate and cause infection.

**Instructions**

**STEP 1** Do not shave hair around the operative site. Shaving increases the risk of infection 5 to 10 fold because the tiny nicks in the skin provide an ideal setting for microorganisms to grow and multiply (Nichols 2001; Seropian & Reynolds 1971). If the hair must be cut, trim the hair close to the skin surface with scissors immediately before surgery.

**STEP 2** Ask the patient about previous allergic reactions (e.g., to iodine preparations) before selecting an antiseptic solution.

**STEP 3** Gently wash the operative site with soap and clean water and dry the area before applying the antiseptic if the skin or external genital area is visibly soiled.

Select the antiseptic solution from the following recommended products:

- Alcohol-based solutions (tinctures) of iodine or chlorhexidine
- Alcohols (60% to 90% ethyl, isopropyl, or “methylated spirit”)

- Chlorhexidine (2% to 4%) (Hibiclens®, Hibiscrub®, Hibitane®)
- Chlorhexidine and cetrimide, various concentrations at least 2% (e.g., Savlon®)
- Iodine (3%); aqueous iodine and alcohol-containing (tincture of iodine) products
- Iodophors (7.5% to 10%), various concentrations (Betadine® or Wescodyne®)
- Chloroxylenol (0.5% to 4%) (para-chloro-meta-xylenol or PCMX) various concentrations (Dettol®)

**STEP 4** Use dry, high-level disinfected forceps and new cotton or gauze squares soaked in antiseptic to thoroughly cleanse the skin.

Cleanse from the operative site outward for several centimeters. (A circular motion from the center out helps prevent recontamination of the operative site with local skin bacteria.)

Do not allow the antiseptic to pool underneath the client's body because this can irritate or burn the skin.

**STEP 5** Allow the antiseptic enough time for better effect before beginning the procedure. For example, when an iodophor is used, allow 2 minutes or wait until the skin is visibly dry before proceeding, because free iodine (the active agent), is released only slowly.

Generally, always allow the antiseptic enough time to dry. Equally important is that care must be taken not to allow the applied antiseptic to pool underneath the patient's body because it can irritate the skin.

**OT Preparation**

**Ventilation:** Keep the movement of surgical team members in and out of the OT to a minimum during the surgery. Keep the doors closed. Maintain positive air pressure ventilation for the OT. Ensure appropriate air exchanges (15 per hour), airflow patterns, temperature (20–23°C [68–73°F]), and humidity (30–60%) for OTs with other than natural ventilation. Air should flow out of the OT, the cleanest area, and move from clean to less-clean areas. For OTs with natural ventilation, ensure that the OT is protected from dust, flies, and other insects.

**Environmental cleaning:** Follow environmental cleaning guidelines to prepare the OT for the first patient of the day. Between patients, focus on cleaning and disinfecting the surfaces of the surgical table and surrounding area. Carry out cleaning of the OT at the end of the day. Follow recommendations for environmental cleaning of OTs in national IPC guidelines and see Volume 1, Chapter 9: Environmental Cleaning.

**Sterile instruments:** Sterile sets of surgical instruments and equipment should be available for surgery, and sterility should be carefully maintained. (See Volume 1, Chapter 7: Decontamination and Reprocessing of Medical Devices [Instrument Processing] for detailed guidance.) When the sterile packs are opened, indicators must be checked; the packs inspected for wetness before the instruments are introduced to the sterile field (do not use those that have failed indicators, dampness, tears, or other threats to sterility). Sterility of the sterile field should be meticulously maintained by all staff in the OT.

## Perioperative Interventions to Prevent SSIs

### Preoperative Measures to Prevent SSIs

**Preoperative bathing**: Advise the patient to bathe or shower using plain soap or an antimicrobial soap before surgery.

**Decolonization** with mupirocin ointment with or without CHG body wash for the prevention of *Staphylococcus aureus* infection in nasal carriers. Patients undergoing cardiothoracic and orthopedic surgery with known nasal carriage of *S. aureus* should receive perioperative intranasal applications of mupirocin 2% ointment with or without combination of CHG body wash. Advise patients not to use body lotion after using CHG body wash. The use of mupirocin 2% ointment is also recommended for other surgeries in patients who are known nasal carriers of *S. aureus*.

**Preoperative SAP**: SAP should be administered before the surgical incision when indicated (depending on the type of operation). SAP should be administered within 120 minutes before incision, while considering the half-life of the antibiotic.

**Mechanical bowel preparation and the use of oral antibiotics**: Preoperative oral antibiotics combined with mechanical bowel preparation should be used to reduce the risk of SSI among adult patients undergoing elective colorectal surgery. Mechanical bowel preparation without oral antibiotics for prevention of SSI should not be used.

**Hair removal**: Do not remove hair, but if it is absolutely necessary, remove it just before surgery (before entering the OT) with a clipper. Do not shave, whether hair removal is done preoperatively or in the OT.

**Surgical site preparation**: Prepare the surgical site using alcohol-based antiseptic solution of chlorhexidine. If chlorhexidine is not available, use alcohol-containing iodine solution.

**Surgical hand preparation**: Perform surgical hand preparation by scrubbing with a suitable antimicrobial soap and water or using alcohol-based hand rub (ABHR) before putting on gloves.

### Intraoperative Measures to Prevent SSIs

**Surgical Techniques:**

Use good surgical techniques to minimize tissue trauma, control bleeding, and eliminate dead space; remove dead tissue and foreign bodies; use minimal sutures; and maintain adequate blood supply and oxygenation. Specifically, it is important to:

- Limit the length of the surgery. The longer the incision remains open, the higher the risk of the introduction of microorganisms into the surgical incision.
- Use minimally invasive surgical approaches, if available, including the use of endoscopes and other devices through a very small skin incision to reduce the risk of SSIs.
- Handle soft tissue gently to avoid crushing, which can result in tissue death (i.e., necrosis).

- Limit the use of electrocautery to control bleeding because it leaves behind dead tissue that is more likely to become infected.
- Use either sterile disposable non-woven or reusable woven drapes to cover the surgical site and surrounding area during a surgical procedure.
- Use closed suction drains that exit through a separate stab wound to help prevent accumulation of tissue fluid in the dependent portion of the wound. This is especially important in obese patients and may reduce SSI. Please note that passive drains (e.g., Penrose drains[3]), exiting through the bottom of the incision should not be used.
- Consider using impervious, single-use, disposable wound protector devices, if available, in clean-contaminated, contaminated, and dirty abdominal surgical procedures in adult patients.
- Irrigate an incisional wound before closure using a sterile aqueous solution of povidone-iodine followed by sterile normal saline solution, particularly in clean and clean-contaminated wounds: use povidone-iodine 10% in open abdominal surgery, 0.35% in orthopedic spine surgery.

**Use absorbable sutures**, whenever possible, because permanent sutures, especially silk sutures, act as foreign bodies and can provide a focus for microorganisms that cause infection.

**Perioperative oxygenation**: In patients undergoing general anesthesia with endotracheal intubation for surgery, provide 80% fraction of inspired oxygen (FiO2) intra-operatively and, if feasible, in the immediate postoperative period for 2 to 6 hours to reduce the risk of SSI.

**Maintaining normal body temperature**: In patients who have an anesthesia duration of more than 60 minutes, maintain core body temperature above 36°C (96.8°F) (i.e., continuously or intermittently monitor temperature) by using external warming techniques, including mechanical warming devices, heat preserving head and foot coverings, and covering the patient with blankets.

**Perioperative blood glucose control**: Keep perioperative blood glucose to less than ≤ 200 mg/dL both in diabetic and non-diabetic patients.

**Maintaining adequate circulating fluid volume**: Use intraoperative goal-directed fluid therapy to reduce the risk of SSI. (Used in critical care medicine, goal-directed fluid therapy involves intensive monitoring and aggressive management of normal perioperative blood flow in patients using optimal fluids, such as crystalloid or colloid.) If appropriate resources and staff trained in administering goal-directed fluid therapy are not available, ensure appropriate volume replacement, proper tissue oxygenation, and normothermia.

**Blood transfusion**: There are no specific recommendations for blood transfusion to prevent SSIs. It is recommended that transfusion of necessary blood component products not be withheld just for the purpose of preventing SSIs if there are other indications.

[3] Penrose open drains are soft and flexible drains that do not have any collection device and drain passively into the dressing materials. Drains act like straws to pull fluids out of the wound and release fluids outside the body, but they provide a direct path for infection into the wound.

**Drapes and gowns**: Use both sterile disposable non-woven or sterile reusable woven drapes and surgical gowns during surgical operations for the purpose of preventing SSIs. (See the section below on Using Drapes for Surgical Procedures.)

**Wound protector device**: If available, consider the use of wound protector devices in clean-contaminated and dirty abdominal surgical procedures for reducing the risk of SSI.

**Incisional wound irrigation**: If resources are available, use irrigation of the incisional wound with an aqueous povidone-iodine solution before closure of clean and clean-contaminated wounds. There is insufficient evidence to recommend for or against the use of sterile normal saline solution by itself for irrigation of an incisional wound for preventing SSI.

**Prophylactic negative-pressure wound therapy**: In settings where resources are available, use of prophylactic negative-pressure wound therapy in adult patients. Primarily closed surgical incisions in high-risk wounds may reduce the risk of SSI. Generally, devices that create negative pressure between 75 and 125 mm of Hg for 1 to 7 days postoperatively are recommended.

**Antimicrobial-coated sutures**: Use of triclosan-coated sutures is suggested for the purpose of reducing the risk of SSI in all surgical procedures. (They can be used if they are available at the facility.)

## Intraoperative and Postoperative Incision Care to Prevent SSIs

### Primarily Closed Wounds

Cover incisions that are closed with suture materials immediately at the end of the surgical procedure (e.g., primary closure). Use sterile, dry gauze and absorbent dressing or occlusive dressing, and secure in position.

When a surgical incision is closed, the incision is usually covered with a sterile dressing for 24 to 48 hours. Beyond 48 hours, there is no need to cover an incision for preventing SSIs.

**Applying topical antibiotics is not recommended because these products have no additional role in reducing SSI.**

### Other Than Primarily Closed Wounds

Incisions that are left open at skin level for a few days (usually 4 to 5 days) before they are closed (e.g., closed by delayed primary closure) or incisions/wounds that are left open to heal by themselves from the base of the wound upward (i.e., healing by secondary intention) should initially be packed and covered with a sterile, moist gauze dressing and changed regularly.

Healthy tissue growth is damaged when dry gauze is removed. Moisten dry gauze with sterile, normal saline before removing the gauze. If gauze dressings moistened with sterile normal saline are used, they should be changed using aseptic technique (i.e., sterile gloves) every 8 hours to prevent the gauze from drying out.

If sterile gauze filled with petroleum jelly or other moistening agents is used to pack and cover the incision, it needs to be changed less often (24 to 48 hours), depending on the type of wound and the manufacturer's directions.

## Postoperative Measures to Prevent SSIs

- Do not continue the use of antibiotic prophylaxis after the completion of the surgical procedure for the purpose of SSI prevention. The antibiotic prophylaxis for SSI prevention should not be continued beyond the completion of the operation.
- Continue to monitor and control blood glucose levels in the postoperative period for up to 48 hours or until tube-feeding is discontinued.
- Cover the dressing and surrounding area to keep them dry while bathing. The patient should avoid showering to keep the dressing and surrounding area dry and should not bathe or shower while the incision is packed and covered with a dressing (or at least until granulation tissue is present in a wound healing by secondary intention). Educate patients and family on hand hygiene and correct incision site care.
- Discharge patients as soon as possible (when indicated by clinical condition) after surgery to decrease the risk of exposure to microorganisms in the healthcare facility.

## Practices Not Recommended for Prevention of SSIs

The following are recommendations about practices to avoid because they have no beneficial effect on reducing or preventing SSIs:

- Do **not** perform routine microbiologic sampling to identify the level of microbial contamination in the air or on OT surfaces.
- Do **not** screen patients for extended-spectrum beta-lactamase colonization.
- Do **not** use antimicrobial sealants to cover the surgical site after skin preparation for reducing SSIs.
- Do **not** discontinue immunosuppressive medication before surgery for prevention of SSI.
- Do **not** use double gloves for the purpose of reducing SSIs; they may be used for additional protection of the HCW against bloodborne pathogens.
- Do **not** use laminar flow ventilation systems to reduce the risk of SSI.
- Do **not** use plastic adhesive incise drapes with or without antimicrobial properties for the purpose of preventing SSIs.
- Do **not** perform special cleaning (e.g., fogging) or close the OT after contaminated or dirty surgeries.

## Systemic Antibiotic Prophylaxis in Surgery

The use of antibiotics preoperatively can significantly reduce the rate of infection, particularly wound infections, after certain surgical procedures. The benefit, however, must be weighed against the risks of toxic and allergic reactions, the emergence of resistant bacteria, drug interactions, super infection, and costs (Nichols 2001).

Ideally, the prophylactic antibiotic should target the organisms most likely to cause infection, which can vary locally and by type of surgery. Selection of prophylactic antibiotic agents before surgery will depend on the microorganism responsible for causing the SSIs, efficacy of the antibiotic in killing these microorganisms, the age of the patient, and the duration of effect of the microbial agent. (See Appendix 2.1.B. Recommendations for Antimicrobial Prophylaxis for Selected Surgical Procedures.) In low-resource settings, the cost of the antimicrobial agents will also be a factor.

For most procedures, an inexpensive first-, second-, or third-generation cephalosporin (e.g., cefazolin, cefoxitin, ceftriaxone) is recommended. These cephalosporins are active against staphylococci and streptococci and have been effective when given intravenously within 60 minutes before surgery. Exceptions to this treatment are for an appendectomy, where cefoxitin and cefotetan are preferred because they are more active than cefazolin against anaerobic microorganisms in the bowel.

For colorectal surgeries, due to resistant anaerobic organisms, cefazolin with metronidazole is likely better than single agent cefoxitin or cefotetan.

Where methicillin-resistant staphylococci are a concern postoperatively, vancomycin can be used. **Routine use of vancomycin, however, should be avoided because it may promote the emergence of resistant microorganisms** (Bratzler, Dellinger, Olsen, et al. 2013).

In most instances, a single IV dose of an antibiotic completed within 60 minutes before the procedure is recommended (See Appendix 2.1.A. Recommended Doses and Re-Dosing Intervals for Commonly Used Antimicrobials for Surgical Prophylaxis.) If vancomycin or a fluoroquinolone is used, it should be administered within 60 to 120 minutes before the initial incision. Therapeutic levels of the antibiotic, however, should be maintained throughout the procedure. If surgery is prolonged (e.g., more than 4 hours), major blood loss occurs, or an antibiotic with a short half-life (e.g., cefoxitin) is used, one or more additional doses should be given during the procedure, depending on the antibiotic used. Dosing should also be adjusted for obese and morbidly obese patients. Antibiotics should be discontinued immediately postoperatively unless otherwise indicated (Bratzler, Dellinger, Olsen, et al. 2013).

## Prevention of Bacterial Endocarditis

Infective endocarditis is an infection caused by bacteria that enter the bloodstream and settle in the inner lining of a heart valve or blood vessels. Certain surgical procedures involving dental, GI, and genitourinary tract procedures result in high bacteremia (i.e., bacteria in the blood). These procedures are associated with the risk of bacterial endocarditis, particularly in patients having congenital heart disease or abnormalities of the heart valves and those with artificial valves. Some strains of streptococci and enterococci are more likely than other strains to cause endocarditis following dental and respiratory procedures. Table 2.1-1 provides a list of recommendations for the prevention of infective endocarditis before dental procedures (American Heart Association [AHA] 2015; Nishimura, Carabello, Faxon, et al. 2008).

Although there is no conclusive evidence of high-quality outcomes with prophylactic antibiotics to prevent infective endocarditis, the AHA recommends the use of prophylactic antibiotics before undergoing dental procedures for patients with artificial heart valves, previous history of endocarditis, active valve disease following cardiac transplantation, and patients with congenital

heart disease. However, the use of antibiotics solely to prevent endocarditis is not recommended for patients who are undergoing GI or genitourinary procedures, including patients with the highest risk of adverse outcomes from infective endocarditis (AHA 2015).

Table 2.1-1. Prevention of bacterial endocarditis before dental procedures

| Situation | Agent | Regimen—Single dose 30–60 minutes before procedure | |
|---|---|---|---|
| | | Adults | Children |
| Oral | Amoxicillin | 2 g | 50 mg/kg |
| Unable to take oral medication | Ampicillin or | 2 g IM or IV | 50 mg/kg IM or IV |
| | Cefazolin or ceftriaxone | 1 g IM or IV | 50 mg/kg IM or IV |
| Allergic to oral penicillin or ampicillin | Cephalexin[a,b] or | 2 g | 50 mg/kg |
| | Clindamycin or | 600 mg | 20 mg/kg |
| | Azithromycin or clarithromycin | 500 mg | 15 mg/kg |
| Allergic to penicillin or ampicillin and unable to take oral medication | Cefazolin or ceftriaxone[b] | 1 g IM or IV | 50 mg/kg IM or IV |
| | Or Clindamycin | 600 mg IM or IV | 20 mg/kg IM or IV |

[a] This can include other first- or second-generation oral cephalosporin in equivalent adult or pediatric dosage.

[b] Cephalosporins should not be used on patients with a history of anaphylaxis, angioedema, or urticaria with penicillin or ampicillin.

*Adapted from*: Wilson, Taubert, Gewitz, et al. 2007

## SSI Prevention and Control Practice Bundle

The Institute for Healthcare Improvement in the United States developed the concept of a "bundle" to help HCWs care for patients during specific treatments. A bundle is a structured way of improving care and patient outcomes. They are a small group of, straightforward set of evidence-based interventions, which when performed collectively and reliably, have proven to improve patient outcomes. Box 2.1-4 provides an example of the components of a bundle of practices for the prevention of SSIs that are easily applicable in low-resource settings.

Box 2.1-4. Bundle for prevention of SSIs

- Patient preoperative bathing with plain or antiseptic soap
- Appropriate hair removal (avoid removal or use clippers)
- Optimize patient skin preparation with alcohol-based and chlorhexidine-based skin disinfection products
- Optimize surgical hand preparation (see Volume 1, Chapter 4: Hand Hygiene)
- Appropriate antibiotic prophylaxis, based on local guidelines, given within 1 hour preoperatively and discontinued postoperatively
- Improved OT discipline, including sterile technique, limits on the number of individuals and reductions in intraoperative traffic

*Source*: Allegranzi, Aiken, Kubilay, et al. 2018

## Selection of Antiseptics

Plain soap and clean water physically remove dirt, other materials, and some transient flora from the skin. However, antiseptic solutions kill or inhibit almost all transient and many resident microorganisms, including most bacteria (except spores) and many viruses. Antiseptics are designed to remove as many microorganisms as possible without damaging or irritating the skin or mucous membranes. Some antiseptic solutions also have a residual effect (i.e., continue to kill microorganisms for a while after they have been applied).

Many chemicals qualify as suitable antiseptics for use on skin or mucous membranes. Appendix 2.1.B lists recommended antiseptic solutions, their microbiologic activity, and potential uses. Recommended antiseptics are CHG (Hibitane and Hibiclens) and iodophors (e.g., Betadine and Wescodyne). Preparations of these antiseptics that also contain alcohol (e.g., Chloraprep and Duraprep), for fast killing of microorganisms are recommended for skin antisepsis.

Some antiseptics are not recommended for skin preparation before clinical procedures, including Savlon (containing 0.3% w/v CHG and 3.0% w/v cetrimide) and Dettol (4.8% w/v chloroxylenol). These are antiseptics used in non-healthcare settings, such as homes, and require dilution. These agents are also not recommended or designed for disinfecting and processing instruments and other inanimate objects. They do not have the same antimicrobial power as chemical disinfectants (e.g., glutaraldehydes, Cidex OPA) (Rutala, Weber, the Healthcare Infection Control Practices Advisory Committee 2008).

When deciding which antiseptic agents to use, consider several factors:

- Appropriateness for desired use
- Recommendations (e.g., WHO's 2016 *Global Guidelines for the Prevention of Surgical Site Infection)*
- Cost of the antiseptic agent
- Effectiveness in killing microorganisms
- Fast-acting properties
- Persistent activity against regrowth of microorganisms

Other factors to consider include environmental impact, fire risks, risk of influencing AMR, adverse effects, and patient outcomes.

The different types of antiseptic agents used to reduce the risk of SSI have been extensively reviewed. The results of these studies have shown the following:

- Preoperative skin preparation using an antiseptic agent, when done correctly, effectively reduces skin flora, both transient and resident, and subsequent infection rates.
- Alcohol-based antiseptic solutions for surgical site skin preparation are more effective compared with aqueous solutions (WHO 2016).
- Alcohol-based CHG is beneficial in reducing SSI rates compared with alcohol-based povidone-iodine (i.e., tincture of iodine) (WHO 2016).

- The use of surgical hand preparation with either an ABHR or an antiseptic soap solution in reducing the number of bacteria and fungi on the hands has also been well-studied and has been found to be effective (WHO 2009a).

### Use of Antiseptics

In surgery, for preoperative preparation of the patient, antiseptics used include those for surgical hand scrub, preoperative bathing, and skin and mucous membrane preparations (e.g., surgical site and vaginal preparations). Commonly used antiseptics are described in Appendix 2.1.C.

**Surgical Hand Scrub**

The purpose of surgical hand scrub is to mechanically remove soil, debris, and transient organisms before surgery and to reduce resident flora for the duration of surgery (residual effect). It is performed to prevent wound contamination by microorganisms from the hands and arms of the surgical team. This is especially important because sterile gloves alone do not prevent wound contamination due to micro-tears or potential punctures in the gloves.

Before performing surgical hand scrub, members of an operating team will change into a hospital-laundered scrub suit and put on appropriate OT attire: protective, closed-toe shoes; shoe covers (if used); a surgical head cover, and a surgical mask and eye protection (see Volume 1, Chapter 5: Personal Protective Equipment). After the surgical procedure, team members should remove their gloves and inspect their hands for blood or body fluids, wash with soap and water if any residual or biological fluids are present, or apply ABHR if their hands are not visibly soiled.

Various protocols are available for preoperative hand scrubbing. Alcohol-based surgical hand rub is thought to be at least as effective as traditional water-based surgical scrubs. However, the use of alcohol-based surgical hand scrub does require that team members have thoroughly washed their hands before using it for the first time each day.

Skin damage caused by allergic reactions to certain antiseptics provides an ideal place for microorganisms to multiply and should be avoided. One strategy for reducing exposure of HCWs to irritating soaps and detergents is to promote the use of ABHRs, including for surgical hand preparation. Several studies have demonstrated that such products are tolerated better by HCWs and are associated with a better skin condition when compared with either plain or antimicrobial soap (WHO 2009a).

## Monitoring and Surveillance of SSIs

### Surveillance of SSIs

Because SSI is the most common HAI in low-resource settings, SSI surveillance should be a priority. It is not advisable to perform surveillance for all procedures. Each healthcare facility should develop its own surveillance program, which can maximize the use of resources by choosing areas in which to focus SSI surveillance based on the characteristics and numbers of surgeries conducted, the outcomes achieved, and the healthcare facility's overall objectives (Association for Professionals in Infection Control [APIC] 2014; Lee, Montgomery, Marx, et al.

2007). A facility IPC Risk Assessment can help guide these decisions (see Volume 2, Section 5, Chapter 2: Managing IPC Programs).

**Steps in the SSI Surveillance Process:**

- **Decide** which procedures to monitor (consider high-volume and high-morbidity surgeries and the results of a facility IPC risk assessment).
- **Define** the numerator and denominator: For SSIs, the numerator is the number of infections and the denominator is the number of procedures during the same time period. (For example, numerator: the total number of SSIs following C-section in a month; denominator: the total number of C-sections in that month.)
- **Use** the definition from a credible source.
- **Develop** a process to identify cases (e.g., monitor positive wound cultures, conduct daily rounds on all patients following the surgery of interest, communicate with outpatient clinics, and call each patient 30 days after the procedure [non-implant] or 90 days after implant procedures).
- **Collate** data and prepare reports.
- **Initiate** quality improvement activities, as necessary.

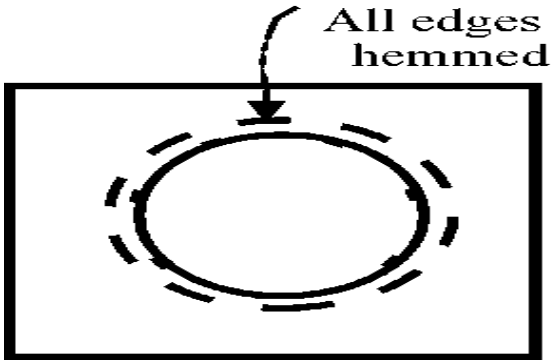
For additional information on developing an SSI surveillance program, see Volume 2, Section 3, Chapter 1: Introduction to Surveillance of HAIs.

**Role of Drapes During Surgery**

Drapes are used as a barrier to reduce the number of microorganisms that spread from unsterile to sterile areas, thus reducing the risk of infection. The main types of drapes include:

- Towel drapes are used for drying hands, squaring off the operative site (several towel drapes are needed for this), and wrapping small instruments and syringes. They are often made of cotton material and are heavier than other reusable textile items, which make them somewhat more water-resistant.
- Drapes or lap sheets are used for covering the patient. They are large, usually made of lightweight cotton, and provide only limited protection to patients and HCWs.
- Site drapes are made of cotton and have a circular opening in the center that is placed over the prepped operative site (figure 2.1-2). These drapes are primarily intended for use in minor surgical procedures with small incisions.
- Pack wrapper drapes are large drapes that act like a table cover when the sterile instrument pack is opened. These drapes need only to be large enough for wrapping the instruments and covering the tabletop completely when opened.

Figure 2.1-2. Site drapes




*Source:* Tietjen, Bossemeyer, McIntosh 2003

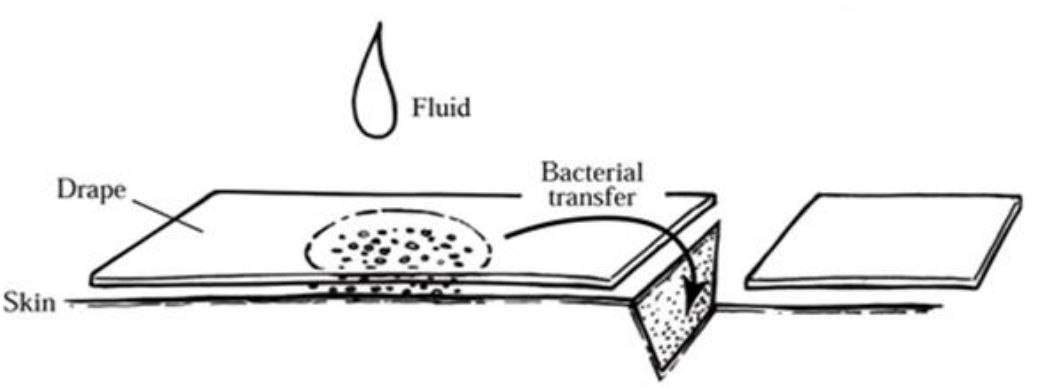
## Using Drapes for Surgical Procedures

The use of sterile towel drapes to create a work area around the incision limits the amount of skin that needs to be cleaned and prepped with an antiseptic solution before placing the drapes. Although this area is often called the "sterile field," it is only briefly sterile.

Moisture can soak through cloth drapes and can help spread organisms from the skin into the incision even after surgical cleansing with an antiseptic agent (figure 2.1-3). Gloved hands, sterile instruments, or other items should not touch the towel drapes once they are in place. Because cloth drapes do not serve as an effective barrier, clean, dry towel drapes can be used if sterile towel drapes are not available.

**Note: Sterile cloth drapes do not replace good aseptic techniques.**

Figure 2.1-3. Moisture penetration with a cloth drape




*Source:* Tietjen, Bossemeyer, McIntosh 2003

The way in which the operative site is prepared and draped depends on the type of procedure being performed. The following guidelines for draping are designed to reduce overuse of costly sterile items and avoid unnecessary draping:

- All drapes should be placed around a completely dry, widely prepped area.
- If sterile drapes are used, sterile surgical gloves should be worn when placing the drapes. (When putting drapes in place, the HCW must be careful not to touch the patient's body with gloved hands.)
- Drapes should be handled as little as possible and should never be shaken or flapped. Always hold drapes above the area to be draped (e.g., the abdominal skin) before placing on the prepped area. Discard the drape if it falls below the level of the skin to be covered.

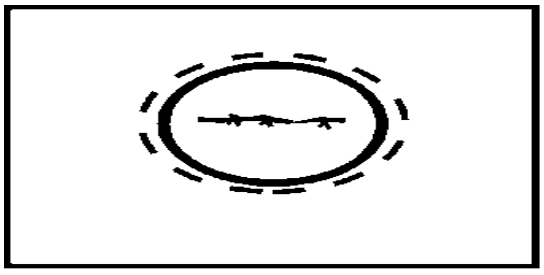
**Note: Once a sterile drape touches the patient's skin, it is no longer sterile.**

**Minor surgical procedures (e.g., Norplant implant insertion/removal or minilaparotomy):**

- Use a site drape that allows at least 5 cm (2 inches) of open skin around the incision (see figure 2.1-4). Alternatively, towel drapes can be used.
- If sterile site or towel drapes are not available, use clean, dry drapes.
- Place the hole in the drape over the prepped incision site and do not move the drape once it has touched the skin.
- If the site drape is not sterile, put on sterile gloves after placing the drape on the patient to avoid contaminating the gloves.

**Note: Lap sheets do not need to cover the entire patient.**

Figure 2.1-4. Placing a site drape




*Source:* Tietjen, Bossemeyer, McIntosh 2003

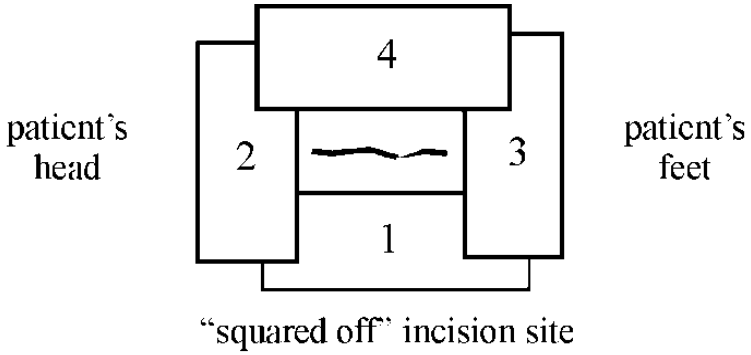
**Major surgical procedures (e.g., laparotomy or C-section):**

- Use large drapes or lap sheets to cover the patient's body.

- After cleansing the skin with an antiseptic agent, place the towel drapes to square off the incision site (allow at least 5 cm [2 inches] of open skin around all sides of the proposed incision site).
- Begin by placing the towel drape closest to you (1) to decrease the chance of contamination (see figure 2.1-5). Holding one side of the drape, allow the other side to touch the skin about 5 cm (2 inches) away from the proposed incision site. Gently drop the rest of the drape onto the abdomen. Once in place, the drape should never be moved closer to the incision. It can, however, be pulled away from the incision area but only at the same horizontal level.
- Place three additional drapes (2, 3, and 4) to square off the work area.
- Use **non-perforating** towel clips to secure the corners of the towel drapes.

**Note: Avoid reaching across the incision site unless it has been draped.**

Figure 2.1-5. Squaring off a work area




*Source:* Tietjen, Bossemeyer, McIntosh 2003

### During Procedures

Do not use the patient's body or the draped area for placing instruments because placing sterile instruments or other items on drapes, even if they were sterile initially, will contaminate the instruments. This may also make the items harder to find and may cause them to fall off the OT table if the patient moves. Use an instrument stand (e.g., Mayo stand) covered with a sterile towel or drape. If an instrument stand is not available, a sterile/high-level disinfected plastic or metal instrument tray can be placed on the drape covering the patient and used to hold instruments during the procedure.

If a drape is torn or cut during a procedure, it should be covered with a new drape. However, do not place new drapes on top of a drape that has become wet.

**Note: As drapes wear out and new drapes are needed, try to buy replacement drapes that have a high thread count.**

## Monitoring of Quality Improvement for SSI

Quality improvement interventions should be planned once SSI rates are known. Reducing SSI can significantly improve patient outcomes and reduce the facility's cost of providing care.

A multidisciplinary team, including representatives from the various disciplines that can have an impact on SSI prevention, (e.g., all levels of HCWs, including surgeons, nurses, healthcare facility administrators, healthcare facility leadership, IPC staff, cleaning staff, Central Sterile Supply Department staff), has been shown to be an effective method to support quality improvement efforts (Wick, Hobson, Bennett, et al. 2012). In this approach, the multidisciplinary team works together to plan, do, and sustain the work of quality improvement, guided by surveillance data and evidence-based practices, with timely feedback of results, outcomes, and next steps.

## SUMMARY

SSIs are a major cause of HAIs. Basic, lifesaving operations (e.g., appendectomies and C-sections) are associated with high infection and mortality rates in limited-resource settings. Relatively simple and inexpensive steps can be taken to reduce the risk; however, success requires commitment at all levels of the healthcare system.

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# CHAPTER 2: PREVENTING CATHETER-ASSOCIATED URINARY TRACT INFECTIONS

### Key Topics

- Epidemiology and mechanisms of catheter-associated urinary tract infections (CAUTIs)
- Risk factors for acquiring healthcare-associated UTIs, including CAUTIs
- Prevention strategies for healthcare-associated UTIs and CAUTIs
- IPC principles during insertion and maintenance of indwelling urinary catheters
- Monitoring and surveillance of CAUTIs
- Quality improvement for prevention of CAUTIs

## BACKGROUND

UTI is one of the most common HAIs. The majority (70%–97%) of healthcare-associated UTIs are caused by indwelling urinary catheters, known as CAUTI (Weber, Sickbert-Bennett, Gould, et al. 2011; WHO 2011). Antibiotic treatment used to treat UTIs promotes AMR and increases the risk of *Clostridium difficile* infection (i.e., bacterial infection that causes diarrhea and colitis) (Lo, Nicolle, Coffin, et al. 2014).

Complications associated with CAUTIs are significant and include discomfort to the patient, longer hospital stay, increased cost, and increased morbidity and mortality rates. For these reasons and because a high percentage of hospitalized patients are catheterized, prevention of CAUTIs is an important aspect of reducing HAIs (CDC 2016; Gould, Umscheid, Agarwal, et al. 2009; Lo, Nicolle, Coffin, et al. 2014). It has been estimated that 12%–16% of adult patients will have an indwelling urinary catheter inserted during their hospitalization (Lo, Nicolle, Coffin, et al. 2014). Urinary catheters are indicated in healthcare to monitor urine output during certain types of surgery and with critically ill patients; manage urinary retention and obstruction; and assist in healing of certain open wounds in incontinent (inability to control bladder) patients. Other indications for indwelling urinary catheters include any prolonged surgery, urological or genitourinary tract surgery, and infusion of large volumes of fluid or administration of diuretics.

The longer a urinary catheter is left in the urethra and bladder, the greater is the risk of an infection (Lo, Nicolle, Coffin, et al. 2014). It has been shown that the risk of infection associated with the use of urinary catheters can be reduced by following recommended IPC practices related to their insertion and maintenance, regardless of whether they are used in low-, middle-, or high-income countries (Lo, Nicolle, Coffin, et al. 2014; Rosenthal, Ramachandran, Dueñas, et al. 2012). This chapter provides evidence-based practices known to reduce the incidence of UTIs associated with urinary catheters. Many of these are achievable in limited-resource settings.

### Epidemiology

In LMIC, the rate is estimated at 8.8 per 1,000 urinary catheter-days. These data reflect the risks associated with catheter insertion and care in LMIC, where patients have at least twice the risk of

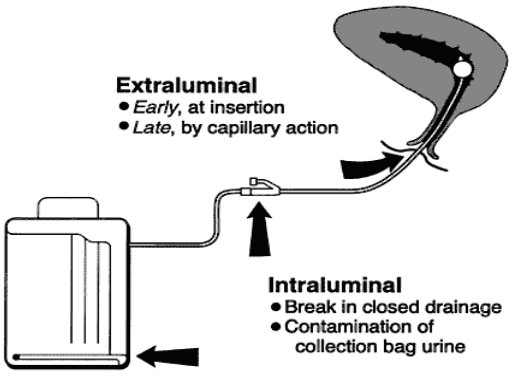
acquiring UTIs than in high-income countries, based on indwelling urinary catheter use (WHO 2011). In one study of CAUTIs in pediatric ICUs across six limited-resource countries, the results showed the pooled CAUTI rate was 5.9 per 1,000 urinary catheter-days (Rosenthal, Ramachandran, Dueñas, et al. 2012). In LMIC, the available data show that CAUTIs are the second most frequent type of HAI (24% of all HAIs), second only to SSIs, which are the most frequent type of HAI (WHO 2011).

## Mechanism

The urinary system is normally sterile except for the end of the urethra. Therefore, the normal defenses against UTIs are the free flow of urine down the urethra and complete evacuation of the bladder during which bacteria do not have the chance to grow and infect the bladder. The insertion of a catheter, however, bypasses these defenses, introduces microorganisms from the end of the perineum and urethra, provides a pathway for organisms to reach the bladder, and is a foreign body on which biofilm can form. Most microorganisms causing CAUTIs are derived from the patient's intestinal and perineal area, or the hands of HCWs during catheter insertion or manipulation of the collection system. Organisms gain access to the bladder in one of two ways (see figure 2.2-1):

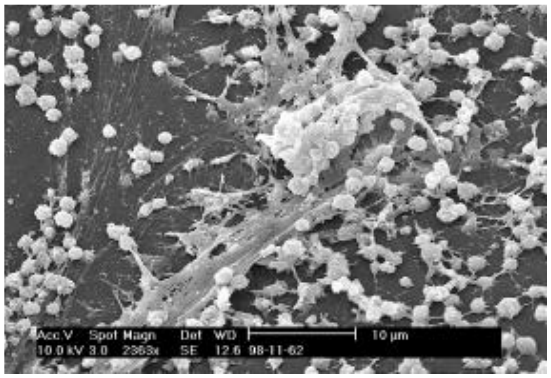
- **From the outside of the catheter (extra-luminal):** Microorganisms migrate to the bladder along the outside of the catheter via the mucosa of the urethra. Microorganisms may be lodged early and directly into the bladder during insertion or may later move up into the bladder from surrounding skin (capillary action) and may form biofilms.
- **From the inside of the catheter (intraluminal):** Microorganisms gain access to the bladder via movement along the inside (lumen) of the catheter. Contamination occurs when: **A break in the closed drainage system** occurs, resulting in contamination of the inside of the tubing or the catheter. **Urine flows in the opposite direction**, toward the bladder (reflux), thereby introducing contamination from the collection bag to the bladder.

Figure 2.2-1. Intra- and extraluminal sources of Infection




*Source*: Maki, Tambyah 2001

Figure 2.2-2. Scanning electron micrograph of the bacteria S. aureus (spheres) on the interior surface of an indwelling catheter with a biofilm (thread-like material)



*Source*: CDC 2005

### Common Organisms

Most CAUTIs are caused by gram-negative coliform bacteria, particularly *Escherichia coli*, *Pseudomonas* spp., *Klebsiella pneumoniae*, and organisms from the *Enterobacter* group. Infections with fungi, such as the *Candida* species, have increased with the advent of HIV/AIDS and widespread use of broad-spectrum antibiotics (Burke, Pombo 2012). Excessive use of quinolones (e.g., ciprofloxacin for treatment of UTI) has increased the rate of *E. coli*-resistant isolates in most countries (Nickel 2007). Additionally, there is a category of multidrug-resistant *Enterobacteriaceae*, including *E. coli*, that produce enzymes, known as extended-spectrum beta-lactamase, which inactivate antibiotics. A small proportion of CAUTIs are caused by *Staphylococcus* spp.

### Biofilm

Microorganisms form biofilms (figure 2.2-2) on most devices that are inserted or introduced into the body, including urinary catheters and collection systems. Biofilms may play an important role in the development of CAUTIs because bacteria within biofilms are protected from being penetrated and killed by antimicrobial agents and host defenses. Following recommended IPC practices (hand hygiene and glove use) when handling catheters can prevent CAUTIs.

## Catheter-Associated Urinary Tract Infections Risk Factors

CAUTI risk factors can be divided into two groups:

- Catheter-related factors include duration of catheterization, poor insertion technique, poor catheter care, and failure to maintain a closed drainage system.
- Patient-related factors: compromised immune system, diabetes mellitus, renal dysfunction, fecal incontinence, female sex, and elderly age (Gould, Umscheid, Agarwal, et al. 2009; Lo, Nicolle, Coffin, et al. 2014).

**Note: The number one risk factor for the development of CAUTIs is the duration of catheterization. For this reason, catheters should be inserted only for appropriate indications and kept in place only as long as needed (Hooton, Bradley, Cardenas, et al. 2010; Lo, Nicolle, Coffin, et al. 2014).**

## Catheter-Associated Urinary Tract Infection Prevention Strategies

**Key strategies for prevention of CAUTIs include the following:**

- Use urinary catheters appropriately: Insert a catheter only when indicated and remove it when no longer needed. Use recommended IPC practices for insertion.
- Keep the catheter secured to minimize bladder trauma.
- Ensure recommended catheter maintenance practices.
- Maintain a closed drainage system using aseptic technique.
- Educate patients and families about preventing CAUTIs.
- Remove the catheter as soon as possible.

**Acceptable Indications for Catheterization**

- For hemodynamically unstable patients who require accurate urinary output every 1–2 hours.
- For managing acute urinary retention and obstruction that is not possible to manage by other methods such as: Assisting in healing open sacral or perineal wounds in incontinent patients, prolonged immobilization due to trauma or surgery, perioperative indications, and prolonged surgeries, such as monitoring urine output during certain types of surgery (e.g., fistula repair, pelvic organ prolapse surgery, cesarean section) (Lo, Nicolle, Coffin, et al. 2014).

**Indications that do not require an indwelling urinary catheter**

- Indicated for management of incontinence, collection of lab specimens in patients who can void spontaneously (Hooton, Bradley, Cardenas, et al. 2010).

**Alternative methods for limiting the use of indwelling catheters for evacuating a urinary bladder**

- Intermittent catheterization using a reusable "red rubber" straight catheter. Loss of control (incontinence) or inability to void (retention) may be managed better by straight (in-and-out) catheterization several times a day rather than by use of an indwelling catheter. Some patients can be trained to catheterize themselves for long-term care.
- If using intermittent catheterization, perform it at regular intervals to prevent over-stretching of the urinary bladder with urine (Gould, Umscheid, Agarwal, et al. 2009).
- Use condom catheters for male patients without urinary retention or bladder outlet obstruction. Regular toileting schedule or voiding on patient demand to prevent incontinence.
- Use of adult diaper pads, bladder retraining to manage incontinence when coughing or sneezing (stress incontinence), and medical management of incontinence (e.g., medications) (Gould, Umscheid, Agarwal, et al. 2009).

**Strategies to limit the use of urinary catheters**

- Provide written guidelines for HCWs, stating appropriate indications for inserting urinary catheters (Hooton, Bradley, Cardenas, et al. 2010; Lo, Nicolle, Coffin, et al. 2014).
- Require an in-charge clinician's order in the chart before an indwelling catheter is placed (Hooton, Bradley, Cardenas, et al. 2010).
- Develop tools/job aids to remind HCWs, including clinicians, to remove the catheter when it is no longer needed (Hooton, Bradley, Cardenas, et al. 2010) (See box 2.2-1.)
- Implement an automatic stop order after a specified number of days, which will require the catheter to be removed if the order is not renewed (Hooton, Bradley, Cardenas, et al. 2010).
- Use daily order renewals requiring a reason to be given each day for continuation of the catheter.

Box 2.2-1. Urinary catheter reminder to prevent CAUTIs

**URINARY CATHETER REMINDER**

Date: ____/____/_____

This patient has had an indwelling urethral catheter since: ____/____/_____

Please indicate below **either** (1) that the catheter should be removed **or** (2) that the catheter should be retained. If the catheter should be retained, please check **all** of the reasons that apply.

___ Please discontinue the indwelling urethral catheter.

___Please continue the indwelling urethral catheter because patient requires indwelling catheterization for the following reasons (please check all that apply):

__Urinary retention

__Very close monitoring of urine output and patient is unable to use urinal or bedpan

__Open wound in sacral or perineal area and patient has urinary incontinence

__Patient is too ill or fatigued to use any other type of urinary collection strategy

__Patient has recent surgery

__Management of urinary incontinence on patient's request

__Other, please specify: _____

*Adapted from*: Lo, Nicolle, Coffin, et al. 2014

## Urinary Catheter Insertion Guidelines

The following are general guidelines for proper catheter insertion techniques.

Provide written guidelines for catheter insertion and educate HCWs on correct insertion technique. Only properly trained persons (e.g., HCWs) who know the correct IPC techniques for catheter insertion perform catheter insertion. Provide HCWs with a checklist for urinary catheter insertion. Ensure that all supplies (for example, hand hygiene supplies, sterile gloves, drapes, antiseptic solution, syringes, and sterile water, etc.) are available and conveniently located. Follow IPC practices during insertion, removal, and replacement of indwelling catheters. Consider using the smallest bore (diameter) catheter possible, consistent with good drainage, to minimize bladder neck and urethral trauma—unless otherwise clinically indicated.[4] Choose an indwelling catheter system with pre-connected, sealed catheter/collection system tubing junctions, if available, to prevent the system being disconnected. Secure indwelling catheters properly after insertion to prevent movement and pulling of the catheter within the urethra. Keep the collection bag off the floor and secure in a position below the bladder (Gould, Umscheid, Agarwal, et al. 2009).

**Do not use antimicrobial-coated catheters for short-term catheterization.**

[4] Catheter sizes are measured by their diameter size based on the French gauge system. No. 8–10 French is generally used for children, No. 14–16 for women, and No. 16–18 is used for men unless a larger size is specified.

## Procedures for Insertion, Removal, and Replacement of Indwelling Urinary Catheters Using Infection Prevention and Control Techniques

Before inserting a urinary catheter, check to be sure that it is being inserted for the right indication; for example, if a catheter is being inserted because of urinary retention, ask the patient if she or he has voided (urinated) and the time of voiding. Also, before removing a catheter, to avoid an error, confirm that the clinician's orders are correct.

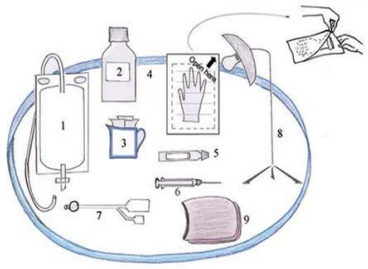
**Urinary catheter insertion procedure:**

**STEP 1**: Make sure that all of the following items are available:

1. A sterile indwelling urinary catheter with an attached closed continuous drainage system or sterile straight catheter and a clean urine collection container (figure 2.2-3)
2. A catheter with a diameter as small as possible to ensure good drainage
3. A 10-mL syringe filled with sterile water for filling the balloon of the indwelling catheter
4. A pair of non-sterile gloves and a pair of sterile gloves
5. A sterile drape, ideally with an opening in the center
6. Either antiseptic solution (e.g., aqueous 10% povidone-iodine) if the patient has an iodine allergy or sterile solution for periurethral cleaning (e.g., sterile water or normal saline)[5]
7. Sterile, sponge-holding forceps with sterile gauze squares (2 x 2) or large, cotton applicators
8. A single-use packet of lubricant (sterile, if possible)
9. Supplies to secure the catheter once inserted (adhesive tape)
10. A light source (flashlight or lamp), if needed
11. A basin of clean, warm water, soap, and a clean, dry towel
12. A waterproof polyethylene sheet
13. A plastic bag or leak-proof, covered waste container for disposal of contaminated items

[5] Use of antiseptic solution versus sterile saline for metal cleaning before catheter insertion is an unresolved issue (Lo, Nicolle, Coffin, et al. 2014).

Figure 2.2-3. Urinary catheter equipment



**List of equipment**

Sterile drainage tubing and collection bag, antiseptic cleaning solution, cotton swabs, sterile gloves, lubricant, syringe containing sterile water, sterile catheter, light, drapes.

*Source:* The Open University n.d.

**STEP 2**: Explain the procedure to the patient and gain verbal consent. Answer any questions that the patient may have.

**STEP 3**: Ensure that a good light source is available.

**STEP 4**: Before starting the procedure:

Have ***female patients*** separate their labia and gently wash the urethral area and inner labia with soap and water if they are able to.

Have ***male patients*** who have not been circumcised retract their foreskin and gently wash the head of the penis and foreskin with soap and water if they are able to.

**STEP 5**: Assist the patient into the supine position with knees bent, hips flexed, and feet resting apart and place the waterproof polyethylene sheet beneath the patient.

**STEP 6**: Perform hand hygiene.

**STEP 7**: Put non-sterile gloves on both hands.

**STEP 8**: Cover both thighs with a sterile drape with the opening in the drape revealing the area around the urethral opening.

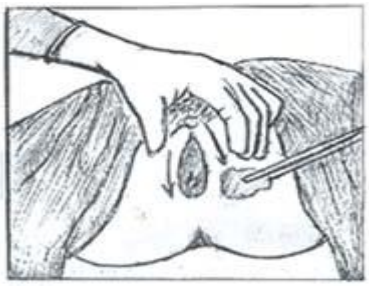
**STEP 9**: For HCWs who are right-handed (dominant hand), stand on the patient's right side (or on the left side if left-handed).

**STEP 10a**: For female patients, separate and hold the labia apart with the non-dominant hand to expose the urethral opening. Using cotton applicators or a gauze swab held with forceps; clean the urethral opening and surrounding area, including the labia minora, with an antiseptic solution. Apply antiseptic by moving from above, downward on one side, and then discarding the swab. Repeat on the other side, and lastly apply antiseptic at the center to clean the urethral opening (figure 2.2-4).

**STEP 10b**: For male patients, push back the foreskin for men who have not been circumcised, and hold the head of the penis with the non-dominant hand. Using cotton applicators or a gauze swab held with forceps, clean the head of the penis and urethral opening by applying antiseptic solution. Apply antiseptic in a circular fashion, moving away from the urethral opening. Apply antiseptic solution two times (figure 2.2-4).

**Note:** If the patient is unable to wash her/himself, a trained HCW will need to complete this part of the procedure while wearing a pair of non-sterile gloves.

Figure 2.2.-4. Cleaning female and male genital areas before insertion of an indwelling catheter



**Note:** Wipe down one side of the urinary meatus, and discard the wipe. Using a sterile wipe, repeat on the opposite side of the urinary meatus, discard the wipe, and lastly, clean down the center.

**Note:** Clean the penis in a circular motion, starting at the tip of the penis and moving downward. Discard the wipe and repeat the cleaning with a new, sterile wipe.

*Sources*: The Open University n.d.; Army Medical Department 2011

**Note:** If the catheter is accidentally inserted into the vagina, do not remove it. Inset a new sterile catheter into the urethra; then remove the one in the vagina. Do not force the catheter if resistance occurs during insertion because this can harm the patient.

**STEP 11**: Remove gloves.

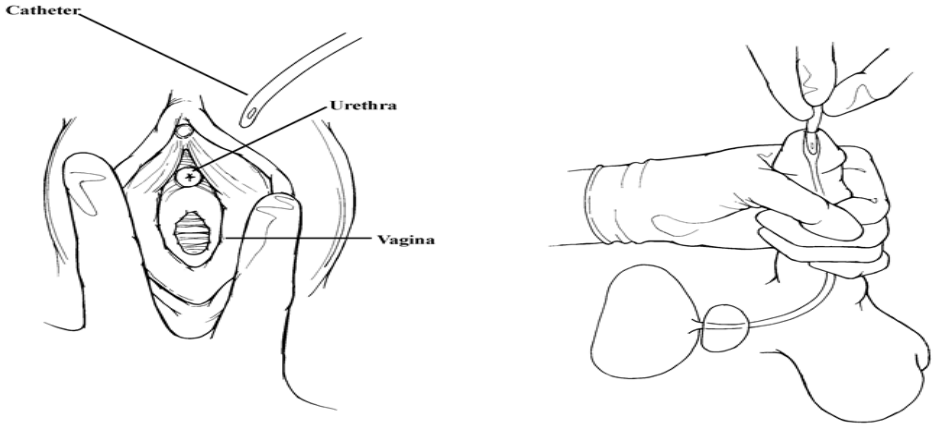
**STEP 12**: Perform hand hygiene and put on sterile gloves.

**STEP 13**: If inserting a **straight catheter**, grasp the catheter about 5 cm (2 inches) from the catheter tip with the dominant hand and place the other end in the urine collection container.

**STEP 14a**: **For women**, apply lubricant jelly on the outer surface of the catheter and gently insert it, as shown in figure 2.2-5, about 5–8 cm (2–3 inches) or until urine flows. For children, insert only about 3 cm (1.5 inches).

**STEP 14b**: **For men**, apply lubricant jelly on the outer surface of the catheter. Using the non-dominant hand, hold the penis with slight upward tension and perpendicular to the patient's body; gently insert the lubricated catheter with the dominant hand, as shown in figure 2.2-5, about 18–22 cm (7–9 inches), lower the penis 90 degrees toward the patient's toes, advance the catheter a little more, and rotate the catheter until urine flows. For children, insert only about 5–8 cm (2–3 inches).

Figure 2.2-5. Catheterization techniques for female and male patients




A. Female B. Male

*Source*: Tietjen, Bossemeyer, McIntosh 2003

**Note:** With indwelling catheters, do not disconnect the catheter from the drainage tube.

**STEP 15**: If inserting an indwelling catheter, push another 5 cm (2 inches) after urine appears and have another trained HCW wearing sterile gloves connect the catheter to the urine collection tubing if not using a closed system. Always ensure that urine is flowing before filling the balloon.

**STEP 16:** **For an indwelling catheter**, fill the balloon as per the manufacturer's instructions and pull out gently to feel resistance.

**For straight (in-and-out) catheterization**, allow the urine to drain slowly into the collection container and then gently remove the catheter.

**STEP 17**: Secure the catheter to the patient's thigh (for women) or lower abdomen (for men) (figure 2.2-6).

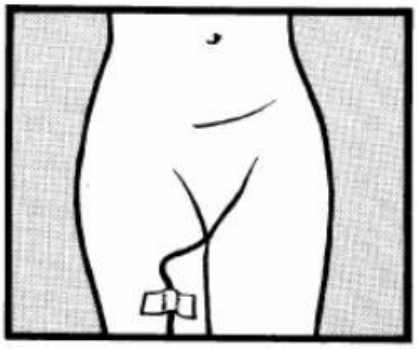
**STEP 18**: Place soiled items, including the straight catheter, in a plastic bag or leak-proof, covered container for contaminated waste.

**STEP 19**: Ensure that the patient is left dry and comfortable.

**STEP 20**: Remove gloves and place them in a plastic bag or container for contaminated waste.

**STEP 21**: Perform hand hygiene.

Figure 2.2-6. Securing a female indwelling catheter



*Source*: Brookside Associates 2007

**Removal or Replacement of a Urinary Catheter**

**STEP 1**: Make sure that all items are available including:

- A pair of non-sterile gloves (if replacing the catheter, a pair of sterile gloves will be needed as well)
- A sterile syringe for removing fluid from the catheter balloon
- Sponge forceps with gauze squares (2 inches x 2 inches) or large, cotton applicators
- A plastic bag for contaminated waste or a leak-proof, covered waste container for disposal of contaminated items

**STEP 2**: Have the patient wash the urethral area (women) or the head of the penis (men) with soap and water, or do this step for them. Perform hand hygiene and wear a pair of non-sterile gloves. Remove and dispose of the gloves after cleaning.

**STEP 3**: Perform hand hygiene.

**STEP 4**: Put gloves on both hands; non-sterile gloves for removal, sterile gloves for replacement.

**STEP 5**: With a syringe, remove the water from the catheter balloon.

**STEP 6a**: **For women**, separate and hold the labia apart with the non-dominant hand; using cotton applicators or a gauze swab held with forceps, clean the urethral opening and area around it with an antiseptic solution. Apply antiseptic by moving from above, downward on one side, then discarding the swab. Repeat on the other side, and lastly, apply antiseptic around the catheter two times and gently remove the catheter.

**STEP 6b**: **For men**, push back the foreskin for those who have not been circumcised, and hold the head of the penis with the non-dominant hand. Using cotton applicators or a gauze swab held with forceps, clean the head of the penis and the area around the catheter by applying antiseptic solution two times. Gently remove the catheter.

**STEP 7**: If you are just removing the catheter, follow Steps 18 through 21 of the Insertion Procedure.

**STEP 8**: If you are replacing the indwelling catheter, follow Steps 4 through 21 of the Insertion Procedure.

## Recommended Catheter Maintenance Practices

- Educate HCWs on the insertion, care, and maintenance of urinary catheters and about prevention of CAUTIs (Lo, Nicolle, Coffin, et al. 2014).
- Always follow standard precautions to protect against contact with blood or body fluids, including wearing gloves and other personal protective equipment (PPE) (face shield, goggles, plastic apron) if there is a risk of splashing, during any manipulation of the catheter or collection system. (See Volume 1, Chapter 3: Standard and Transmission-Based Precautions.)
- Perform hand hygiene immediately before and after any handling of the urinary catheter, insertion site, or collection set. (These are two of the five moments included in WHO's *My 5 Moments for Hand Hygiene*) (See Volume 1, Chapter 4: Hand Hygiene.)
- Check the flow of urine through the catheter several times a day to ensure that the catheter is not blocked.
- Maintain catheter securement to the patient's leg or abdomen to prevent movement and pulling.
- Cleanse the perineal area daily with soap and water during routine bathing while the catheter is in place. (Cleansing with antiseptic solution is not necessary.)
- Wash the head of the penis and urethral opening (men) or the tissue around the urethral opening (women), the perineal area, buttocks, and any area that is soiled after a bowel movement or if the patient is incontinent.
- Keep the catheter and collecting tube free from kinks and dependent loops (figure 2.2-7).

Figure 2.2-7. Dependent loops in a urinary catheter tube

**Dependent loops (inside red circle) create a back pressure and obstruct urine flow from the bladder**

*Source*: Curless, Ruparelia, Thompson, et al. 2018

Secure the collection bag below the level of the bladder at all times, including during transport.

**Never rest the bag on the floor (even atop a clean/sterile towel).**

**When moving a patient:**

- Do not raise the bag above the patient; urine should always flow away from the patient.
- Drain all urine from the tubing into the bag before the patient stands up.
- Empty the drainage bag before transferring the patient.
- Empty the collecting bag regularly (e.g., when two-thirds full) using a separate, clean urine collecting container for each patient; avoid splashing and prevent contact of the drainage spigot with the non-sterile collecting container.
- Train family and attendants in IPC for catheter care, including hand hygiene and not pulling on the catheter, and educate them about reasons to avoid catheter use.
- If any breaks in aseptic technique occur, the collection system is disconnected for any reason, or there is leakage, replace the catheter and collecting system using aseptic technique and new sterile equipment.
- If available, collect urine samples from the needleless sampling port to avoid disconnecting the drainage system.

**Avoid the following practices for catheter maintenance:**

- Avoid disconnecting the catheter from the drainage tubing (unless deemed medically necessary). Change the urinary catheter if the closed system is disconnected.
- Do **not** clean the perineum area with antiseptics while the catheter is in place. Routine hygiene (e.g., cleansing of the metal surface [opening of the urethra] during daily bathing or showering with soap and water) is appropriate.
- Do **not** screen for asymptomatic bacteriuria in catheterized patients.
- Do **not** treat asymptomatic bacteriuria in catheterized patients except before invasive urologic procedures.
- Do **not** perform continuous irrigation of the bladder with antimicrobials as a routine IPC measure. If continuous irrigation is being used to prevent obstruction, maintain a closed system.
- Do **not** use systemic antimicrobial routinely as prophylaxis (a preventive treatment) either for short- or long-term catheterization unless there are clinical indications (e.g., bacteriuria upon catheter removal post-urologic surgery).
- Do **not** change catheters or drainage bags at routine, fixed intervals. Rather, change catheters and drainage bags based on clinical indications, such as infection, obstruction, or when the closed system is compromised (Lo, Nicolle, Coffin, et al. 2014).

- Do **not** use antibiotic-coated catheters.
- Do **not** use routine instillation of antiseptic or antimicrobial solutions into urinary drainage bags.
- Unless obstruction is anticipated (e.g., bleeding after prostatic or bladder surgery), bladder irrigation is not recommended. If obstruction is anticipated, closed continuous irrigation is suggested to prevent obstruction.
- Complex urinary drainage systems (i.e., utilizing mechanisms for reducing bacterial entry, such as antiseptic-release cartridges in the drain port) are not necessary for routine use (Gould, Umscheid, Agarwal, et al. 2009).
- Do **not** reuse catheters between patients; biofilm develops in the lumen, which is narrow and difficult to reprocess adequately.

## Collecting a Urine Specimen from a Urinary Catheter for Laboratory Testing

Do not send urine for culture unless the patient has signs or symptoms consistent with a UTI and findings on urinalysis. Do not collect urine from bedpans or collection bags to be cultured for testing. During urine specimen collection:

**STEP 1**: Perform hand hygiene and wear sterile gloves.

**STEP 2**: If necessary, compress the drainage tubing below the sample port until urine is visible below the access site. (Compress the drainage tubing for the minimal amount of time required to obtain urine for sampling. *Do not clamp the drainage tubing for an excessive period of time because doing so increases the risk of CAUTI and may lead to urine flow obstruction.*) (Perry, Potter 2019)

**STEP 3**: Disinfect the port with an alcohol swab for at least 10 "scrubs" (using a circular motion, one circle completes one "scrub").

**STEP 4**: Attach a syringe or insert a needle into the port (needle/syringe if no needleless alternative) and draw urine into the syringe. (Obtain the required amount of urine per institution/laboratory policy for culture and/or for routine urinalysis.)

**STEP 5**: Release any compression of the drainage tubing below the sample port.

**STEP 6**: Transfer urine for culture from the syringe into a sterile urine container or Vacutainer® tube (urine collection tube).

**STEP 7**: Check that the lid is tightly secured if a container is used. Place the container or Vacutainer® tubes, if used, in a clear plastic biohazard bag for transport to the laboratory.

**STEP 8**: Ensure that the specimen is delivered to the laboratory immediately. If the specimen cannot be delivered within two hours, place it in a refrigerator until it can be delivered to the laboratory.

**STEP 9**: Discard needle/syringes into a sharps container.

**STEP 10**: Perform hand hygiene.

**CAUTI Prevention and Control Practice Bundles and Initiatives**

An HAI bundle is a structured way of improving care and patient outcomes. They are a small group of, straightforward set of evidence-based interventions, which when performed collectively and reliably, have proven to improve patient outcomes. Studies have shown that IPC interventions can significantly reduce CAUTIs, even in limited-resource settings (Rosenthal, Ramachandran, Dueñas, et al. 2012). Box 2.2-1 is an example of the components of a bundle of practices for the prevention of CAUTIs that are easily applicable in low-resource settings.

The tool provided in Appendix 2.2.A is an example of a daily CAUTI maintenance bundle checklist to determine the continuation of a urinary catheter (process measures). The decision to remove or continue with an indwelling catheter should be reviewed on a daily basis. A catheter should be removed if it is no longer indicated.

Box 2.2-1. Components of a practice bundle to prevent CAUTIs

**The CAUTI prevention practice bundle consists of the following interventions:**

- **Insertion of catheters only when indicated** and removal of catheters when they are not medically necessary.
- **Consideration of alternatives for urinary output management**, including condom catheters and in-and-out catheterization, when appropriate.
- **Hand hygiene** before insertion and manipulation of catheters.
- Use of as small a catheter as possible.
- **Insertion of catheters** following IPC practices and sterile equipment.
- **Appropriate management of indwelling catheters,** including properly securing indwelling catheters to prevent movement; maintaining a sterile, continuously closed drainage system; not disconnecting the catheter and drainage tube; and replacing the collecting system following IPC practices and after disinfecting the catheter tubing junction when breaks in IPC practices, disconnection, or leakage occur.

*Source*: Rosenthal, Ramachandran, Dueñas, et al. 2012

## Monitoring and Surveillance of CAUTIs

Surveillance can be used to identify areas in which IPC practices can be improved to decrease CAUTIs. However, surveillance can be labor-intensive and consume precious resources. Because CAUTI is one the most common HAIs in low-resource settings, CAUTI surveillance in areas with high use of indwelling urinary catheter should be considered (APIC 2014; Lee, Montgomery, Marx, et al. 2007).

It is important to have a thoughtful approach when developing a CAUTI surveillance plan. Each healthcare facility should develop its own surveillance program, which should maximize the use of resources by focusing CAUTI surveillance according to the use of indwelling urinary catheters, the outcomes experienced, and the healthcare facility's overall objectives (APIC 2014; Lee, Montgomery, Marx, et al. 2007). A facility IPC risk assessment can help guide these decisions (Volume 2, Section 5, Chapter 2: Managing Infection Prevention and Control Program).

### Steps in the CAUTI surveillance process:

- Decide which procedures to monitor (consider areas with highest indwelling urinary catheter use [e.g., ICUs and surgical areas] and the facility IPC risk assessment).
- Define the numerator and denominator: For CAUTI surveillance, the numerator is the number of CAUTIs and the denominator is the number of urinary-catheter days during the same time period. (For example, numerator: the total number of CAUTIs in the surgical ICU in a month; denominator: the total number of urinary-catheter days during that month.)
- Use a definition from a credible source.
- Develop a process to identify cases (e.g., monitor positive urine cultures, conduct daily rounds on all patients with an indwelling urinary catheter, communicate with the clinical team in areas of interest to help find cases for further review).
- Collate data and prepare reports.
- Initiate quality improvement activities, as necessary.
- For additional information on developing a CAUTI surveillance program, see Volume 2, Section 3, Chapter 1: Introduction to Surveillance of Healthcare-Associated Infections.

## Quality Improvement for CAUTIs

Once CAUTI rates are known, efforts should be made to reducing CAUTIs, which can improve patient outcomes and reduce a facility's cost of providing care. Multidisciplinary teams with representatives from the various disciplines can help prevent CAUTIs, (e.g., all levels of HCWs, including clinicians, nurses, healthcare facility administrators, healthcare facility leadership, IPC staff, cleaning staff, and others). The multidisciplinary team should work together to plan, do, and sustain quality improvement efforts, guided by surveillance data and evidence-based practices. Based on the team's consensus, the improvement process should include ongoing quantitative measurement of improvements and timely feedback of results and successes.

## SUMMARY

HCWs can prevent CAUTIs by limiting the use of indwelling urinary catheters, daily reviews of indications for the continuation of indwelling catheters, and stringently applying the IPC practices recommended in this chapter for insertion, maintenance, and removal. Applying recommendations of the CAUTI prevention bundle will also help avoid infections.

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# CHAPTER 3: PREVENTING INTRAVASCULAR CATHETER-ASSOCIATED BLOODSTREAM INFECTIONS

### Key Topics

- Commonly used intravascular catheters and their potential side effects
- Epidemiology and microbiology of intravascular catheter-associated bloodstream infections
- Intravascular catheter-related bloodstream infection risk factors
- Preventing the risk of bloodstream infection related to intravascular catheters
- Monitoring and surveillance of central line-associated bloodstream infections (CLABSIs) and other intravascular catheter-associated bloodstream infections
- Quality improvement for prevention of intravascular catheter-associated bloodstream infections

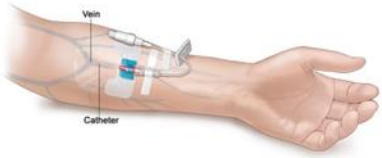
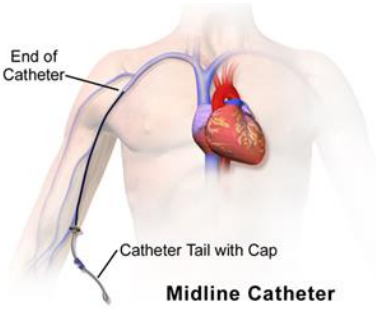
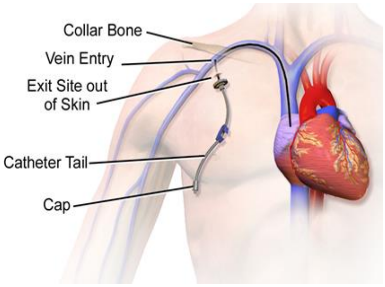
## BACKGROUND

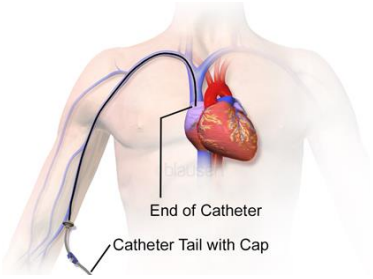
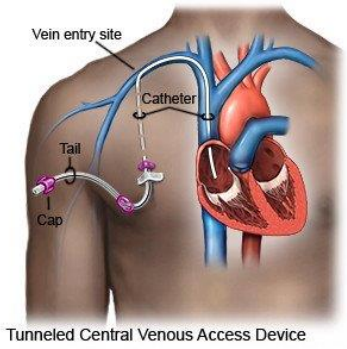
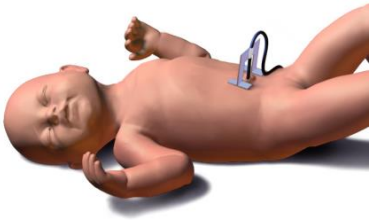
Intravascular catheters (central lines, arterial lines, and peripheral IV lines, and those given in table 2.3-1) are often necessary for administering fluids, medications, and nutritional products to patients. They are also used for monitoring hemodynamics (i.e., monitoring blood pressure and blood flow in the veins, arteries, and heart) in intensive care settings and for providing hemodialysis (i.e., the process of cleansing the blood using a dialyzer machine). Although intravascular catheters can be essential for patient care, they put patients at risk for infection by interrupting the protective barrier that intact skin provides. They also provide a direct route of entry for microorganisms into the bloodstream and can easily become contaminated during use.

Evidence-based practices can reduce the incidence of infections related to intravascular catheters (both central lines and peripheral IV lines). A large multi-center study in India found up to a 53% reduction in CLABSI rates after hospitals implemented evidence-based IPC practices, measured CLABSI rates, and instituted a performance improvement and feedback program (Jaggi, Rodrigues, Rosenthal, et al. 2013).

The relevant published guidelines from the Society for Health Care Epidemiology of America (SHEA), the Infectious Diseases Society of America (IDSA), CDC, and WHO include cost-effective IPC measures that are feasible and applicable in high- and low-resource settings.

Table 2.3-1. Common types of intravascular catheters for venous and arterial access and potential side effects

| Catheter type | Entry site | Length | Potential side effects |
|---|---|---|---|
| **Peripheral catheters** | | | |
| **Peripheral venous catheter (IV line)**   *Source*: National Cancer Institute n.d. https://www.cancer.gov/publications/dictionaries/cancer-terms?cdrid=463728 | Usually inserted in veins of forearm or hand | < 8 cm (3 in.) | Phlebitis with prolonged use, rarely associated with bloodstream infections |
| **Peripheral arterial catheter** | Usually inserted in radial artery but also in femoral, axillary, brachial arteries | 8 cm (3 in.) | Low infection risk; rarely associated with bloodstream infections |
| **Midline catheter (a type of IV line)**   *Source*: Royal Brompton & Harefield NHS Foundation Trust 2019 | Inserted via antecubital fossa (forearm) into the proximal basilic or cephalic veins; does not enter central veins | 8 to 20 cm (3 to 8 in.) | Severe allergic reactions in some patients; lower rates of phlebitis than short peripheral catheters |
| **Central Venous Catheters** | | | |
| **Non-tunneled central venous catheter**   *Source*: NHS 2015. https://nhsbtdbe.blob.core.windows.net/umbraco-assets-corp/14532/vascular-access-guide2.pdf | Inserted via skin into central veins (subclavian, internal jugular, or femoral) | ≥ 8 cm (3 in.) depending on patient size | Accounts for majority of central line-related bloodstream infections. Femoral insertion site has the highest risk of infection. |

| | | | |
|---|---|---|---|
| **Peripherally inserted central catheter (PICC)**<br>  | Inserted into basilica, cephalic, or brachial veins and enters the superior vena cava | ≥ 20 cm (8 in.) depending on patient size | The risk of infection is similar to that of non-tunneled central venous catheters |
| *Source*: Royal Brompton & Harefield NHS Foundation Trust 2019. https://www.rbht.nhs.uk/sites/nhs/files/PILs/PICC%20-%20A5.pdf | | | |
| **Tunneled central venous catheter**<br>  | Implanted into subclavian, internal jugular, or femoral veins | ≥ 8 cm (3 in.) depending on patient size | Cuff inhibits migration of organisms into catheter tract; lower risk of infection than non-tunneled central venous catheter |
| *Source*: Drugs.com 2022, https://www.drugs.com/cg/tunneled-central-lines.html | | | |
| **Umbilical catheter**<br>  | Inserted into either the umbilical vein or artery of a newborn infant | ≤ 6 cm (2.5 in.) depending on patient size | High risk of infection. Risk similar for catheters placed in umbilical vein versus artery |
| *Source*: https://en.wikipedia.org/wiki/Umbilical_line | | | |

## Epidemiology

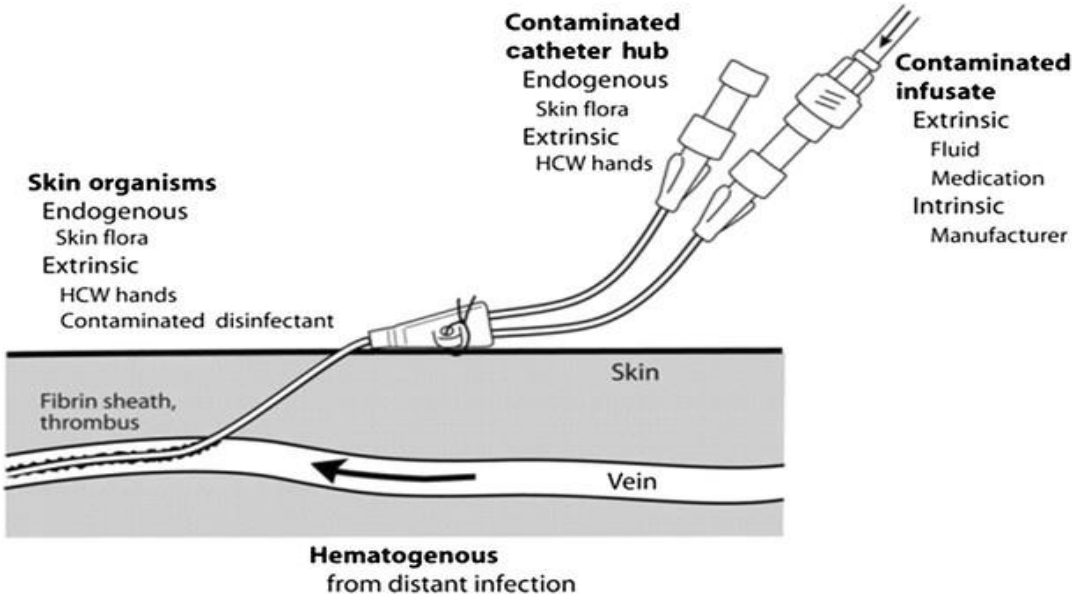
Studies have found that up to 90% of healthcare-associated bloodstream infections are caused by some form of vascular access (Esposito, Purrello, Bonnet, et al. 2013). Bloodstream infections represent about 19% of all reported HAIs in LMIC (WHO 2011). In low-income settings, healthcare-associated bloodstream infections result in a 24% mortality rate (WHO 2011). The economic impact of each case of CLABSI has been estimated at $14,818 (India), $11,591 (Mexico), and $4,888 (Argentina) (WHO 2011). In low-resource settings, the most common causes of CLABSI are *Staphylococcus aureus* and *Acinetobacter* spp (WHO 2011).

## Intravascular Catheter-Related Bloodstream Infection Risk Factors

Intravascular catheters can be essential for patient care, but they put patients at risk for infection by interrupting the skin barrier and providing a direct route of entry for microorganisms into the bloodstream (figure 2.3-1). HCWs should be aware that intravascular catheters (both central lines and IV lines) can become contaminated by:

- Handling the catheter with contaminated hands
- Contamination of the insertion site
- Contamination of the catheter hub (including touching the patient's skin), end caps, tubing ends, injection ports IV fluids or medications (either introduced by the manufacturer or during medication mixing and preparation)
- Excessive or substandard manipulation of the catheter or tubing

Figure 2.3-1. Risk factors for intravascular catheter-associated infections




*Source*: Crnich, Maki 2002

### Peripheral Venous Catheters—IV lines

If not properly inserted and maintained, these devices can cause bloodstream infections and local reactions (e.g., phlebitis, exit-site infection, and extravasation [discharge or escape of blood into tissues]) that potentially increase the risk for the development of subsequent systemic bloodstream infections.

### Central Lines—Central Venous Catheters

In contrast to the relatively low risk of bloodstream infection from peripheral IV lines, central lines are associated with a much higher risk, especially in LMIC. CLABSIs in low-income countries have been estimated to be 12.2 cases per 1,000 central line-days in adult ICUs (WHO 2011). This is more

than three times higher than the rates in high-income countries (3.5 cases per 1,000 central line-days) (WHO 2011). Similarly, rates reported from neonatal ICUs (NICUs) in low-income countries are between three to 20 times higher than in high-income countries, with estimates of up to 60 cases per 1,000 central line-days (WHO 2011). CLABSIs can also occur outside the ICU (e.g., dialysis, general medical, and other settings where patients have central lines).

Several factors increase the risk of infection from intravascular catheters (table 2.3-2), such as central lines. These can be divided into modifiable and non-modifiable risk factors. Some modifiable risk factors can potentially be changed using proper IPC measures during line insertion and the proper maintenance of the intravascular catheters.

Table 2.3-2. Risk factors for intravascular catheter-associated infections

| Non-modifiable risk factors | Potentially modifiable risk factors |
|---|---|
| • Old age<br>• Male gender<br>• Underlying disease, such as hematological deficiencies, immunological deficiencies, and cardiovascular, and GI diseases<br>• Admission to ICU<br>• Neutropenia | • Prolonged hospitalization before catheter insertion<br>• Multiple central lines<br>• Parenteral nutrition (providing nutrition through an IV line)<br>• Femoral or internal jugular access (in adults)<br>• Catheters with more than one lumen<br>• Heavy microbial colonization at the insertion site<br>• Lack of proper technique used for insertion<br>• Emergency insertion of the catheter<br>• Poor catheter care<br>• Increased length of time the catheter is left in the body |

*Adapted from:* O'Grady, Alexander, Burns, et al. 2011

**The use of evidence-based IPC practices can decrease the risk of intravascular catheter infections from both central and peripheral IV lines. In LMIC, many factors thwart the use of these measures for intravascular catheters.**

Barriers to implementation of evidence-based practices to prevent CLABSI include the type of ICU facilities available; overcrowded in-patient wards; insufficient rooms for isolation; poor hand hygiene compliance; lack of IPC supplies and other medical supplies (e.g., PPE, antiseptics, and needleless connectors); and non-compliance with recommended IPC practices (e.g., keeping intravascular catheters in place longer than indicated, poor dressing techniques, using unsafe injection practices) (International Nosocomial Infection Control Consortium 2013).

## Biofilm as Risk Factor

Microorganisms form biofilms on most indwelling devices, including invasive medical devices that are inserted or introduced in the body. Biofilms allow bacteria to tightly adhere to the surfaces, make them difficult to remove with routine measures, and may play an important role in the development of CLABSI because bacteria within biofilms are protected from being penetrated and killed by antimicrobial agents and host defenses.

Contamination that leads to biofilm production can occur from flora on the patient's skin or on the hands of HCWs. Biofilm forms on the outside of the catheter lumen. The microorganisms most commonly isolated from central line biofilms are *S. epidermidis, S. aureus, C. albicans, Pseudomonas aeruginosa, Klebsiella pneumoniae,* and *E. faecalis* (Donlan 2001).

## Intravascular Catheter-Related Bloodstream Infection Prevention Strategies

Prevention of infection from intravascular catheters involves an approach that targets the causes of infection. This approach should include limiting unnecessary use and following recommended IPC practices to reduce infection when inserting and caring for intravascular catheters, including:

### Educate and train staff

- Offer competency-based training in recommended IPC practices for intravascular catheter (central line and IV line) indications, insertion, maintenance, and removal, and use of prevention bundles.
- Conduct periodic assessment of competency and refresher training.
- Have a team of trained competent staff assigned to perform insertion of central lines.
- Choose appropriate catheter type, insertion site, and technique.

### Weigh the risk and benefits of placing central lines. Minimize use.

- Use upper extremities (i.e., access subclavian veins) and avoid femoral veins in adult patients.
- Choose catheter types (peripheral versus central line ) based on duration of IV therapy and type of fluids (pH/osmolarity).
- Use a central line with a minimum number of lumens.
- Use ultrasound-guided insertion technique to place a central line, if such technology is available.

### Comply with IPC recommendations for insertion, maintenance, and removal processes

- Full barrier precautions, including drapes and PPE for insertion
- Sterile technique for insertion
- Skin antisepsis for insertion site and dressing
- Implementation of bloodstream infection surveillance and quality improvement interventions
- Remove peripheral and central lines as soon as possible

### Methods to Limit the Use of Intravascular Catheters

- Insert intravascular catheters only when indicated, use a peripheral IV when possible.
- Remove a catheter as soon as it is not indicated (CDC 2014).

### Indications for the Use of Intravascular Catheters

Indications for intravascular catheters include:

- Infusion of intravenous (IV) solution for rehydration
- Emergency venous access
- Hemodialysis: a process of purifying the blood of a person whose kidneys are not working normally
- Nutritional support
- Administration of certain medications (e.g., vasopressors used to raise blood pressure)
- Monitoring of central venous pressure
- Pulmonary artery catheterization

## Insertion, Maintenance, and Removal of Peripheral IV Lines

### Insertion Procedure for Establishing a Peripheral IV Line

**STEP 1**: Gather all materials needed for the procedure including:

- An IV solution bag or bottle
- An IV infusion set
- A plastic catheter (a steel needle inserter covered with soft plastic tubing that is left in place after the needle is withdrawn)
- If a plastic IV line is not available, use a straight or butterfly needle. If possible, avoid the use of needles for the administration of fluids and medication that might cause tissue necrosis (premature breakdown of body tissue).
- Antiseptic solution (2% chlorhexidine with alcohol, 60%–90% alcohol, or 10% povidone-iodine)
- Sterile or clean gauze squares (e.g., 2 x 2 inches square or cotton swabs)
- Surgical tape or a transparent dressing
- A new or cleaned and disinfected tourniquet
- A towel to place under the patient’s hand or forearm

- A disinfected IV pole
- A new or cleaned and disinfected arm board
- A new pair of non-sterile gloves
- A basin of clean, warm water, soap, a washcloth, and a clean, dry towel
- A plastic bag or leak-proof, covered, contaminated-waste container for disposal of contaminated items
- A sharps container, positioned by the dominant hand

**Note:** Use distal veins (farthest from the wrist or elbow) first and avoid placing the IV line over the wrist or in the patient's dominant hand (the one the person writes with).

**STEP 2**: Explain the procedure to the patient.

**STEP 3**: Before starting the procedure, identify the best vein for inserting the IV catheter.

**STEP 4**: If the insertion site is visibly soiled, first wash it with soap and clean water and dry it with a clean cloth.[1]

**STEP 5**: Perform hand hygiene.

**STEP 6**: Open the infusion set and assemble the parts, if necessary, using aseptic technique (i.e., do not touch the ends of the IV tubing).

**STEP 7**: Insert the infusion set into the solution bottle or bag using the following technique:

- Remove the protective cover from the solution bottle or bag without touching the opening.
- Wipe the entry site on the bag or bottle with an alcohol swab and allow it to dry. Do not touch the entry site once it has been disinfected with alcohol.
- Remove the protective cap covering the insertion spike without touching the spike and insert the spike into the stopper of the IV bottle or opening of the IV bag.

**STEP 8**: Fill the infusion tubing using the following technique:

- Compress the drip chamber and release.
- Remove the protective cover from the end of the IV tubing (do not let the opening touch any surface or item) and release the roller clamp to allow fluid to fill the tubing, close the roller clamp, and replace the protective cover.
- Check to be sure the tubing is clear of air bubbles.

[1] Use clean water. (See Volume 1 , Chapter 11, Food and water safety, and Volume 2 Section 2 Chapter 5, Preventing Health Care-Associated Infectious Diarrhea in this manual for details on preparing clean water.)

**Note:** The tourniquet should be washed with soap and water, rinsed, and dried whenever visibly soiled and wiped with 1% chlorine solution, quaternary ammonia product, or 60%–70% alcohol between patients.

**STEP 9**: With the patient's forearm and hand hanging down, place the tourniquet 10–12 cm (5–6 inches) above the insertion site. (Ask the patient to open and close her/his fist and/or tap lightly over the vein to make it easier to see or feel.)

**STEP 10**: With the tourniquet in place and vein filled, place the patient's hand and arm on the clean towel on the bed or the arm board.

**STEP 11**: Put new, clean, non-sterile gloves on both hands.

**STEP 12**: Cleanse the insertion site with antiseptic solution using the appropriate technique for the type of solution (e.g., a circular motion moving outward from the insertion site for iodine, a back-and-forth motion for 2 minutes for chlorhexidine). Allow the antiseptic to dry completely before puncturing the skin. Do not fan or blow on it.

**STEP 13**: Fix the vein by placing the thumb over the vein and gently pulling against the direction of insertion. **Never place your fingers or thumbs above the insertion site** (i.e., above the sharp point of the needle). You could accidently stick yourself.

**STEP 14**: Using the dominant hand, insert the IV catheter with the bevel facing up. Look for blood return in the tubing and carefully advance the needle or butterfly until the hub rests at the venipuncture site.

**STEP 15**: When using peripheral IV catheters, after getting blood return, advance the needle about 1 cm (.5 inch), withdraw the inner insertion needle (place it directly in the sharps container), and at the same time, advance the plastic catheter to the hub.

**STEP 16**: While stabilizing the catheter or needle, release the tourniquet. Apply gentle pressure on the tip of the IV catheter to stop blood from flowing out and gently connect the syringe if collecting blood for laboratory test. Otherwise, connect the tip of the IV line to the catheter and open the roller clamp to permit a rate of flow sufficient to keep the IV line open.

**STEP 17**: Secure the IV catheter by placing a narrow piece of tape (1 cm, or .5 inch) under the hub with the adhesive side up and cross tape it over the hub. Then place a second piece of narrow tape directly across the hub of the IV catheter.

**STEP 18**: Place a transparent dressing over the point where the IV catheter enters the skin, for easy viewing of the insertion site and detection of any related issues (figure 2.3-2). Alternatively, place a sterile gauze square (2 x 2 inches) over the venipuncture site and secure it with two pieces of tape. Write the date and time of the placement of the IV line and needle size on the dressing.

**STEP 19**: Secure the patient's wrist or forearm to the arm board by applying two strips of tape directly and snuggly (but not tightly) across the wrist or forearm. To minimize the

patient's discomfort when removing the arm board, attach a shorter piece of tape to the longer piece (adhesive side to adhesive side) that will cover the wrist or arm.

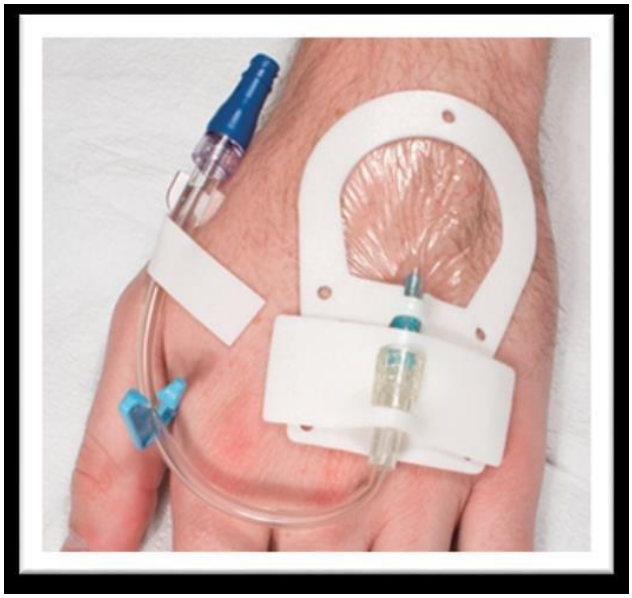
**STEP 20**: Adjust the flow rate to the correct number of drops per minute.

**STEP 21**: Before removing gloves, place any contaminated-waste items, including cotton or gauze squares, in a plastic bag or leak-proof, covered, contaminated-waste container. Place any sharps (needles or sharp materials) in a hard, puncture-proof container with a lid immediately after placement of the IV.

**STEP 22**: Remove gloves and place them in a waste container.

**STEP 23**: Perform hand hygiene.

Figure 2.3-2. Transparent dressing over insertion site of a peripheral IV catheter



*Source*: Nancy, 2017

## Maintaining IV Lines

- Follow recommended IPC practices at all times.
- Check at least every 8 hours for phlebitis or evidence of infection.
- Rotate the IV catheter site at 72–96 hours (3–4 days), when practical, to reduce the risk of phlebitis and local infection.
- The infusion (administration) sets should be changed whenever they are damaged, the tubing becomes disconnected, or routinely, as follows:
    - Change continuous infusion sets at 96 hours (4 days)
    - Change intermittent infusion sets every 24 hours
- Provide instructions to the patient/family members on maintaining the IV line.

## Changing IV Solutions

The procedure described below is for changing IV solution for an IV line and a central line.

**STEP 1**: Perform hand hygiene.

**STEP 2**: Check the patient's identity, confirm the clinician's order, and ensure that the replacement solution is according to the clinician's order and is free from any particles and within the expiry date.

**STEP 3**: Prepare the new solution. If using a plastic IV bag, remove the protective cover from the entry site. If using a glass bottle, remove the metal cap and metal and rubber disks.

**STEP 4**: Wipe the entry site on the bag or bottle with an alcohol swab and allow it to dry. Do not touch the entry site once it has been disinfected with alcohol.

**STEP 5**: Remove the spike from the old IV solution bag or bottle and, without touching the tip, insert the spike into the new IV solution bag or bottle.

**STEP 6**: Adjust the flow rate.

**STEP 7**: Discard waste.

**STEP 8**: Perform hand hygiene.

## Changing Dressing of a Peripheral IV Line

**STEP 1**: Gather all supplies needed for the procedure including:

- Sterile or clean gauze squares (2 x 2 inches) and surgical tape or sterile, wide (2 cm/1 inch) bandage
- Antiseptic solution (2% chlorhexidine with alcohol, 60–90% alcohol, or 10% povidone-iodine)
- Sterile field or dressing pack
- Clean, non-sterile and sterile gloves

**STEP 2**: Perform hand hygiene.

**STEP 3**: Put on clean, non-sterile gloves.

**STEP 4**: Remove the dressing.

**STEP 5**: Discard the dressing and remove gloves.

**STEP 6**: Perform hand hygiene and put on non-sterile gloves.

**STEP 7**: Assess the site for signs of phlebitis.

**STEP 8**: Prepare the site using antiseptic solution and the appropriate technique for the type of solution (e.g., a circular motion moving outward from the insertion site for iodine, a back-and-forth motion for 2 minutes for chlorhexidine). Allow the antiseptic to dry completely before puncturing the skin. Do not fan or blow on the insertion site.

**STEP 9**: Apply a new, sterile dressing using aseptic (non-touch) technique.

**STEP 10**: Remove gloves and place them in a waste container.

**STEP 11**: Secure the patient's wrist or forearm to an arm board by applying two strips of tape directly and snuggly (but not tightly) across the wrist or forearm. To minimize the patient's discomfort when removing the arm board, attach a shorter piece of tape to the longer piece (adhesive side to adhesive side) that will cover the wrist or arm.

**Note:** Carefully write the date and time of placement of the IV line and needle size on the dressing.

**STEP 12**: Discard waste.

**STEP 13**: Perform hand hygiene.

### Peripheral IV Line Removal Procedures

**STEP 1**: Make sure that all items are available:

- A new, clean pair of non-sterile gloves
- Gauze squares (2 x 2 inches) and surgical tape or a sterile, wide (2 cm/1 inch) bandage
- A puncture-resistant sharps container within arm's reach, if a straight or butterfly needle was used
- A plastic bag or leak-proof, covered, contaminated-waste container for disposing of the contaminated items

**STEP 2**: Perform hand hygiene.

**STEP 3**: Put on new, clean, non-sterile gloves.

**STEP 4**: Stop the infusion.

**STEP 5**: Remove the arm board and dressing and discard the dressing in a plastic bag or leak-proof, covered, contaminated-waste container.

**STEP 6**: Check the patient's hand or wrist for phlebitis or evidence of an infection.

**STEP 7**: Carefully remove the needle or the plastic catheter with one hand and with the other hand apply light pressure to the insertion site with a sterile gauze square (2 x 2 inches).

**STEP 8**: Press firmly for about a minute or place two pieces of narrow tape, about 1 cm (½ inch) wide, directly across the gauze square. Alternatively, after pressing on the gauze square, remove it and cover the insertion site with a sterile bandage.

**STEP 9**: Discard the needle in a sharps container and if using a plastic catheter, place the plastic catheter with IV tubing and any blood-contaminated waste items (cotton or gauze squares) in a leak-proof, covered, contaminated-waste container.

**STEP 10**: Remove gloves and place them in either a plastic bag or a leak-proof, covered, contaminated-waste container.

**STEP 11**: Perform hand hygiene (O'Grady, Alexander, Burns, et al. 2011)

## Insertion, Maintenance, and Removal of Central Lines

### Insertion Procedure for Central Lines

Before inserting a central line, check the patient's record and confirm the insertion with the clinician responsible for managing the patient or review the indication for the central line.

General guidelines for central lines:

- Ensure that only trained HCWs with demonstrated competency insert a central line.
- Select an appropriate insertion site and type of catheter and technique.
- Use upper extremities for the insertion. The subclavian vein site is preferred due to a lower risk of CLABSI. Avoid using femoral veins in adults who are overweight.
- Use ultrasound-guided technique to place a central line, if available.
- Choose a central line with a minimum number of lumens.
- Use suture-less devices (e.g., adhesive tape) to secure the catheter, if available.
- Avoid use of stainless steel needles for the administration of fluids and medication.

Have a process in place to ensure adherence to IPC practices are maintained throughout the procedure, such as a checklist.

An observer should use an insertion checklist outlining the key IPC steps required. (The observer may be the HCW assisting with the insertion procedure or another HCW.)

The observer should alert the HCW to stop the insertion procedure if incorrect technique is used.

Use a trolley or kit containing all supplies needed for the procedure and practice sterile technique. It has been shown that using a kit or cart that contains all supplies needed for insertion, in conjunction with the central line bundle method, can prevent CLABSIs (Pronovost, Needham, Berenholz, et al. 2006).

Use the following IPC guidelines when inserting a central line:

- Use sterile equipment and supplies.
- Perform hand hygiene (washing hands with soap and water or applying alcohol-based hand rub) before and after performing palpation of insertion sites and before and after removing gloves.
- Prepare skin at the insertion site using antiseptic preparations containing at least 0.5% chlorhexidine and ethyl alcohol 70% for patients over two months of age. (See Volume 2, Section 4, Chapter 5: Preventing Maternal and Newborn Infections in Healthcare Settings,

for considerations on skin antisepsis in neonates.) Use the appropriate technique for the type of solution (e.g., a circular motion moving outward from the insertion site for iodine; a back-and-forth motion for 2 minutes for chlorhexidine).

- Allow the antiseptic to dry completely before puncturing the skin. Do not fan or blow on it.
- Use maximal sterile barrier precautions for insertion: A full body drape should be used for the patient. The HCW and assistant should wear a mask, a cap, protective eyewear, sterile gown, and sterile gloves during the procedure.
- Secure catheters carefully to prevent catheter movement (O'Grady, Alexander, Burns, et al. 2011).

### Steps for Inserting a Central Line

During the procedure, an assistant or observer must stop the procedure if there is a break in sterile technique.

**STEP 1**: Gather all supplies needed for the procedure:

- A Mayo stand
- Ultrasound guidance for internal jugular placement, if available
- A sterile cover for the ultrasound probe, if being used
- Non-sterile marking pens
- Two or three sterile saline flushes
- Local anesthetic (lidocaine 1%)
- The appropriate central line with dilator

The following should be included in a central line insertion pack or trolley:

- A drape sufficient to cover the entire body. (If a full body drape is not available to cover the patient's face, have the patient turn their head away from the insertion site and wear a mask.)
- Sterile gloves, mask, and gown for inserter and assistant
- Eye protection
- A cap
- Skin prep (at least 0.5% chlorhexidine and ethyl alcohol 70%)
- A sterile dressing (transparent occlusive dressing preferred over sterile gauze)
- A 22-gauge, 1.5-inch needle
- 18- or 20-gauge IV catheters on a needle and syringe, or 18-gauge hollow-bore needle

- Pressure tubing
- A guide wire
- A scalpel
- A 3.0 suture on a cutting needle

**STEP 2**: Explain the procedure to the patient.

**STEP 3**: If the site is visibly soiled, first wash it with soap and clean water and dry it with a clean cloth.

**STEP 4**: Position the patient in a supine position and let them know that their head will be covered but they will still be able to breathe. Instruct the patient to let the clinician performing the procedure know if they need to communicate during the procedure by carefully raising the opposite arm from the procedure site.

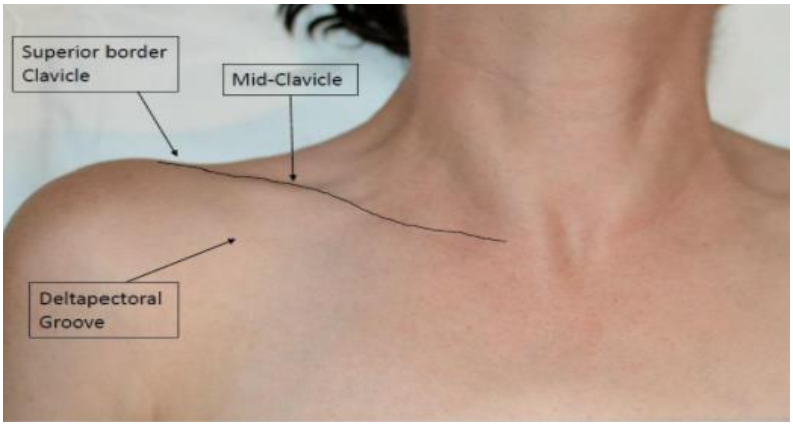
Avoid selecting a femoral site for central line access in adult patients.

Use the subclavian site in adults, when possible.

Identify the needle insertion site using anatomical landmarks for a subclavian approach (figure 2.3-3) 1 cm inferior to the junctions of the middle and medial third of the clavicle, inferior to the clavicle at deltopectoral groove, just lateral to the midclavicular line, with the needle perpendicular along the inferior lateral clavicle, one finger breadth lateral to the angle of the clavicle.

**STEP 5**: Mark the insertion site with a pen.

Figure 2.3-3. Anatomical landmarks for a subclavian approach




*Source*: Roe, Rowe 2022

**STEP 6**: Perform hand hygiene.

**STEP 7**: Open the insertion pack and put on a sterile cap, mask, gown, and gloves.

**STEP 8**: Have the assistant open other required sterile items into the sterile field. Organize the supplies and other items. Also, uncap the distal lumen, which is commonly the brown lumen.

**STEP 9**: Prepare the insertion site using at least 0.5% alcohol-based chlorhexidine antiseptic solution following the manufacturer's instructions for use (i.e., chlorohexidine scrub in a back-and-forth motion for 30 seconds). Femoral sites require a 2-minute scrub because of heavy microbial burden on the skin near the groin. Be sure to include a wide area of skin around the insertion site.

**STEP 10**: Allow the area to completely dry.

**STEP 11**: Place the drape to cover the entire body of the patient.

**STEP 12**: Infiltrate local anesthesia to cover the area around insertion site.

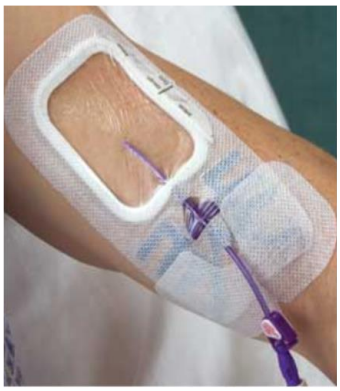
**STEP 13**: Complete the insertion procedure following the standard operative procedure for insertion of a central line:

- Position the introducer needle in line with the numbers on the syringe. Upon insertion, orient the bevel to open caudally; this facilitates smooth caudal progression of the guide wire down the vein toward the right atrium.
- Insert the introducer needle at the desired landmark while gently withdrawing the plunger of the syringe. Advance the needle under and along the inferior border of the clavicle making sure that the needle is virtually horizontal to the chest wall.
- Once under the clavicle, the needle should be advanced toward the suprasternal notch until the vein is entered. If the vein is difficult to locate, remove the introducer needle, flush it, and try again. Change the inserter site after three failed attempts.
- When venous blood is freely aspirated, disconnect the syringe from the needle, immediately occlude the lumen to prevent air embolism, and reach for the guide wire.
- Insert the guide wire through the needle into the vein with the J-tip directed caudally to improve successful placement into the subclavian vein. If the kit used allows the wire to be placed directly through a port on the syringe, then it is not necessary to disconnect the syringe. Be aware that disconnecting the syringe gives the added benefit of allowing verification of non-pulsatile flow of venous blood.
- Advance the wire until it is mostly in the vein or until ectopy is seen on the cardiac monitor. Then, retract the wire 3–4 cm (1.18–1.57 inches). Holding the wire in place, withdraw the introducer needle and set it aside.
- Use the tip of the scalpel to make a small stab just against the wire to enlarge the catheter entry site. Thread the dilator over the wire and into the vein with a firm and gentle twisting motion while maintaining constant control of the wire. After the introducer is inserted, hold the wire in place and remove the dilator.
- Thread the catheter over the wire until it exits the distal (brown) lumen, and grasp the wire as it exits the catheter. Continue to thread the catheter into the vein to the desired length.

- Hold the catheter in place and remove the wire. After the wire is removed, occlude the open lumen.
- Attach a syringe with some saline in it to the hub, and aspirate blood. Take any needed samples, and then flush the line with saline and recap. Repeat this step with all lumina.
- Verify proper line placement with chest radiography. The tip of the line should end in the vena cava at the manubriosternal angle, not in the right atrium.
- Secure the catheter in place. For patient comfort, the clinician may need to infiltrate this area if using sutures. Other methods of central line securement are preferred if available.

Once the line is properly inserted and secured, place a sterile dressing over the insertion site.

Figure 2.3-4. Transparent dressing over insertion site of a PICC



*Source*: Nancy, 2017

## Key points to remember

- Ensure meticulous preparation and setup of supplies on the sterile field before starting the procedure.
- Prepare a wide area surrounding the insertion site from jaw to shoulder and several inches below the clavicle with antiseptic solution.
- Keep ready an additional dose (at least 10 mL) of lidocaine 1%.
- If the wire does not pass easily through the needle down the vein, remove the wire, reattach the syringe, and confirm that the needle is still in the lumen of the vein before reattempting.
- If you notice return of red pulsatile blood, the wire is in an artery. Withdraw the wire and needle and attempt again.
- Aspirating air bubbles through the probing introducer needle indicates a pneumothorax.
- Anesthetize the suture site (if using sutures to secure the line) and the insertion site.

- Some clinicians find it useful to remove the contents of the line kit and lay them out in the order and configuration that they will be used.
- Never place equipment on a patient.
- Antibiotic ointments are contraindicated.
- Choose the central line with the smallest number of lumina required; increasing the number of lumina has been shown to increase infection rates.
- Using ultrasound-guided approaches reduces mechanical complications.

(O'Grady, Alexander, Burns, et al. 2011; The Joint Commission 2013)

## Maintaining Central Lines

To minimize the risk of infection, the clinician and healthcare team should assess the need for continuing the line on a daily basis (such as on daily rounds) and promptly remove it if it is no longer indicated. Use any of the following ways to review the indication:

- During daily patient care rounds
- Using stickers on patient records or the bed indicating the need for a daily review
- Keep any lumens, such as catheter hubs or stopcocks, covered by injection ports, sterile endcaps, or needleless connectors
- Minimize the use of stopcocks/three-ways as portals on entry of infection. If stopcocks must be used, consider a product with an attached needless connector.
- Access the stopcock or injection port only with sterile devices.
- Minimize the number of times the line is accessed. Try to collect all lab specimens together and group medication administration at the same time to minimize line access/breaks.
- Before every access, disinfect the end, cap, hub, or any port of entry by scrubbing vigorously to provide mechanical friction for a minimum of 5 seconds with an alcohol-based chlorhexidine preparation, 70% alcohol, or povidone-iodine (Marschall, Mermel, Fakih, et al. 2014; O'Grady, Alexander, Burns, et al 2011).

## Central Line Tubing Changes

- Perform hand hygiene before and after handling the catheter and tubing.
- Use new, non-sterile gloves for manipulating central line and associated tubing.
- Use aseptic technique during accessing central lines and changing associated tubing.
- Change tubing, needless connectors, stopcock (three-ways), and end caps at recommended intervals according to events and the type of infusion (table 2.3-3).
- Change IV administration sets anytime they are disconnected.

- Disinfect the end of the central line by scrubbing vigorously to provide mechanical friction for a minimum of 5 seconds with an alcohol-based chlorhexidine preparation, 70% alcohol, or povidone-iodine after disconnecting old tubing, before joining new tubing.
- Educate patients and families about hand hygiene and avoiding touching the tubing.

## Central Line Dressing Change

- Use a trolley or kit containing all supplies needed for the procedure and practice sterile technique.
- Perform hand hygiene before and after dressing.
- Dress central lines using aseptic technique at recommended intervals (according to the type of dressing).
- Change the gauze dressing every two days and clear dressing every seven days (and more frequently if dressing is soiled, damp, or loose) (table 2.3-3).
- Educate patients and families about hand hygiene, not getting the dressing wet, and avoiding touching the line dressing

(Marschall, Mermel, Fakih, et al. 2014).

Table 2.3-3. Recommendations for timing of dressing, tubing, and fluid changes*

| Item | Frequency of change |
|---|---|
| Transparent dressings | Every 7 days unless not intact, wet, or visibly soiled; then change as needed |
| Gauze dressings | Every 48 hours (2 days) unless not intact, wet, or visibly soiled; then change as needed |
| Continuous IV fluid bags | Other than blood, blood products, fat emulsions, or parenteral nutrition, change every 96 hours (4 days) or earlier |
| Tubing | No longer than 96 hours (4 days) (for continuous infusions) |
| Tubing caps | With tubing changes |
| Intermittent administration sets | Replace whenever disconnected.<br>For intermittent infusions other than blood, blood products, or fat emulsions, every 96 hours (4 days) |
| Tubing and vials used to infuse propofol | Every 6 to 12 hours |
| Blood products | After infusion or every 24 hours |
| Parenteral nutrition with or without lipids | Every 24 hours |

Follow recommended aseptic practices while changing the tubing.
* Change tubing with same IPC practices as when initiating fluids.

*Adapted from:* Marschall, Mermel, Fakih, et al. 2014

## Removing a Central Line

In addition to infection, there are several serious risks associated with removal of a central line, including air embolisms, bleeding, and catheter fractures. In addition to appropriate IPC practices,

measures should be taken to prevent these during removal. Removal procedures will depend on the type of central line used. Only trained HCWs should remove a central line. The following are general guidelines.

- Assess the patient and check the insertion site for signs of infection: redness, tenderness, and drainage.
- Use a trolley or kit containing all supplies needed for the procedure and practice sterile technique.
- Stop the infusion.
- Put on non-sterile gloves.
- Remove the old dressing.
- Remove gloves, perform hand hygiene, and put on sterile gloves.
- Prepare the site and drape the area to produce a sterile field.
- Cut sutures and withdraw the central line slowly and steadily without resistance. Stop and seek assistance if resistance is encountered.
- Apply firm pressure to the catheter exit site until bleeding stops.
- Inspect the catheter to ensure that it is intact; if it is not, seek assistance.
- Apply a sterile, dry dressing to the exit site and cover with an airtight bandage.

### Practices to Avoid

- Do not use systemic antibiotics for prophylaxis to prevent infections.
- Do not routinely replace central lines at a specific time interval for IPC purposes.
- Do not use PICCs as a strategy to reduce the risk of CLABSI.
- Do not wrap anything around the joins in the tubing or rest open ends of tubing in anything.
- Do not reattach IV tubing that has been de-attached.
- Do not routinely use any of the following before comprehensively implementing all basic practices and assessing risk and cost versus benefit: antiseptic- or antimicrobial-impregnated central lines, chlorhexidine-containing dressings, antiseptic-containing hub/connector cap/port protector to cover connectors, silver zeolite-impregnated umbilical catheters in preterm infants, and antimicrobial locks (Marschall, Mermel, et al. 2014).

## Central Line-Associated Blood Stream Infection Prevention and Control Practice

## Bundles and Initiatives

The Institute for Healthcare Improvement (United States) developed the concept of a "bundle" to help HCWs care for patients during specific treatments. A bundle is a structured way of improving care and patient outcomes. They are a small, straightforward set of evidence-based interventions, which when performed collectively and reliably, have proven to improve patient outcomes. Studies have shown that IPC interventions can significantly reduce CLABSIs, including in limited-resource settings (Pronovost, Needham, Berenholz, et al. 2006; Rosenthal 2009). Box 2.3-1 is an example of a bundle for the insertion of central lines that are easily applicable in low-resource settings.

Box 2.3-1. Bundle for prevention of CLABSIs

The Central Line Bundle for Prevention of CLABSIs

- Educate staff
- Reduce complexity by creating an insertion kit/trolley
- Ask daily about the line necessity and remove unnecessary lines
- Implement insertion checklist to ensure adherence to IPC practices
- Empower staff to stop the insertion if IPC guidelines are not followed

## Monitoring and Surveillance of Infections Related to Intravascular Catheter Use (Including CLABSIs)

Surveillance is an effective tool that can be used to improve IPC practices and decrease HAIs. However, it can be labor-intensive and consume precious resources; therefore, it is important to have a thoughtful approach when developing a surveillance plan. Each healthcare facility should develop its own surveillance program based on the facility risk IPC assessment (see Volume 2, Section 5, Chapter 2: Managing Infection Prevention and Control Programs), which should maximize the use of resources by focusing on the areas where the most serious infections related to intravascular catheters are likely to occur, and the healthcare facility's overall objectives (APIC 2014; Lee, Montgomery, Marx, et al. 2007). If central lines are used at the facility, this would be the group with the highest risk and most serious consequences of infection. CLABSI surveillance in the areas where the most central lines are used (such as ICUs), would be a logical area on which to focus. If central lines are not used at the facility, and infections of peripherally inserted catheters are an issue, then the focus should be on this area.

### Steps in the CLABSI Surveillance Process

**Decide which procedures to monitor:** consider areas with the highest intravascular catheter use (e.g., central lines in ICUs) and the facility IPC risk assessment.

- Define the numerator and denominator: for CLABSI surveillance, the numerator is the number of CLABSIs and the denominator is the number of central-line days during the same time period. For example, numerator: the total number of CLABSIs in the ICU in a month/denominator: the total number of central-line days during that month.

- For peripheral IV bloodstream infection surveillance, the numerator is the number of bloodstream infections in patients with peripheral IV, and the denominator is the number of peripheral IV-days during the same time period.

**Establish the definition to be used to identify cases:**

- Develop a process to identify cases (e.g., monitor positive blood cultures, conduct daily rounds on all patients with a central line, communicate with the clinical team in areas of interest to help find cases for further review).

**Perform surveillance systematically:**

- Collate data and prepare reports.
- Initiate quality improvement activities, as necessary.
- For additional information on developing a CLABSI surveillance program, see Volume 2, Section 3, Chapter 1, Introduction to Surveillance of Healthcare-Associated Infections.

## Quality Improvement for Infections Related to Intravascular Catheter Use (Including CLABSIs)

Once infection rates are known for intravascular catheter-associated bloodstream infection, efforts should be made to improve. Reducing infections can improve patient outcomes and reduce facilities' cost of providing care.

When conducting quality improvement interventions to reduce intravascular catheter-associated bloodstream infection, the formation of multidisciplinary teams has been shown to be an effective method to support quality improvement efforts (Rosenthal et al. 2009; Geldenhuys, Dramowski, Jenkins, et al. 2017). Effective teams include representatives from the various disciplines with influence on preventing intravascular catheter-associated bloodstream infection, (e.g., all levels of HCWs, including clinicians, nurses, healthcare facility administrators, healthcare facility leadership, IPC staff, cleaning staff, and others). In this approach, the multidisciplinary team works together to plan, do, and sustain the work of quality improvement guided by surveillance data and evidence-based practices. Based on the team's consensus, the improvement process should include ongoing quantitative measurement of improvements and timely feedback of results and successes.

## SUMMARY

The use of intravascular catheters places the patient at risk for bloodstream infection, which results in higher mortality and increased healthcare costs. However, by following evidence-based IPC practices, these infections can be prevented. Prevention practices are aimed at avoiding unnecessary use of intravascular catheters and improving insertion and care of lines. Interventions using a "bundle" approach have been shown to be effective, sustainable, and cost-effective at reducing infections. Surveillance for monitoring insertion and maintenance processes and measuring outcomes can help identify risks and areas for performance improvement, but are not essential for implementing evidence-based procedures to prevent intravascular infections.

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# CHAPTER 4: PREVENTING HEALTHCARE-ASSOCIATED PNEUMONIA

### Key Topics

- Epidemiology and mechanisms of healthcare-associated pneumonia
- Risk factors for healthcare-associated pneumonia
- Strategies for preventing ventilator-associated pneumonia and other healthcare-associated pneumonia in adults, children, and infants
- Monitoring and surveillance of infections related to healthcare-associated pneumonia (including ventilator-associated pneumonia)
- Quality improvement for prevention of infections related to healthcare-associated pneumonia (including ventilator-associated pneumonia)

## BACKGROUND

Hospital-acquired pneumonia (HAP), which includes non-ventilator-associated pneumonia (VAP) and VAP, accounts for 15% of all HAIs. Half of all cases of HAP occur after surgery. Mechanical ventilation greatly increases the risk of acquiring pneumonia. VAP accounts for 32% of all infections acquired in ICUs (WHO 2011). The presence of HAP increases hospital stays by an average of seven to nine days per patient and carries a high risk of morbidity and mortality (American Thoracic Society and Infectious Diseases Society of America 2005). Due to the frequency of HAP in hospitalized patients, preventing HAP is an important aspect of reducing HAI. Because patients who acquire VAP have poor outcomes, surveillance and prevention efforts are usually focused on VAP.

Although surveillance in high-income settings is moving toward ventilator-associated event (VAE; a range of complications that occur in patients on mechanical ventilation), this chapter focuses on non-VAP and on infectious complications of mechanical ventilation.

### Epidemiology

Ninety percent of healthcare-associated pneumonia episodes occur among ICU patients receiving mechanical ventilation. VAP occurs in 9%–27% of intubated patients on ventilators in ICUs.

- The risk of VAP increases 1%–3% for every day a patient is on a ventilator.
- The majority of non-VAP and VAP is caused by bacteria.
- The highest risk of developing VAP is during the first 96 hours of mechanical ventilation.
- Those with early onset (within 96 hours of being on a ventilator) of VAP have a better prognosis than those with late onset of VAP (after the first 96 hours of being on the ventilator).

(American Thoracic Society and Infectious Diseases Society of America 2005).

Non-VAP and VAP are thought to be caused by similar pathogens. A wide variety of bacteria pathogens are implicated and a patient may be infected with more than one pathogen. Some pathogens are more common in various patient groups; for example, viral or fungal causes are more common in immunocompromised patients.

Causative organisms for early-onset VAP (first 4 days of ventilation) are likely to involve the patient's own flora (microorganisms that normally reside on or in an individual), especially *Streptococcus* and *Haemophilus* species. Late-onset VAP (after the fourth day) is more likely to be caused by multidrug-resistant pathogens, such as *Pseudomonas aeruginosa*, *Acinetobacter* spp., or MRSA, and is associated with increased patient mortality rates.

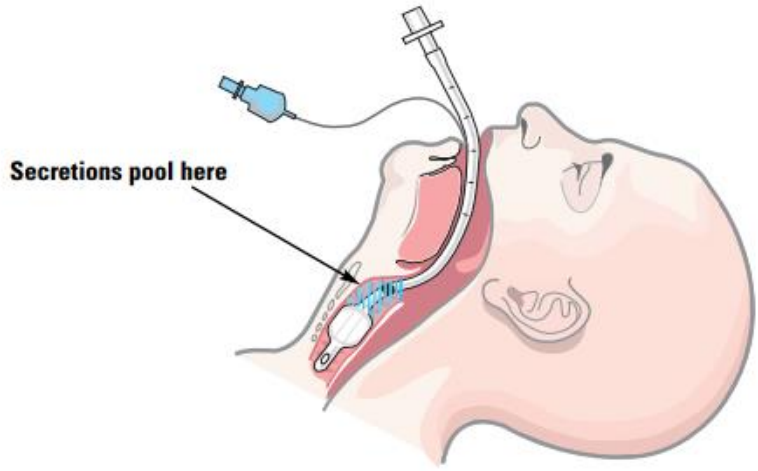
## Mechanism

Pneumonia usually occurs by breathing in (micro-aspiration) bacteria growing in the back of the throat (oropharynx) or stomach. In addition, hospitalized patients are at risk for aspiration pneumonia, which happens when they accidentally inhale food, drink, mouth secretions, or regurgitated stomach contents (vomit). Healthy people have the ability to cough, so microorganisms and food do not enter the lungs during breathing (aspiration). Most healthy individuals' immune systems can fight off these microorganisms that cause pneumonia.

Surgery, intubation, and mechanical ventilation greatly increase the risk of infection because they:

- Block the normal body defense mechanisms—coughing, sneezing, and the gag reflex.
- Prevent the washing action of the cilia (fine hair in the airways that aid in the movement of particles in the nose and lungs) and mucus-secreting cells lining the upper respiratory system that aid in removing foreign substances.
- Cause pooling of secretions in the subglottic area where microorganisms can grow and then migrate to the lower respiratory tract (figure 2.4-1).
- Reduce oral immunity leading to the accumulation of dental plaques, which may then be colonized by oral microorganisms.
- Provide a direct pathway for microorganisms to get into the lung.

Figure 2.4-1. Pooling of secretions in subglottic area




*Source*: Respiratory Therapy Cave 2014

## Risk Factors for Healthcare-Associated Pneumonia

The major risk factors for HAP include the following:

- Surgery
- Intubation and mechanical ventilation (risk increases with the duration of ventilation)
- Aspiration of stomach or oropharyngeal fluids contaminated with colonizing organisms
- Enteral feeding in a supine body position
- Subglottic pooling of secretions
- Oropharyngeal colonization
- Stress ulcer prophylaxis

(American Thoracic Society and Infectious Diseases Society of America 2005).

## Strategies for Preventing Healthcare-Associated Pneumonia

### Reducing the Risk of Pneumonia among All Patients

The transfer of microorganisms among hospitalized patients occurs frequently. The following procedures should be followed to prevent transmission of pathogens:

- Perform hand hygiene, including after contact with body secretions or anything contaminated with body secretions (see Volume 1, Chapter 4: Hand Hygiene).
- Wear clean gloves when handling respiratory secretions or objects contaminated with respiratory secretions. Change gloves before and after patient contact and between

contacts with contaminated body sites, the respiratory tract, or devices used on the same patient (see Volume 1, Chapter 5: Personal Protective Equipment).

- Wear a gown when contact with respiratory secretions from a patient is anticipated and change it after soiling occurs and before providing care to another patient (see Volume 1, Chapter 5: Personal Protective Equipment).
- Use single-use respiratory care items where possible (e.g., oxygen masks, nebulizer sets); when not possible, meticulously reprocess respiratory care items (see Volume 1, Chapter 7: Decontamination and Reprocessing of Medical Devices).
- Teach patients to cough or sneeze into a tissue (and throw it into the trash right away), or cough or sneeze into the fabric of a sleeve or elbow, and then wash their hands.
- Assess patients with clinical signs or symptoms of respiratory illnesses (see Volume 1, Chapter 3: Standard and Transmission-Based Precautions).
    - Use empiric isolation
    - Use source control (have them wear a mask as soon as possible on entering a healthcare facility)
    - Cohort patients with the same signs and symptoms together if single rooms are not available
- Avoid crowding patients in wards or outpatient treatment areas.
- Space beds 1 meter (3 feet) or more from other beds.
- Place only one person in a bed.
- Consider placing patients (in consecutive beds) in a head-to-foot position to increase the distance between the patients' faces if the beds are pushed close together.
- Ensure proper air ventilation in the room where patients are waiting to be seen or staying during the inpatient hospitalization process.
- Provide airborne infection isolation rooms or single, well-ventilated rooms to isolate patients with respiratory infections that tend to spread in healthcare facilities.
- Clean hard surfaces that are frequently touched (e.g., countertops, phones, doorknobs, light switches) regularly with a disinfectant (see Volume 1, Chapter 9: Environmental Cleaning in Healthcare Setting).

## Reducing the Risk of Pneumonia among Surgery Patients

### Preoperative Pulmonary Care

Numerous studies have shown that the risk of pneumonia can be reduced by teaching patients—before their operation—how to prevent postoperative pulmonary problems by using deep breathing techniques, moving in bed, coughing frequently, and moving soon after the operation (e.g., sitting up and walking). The greatest opportunities for prevention of pneumonia are with those surgical patients not expected to need postoperative ventilation.

**Postoperative Management**

As mentioned above, surgical patients should be taught preoperatively how to prevent postoperative pneumonia. Surgical units in healthcare facilities should have effective plans for:

- Optimizing the use of pain medication to keep the patient comfortable enough to cough effectively.
- Moving and exercising patients on a regular schedule.
- Encouraging deep breathing in the immediate postoperative period and over the following few days after surgery.

Procedures that may increase the risk of infection include oxygen therapy, bi-level positive airway pressure (i.e., continuous airway pressure during inhalation and exhalation), or intermittent positive pressure breathing (e.g., used for hyperventilation) treatments, endotracheal suctioning, and intubation with an endotracheal tube.

## Strategies For Preventing Healthcare-Associated Pneumonia (including VAP)

Many aspects of VAP prevention differ according to the age of the patient; however, there are IPC practices that should be followed in all patients.

### Prevention of Ventilator-Associated Pneumonia in Patients of All Ages

Ensure the following IPC practices for all patients on a ventilator.

- Perform hand hygiene including before and after touching a medical device, including the endotracheal tube and other parts of ventilator circuit (see Volume 1, Chapter 4: Hand Hygiene).
- Use aseptic technique for intubation and other procedures that involve manipulation of the endotracheal tube and the ventilator circuit.
- Use single-use respiratory care items, where possible; when they are not available, meticulously reprocess respiratory care items (see Volume 1, Chapter 7: Decontamination and Reprocessing of Medical Devices).
- Maintain aseptic technique when suctioning mucus via an endotracheal tube.

**Note:** Mechanical ventilation should be used only when necessary and only for as long as necessary.

### Suctioning Ventilated Patients

To minimize cross-contamination when suctioning patients on ventilators:

- Wash hands or use ABHR before putting on gloves.
- Wear clean, non-sterile gloves and use standard precautions (may need a protective face shield or mask with eye protection).

- Remove gloves immediately after therapy is completed and discard them in a plastic bag or leak-proof, covered, contaminated-waste container.
- Wash hands or use ABHR after removing gloves.

**Note:** Do not touch other items in the room or the patient after suctioning and while still wearing gloves.

Suction catheters should be single-use. The use of large containers of saline or other fluids for instillation or rinsing of the suction catheter should be avoided. If possible, use only small containers of sterile solutions (or if not available, boiled water), which should be used only once and then replaced.

To reduce the risk of contamination and possible infection from mechanical respirators and other equipment, follow these guidelines:

- Prevent condensed fluid in the ventilator tubing from refluxing (going backward or return flow) into the patient because it contains large numbers of microorganisms. (Any fluid in the tubing should be drained and discarded, taking care not to allow the fluid to drain toward the patient.)
- Clean and disinfect humidifiers between patients. Although contaminated humidifiers for oxygen administration and ventilator humidifiers are unlikely to cause pneumonia because they do not generate aerosols (liquids or solids suspended in gas or vapor), they can be a source of cross-contamination. Use sterile (not distilled, non-sterile) water to fill bubbling humidifiers.

**Note:** Use proper hand hygiene before and after touching a patient and putting on and removing gloves.

- Change ventilator circuits (tubing to guide airflow in the ventilator) only when they are visibly soiled or mechanically malfunctioning. Although ventilator circuits may become contaminated at the patient end by microorganisms from the respiratory tract, there is little evidence that pneumonia is associated with this contamination.
- Clean and disinfect breathing circuits using high-level disinfection procedures (see Volume 1, Chapter 7: Decontamination and Reprocessing of Medical Devices).
- Ensure that resuscitation devices (e.g., Ambu bags), which are difficult to clean and disinfect, are completely dry before reuse because fluids containing infectious materials left inside the bag or facepiece can be aerosolized during subsequent use. Ambu bags and other components should be meticulously cleaned, dried, and high-level disinfected using an appropriate disinfectant or by steaming for 20 minutes (see Volume 1, Chapter 7: Decontamination and Reprocessing of Medical Devices).

## Preventing Gastric Reflux

Even short-term (for a few days) use of nasal feeding tubes increases the risk of aspiration. Feeding small, frequent amounts rather than large amounts may reduce the risk of gastric reflux (i.e., stomach juices going backward into the esophagus). Also, raising the head while the patient is in bed, so that the patient is in a sitting position, makes reflux less likely.

## Prevention of Ventilator-Associated Pneumonia in Adult Patients

Basic practices to prevent VAP in adult patients (these include interventions that have little risk of harm and decrease the duration of mechanical ventilation, length of stay, and cost) (Klompas, Branson, Eichenwald, et al. 2014).

- Avoid intubation, if possible:
    - Use noninvasive positive pressure ventilation (NIPPV) whenever feasible.
- Minimize sedation:
    - Manage ventilated patients without sedatives whenever possible.
    - Interrupt sedation once a day (spontaneous awakening trials) for patients without contraindications.
    - Assess readiness to extubate once a day (spontaneous breathing trials) in patients without contraindications.
    - Pair spontaneous breathing trials with spontaneous awakening trials.
- Maintain and improve patients' physical conditioning:
    - Provide early exercise and mobilization.
- Minimize pooling of secretions above the endotracheal tube cuff:
    - Provide endotracheal tubes with subglottic secretion drainage ports for patients likely to require greater than 48–72 hours of intubation.
- Elevate the head of the bed to 30–45$^{o}$.
- Maintain ventilator circuits and respiratory care equipment:
    - Change the ventilator circuit only if visibly soiled or malfunctioning.
    - Meticulously clean, disinfect, and sterilize respiratory care equipment.

Interventions commonly used to prevent VAP for which there are insufficient data at present to determine their impact in lowering the VAP rates include:

- Performing oral care with chlorhexidine
- Administering prophylactic probiotics
- Using ultrathin polyurethane endotracheal tube cuffs
- Instilling saline before tracheal suctioning

Practices not generally recommended for routine VAP prevention:

- Use of silver-coated endotracheal tubes
- Use of kinetic beds (continuous lateral rotational therapy or oscillation therapy)
- Use of prophylaxis for stress ulcers only for the purpose of preventing VAP
- Tracheostomy, unless it is clinically indicated
- Initiation of early parenteral nutrition

(Klompas, Branson, Eichenwald et al. 2014)

## Prevention of Ventilator-Associated Pneumonia in Pediatric Patients

Basic practices to prevent VAP in pediatric patients (these include interventions that have little risk of harm and lower VAP rates) (Klompas, Branson, Eichenwald, et al. 2014).

Measures for prevention of VAP among pediatric patients are derived from adult practices but have been adapted to pediatric patients:

- Avoid intubation if possible: Use NIPPV with or without nasal intermittent mechanical ventilation as an alternative.
- Minimize the duration of mechanical ventilation by assessing readiness to extubate daily using spontaneous breathing trials in patients without contraindications.
- Avoid unplanned extubation and reintubation.
- Provide regular oral care: tooth brushing or gauze if no teeth.
    - For infants, before teeth have emerged, wipe the gums with a gauze pad after each feeding.
    - After teeth have emerged in children under two years of age, brush them gently twice a day with a child's size toothbrush and water.
    - Use routine toothbrush and toothpaste in patients more than two years old. Keep the oral mucosa and lips clean, moist, and intact using non-alcohol, non-peroxide mouth rinse.
- Elevate the head end of the bed to 30–45°.
- Change ventilator circuits only when visibly soiled or malfunctioning.
- Remove condensate from ventilator circuits frequently. Prevent condensate from reaching the patient.
- Suction oral secretions before each position change.
- Use cuffed endotracheal tube and maintain the cuff pressure and volume.

- Interventions effective in adults with minimal risk of harm and but few data in pediatric patients:
    - Interrupt sedation once a day.
    - Administer prophylactic probiotics.
    - Use endotracheal tubes with subglottic secretion drainage ports in older pediatric patients who may require mechanical ventilation for more than 48–72 hours.

Interventions that are not recommended for pediatric patients:

- Using systemic prophylactic antibiotic therapy
- Selecting oropharyngeal or digestive decontamination using oral antibiotics
- Oral care with chlorhexidine
- Stress ulcer prophylaxis
- Early tracheotomy
- Thromboembolism prophylaxis
- Using silver-coated endotracheal tubes

(Klompas, Branson, Eichenwald, et al. 2014)

## Prevention of Ventilator-Associated Pneumonia in Neonatal Patients

Basic interventions for prevention of VAP among neonatal patients have minimal risk of harm:

- Avoid intubation in preterm neonates, if possible. Use NIPPV with or without nasal intermittent mechanical ventilation as an alternative.
- Minimize duration of mechanical ventilation by:
    - Managing patients without sedation when possible.
    - Assessing readiness to extubate daily in patients without any contraindications.
    - Avoid unplanned extubation and reintubation.
- Provide regular oral care with sterile water.
- Minimize breaks in ventilator circuits and change only if visible soiled or malfunctioning.
- Change ventilator circuits only when visibly soiled or malfunctioning.
- Remove condensate from ventilator circuits frequently. Prevent condensate from reaching the patient.

Interventions with minimal risk of harm but unknown impact on reducing VAP rates include:

- Lateral recumbent positioning
- Keeping the patient’s head 15–30° higher than the feet
- Closed suctioning

Practices that are not recommended or are considered harmful and should not be used include:

- Oral care with antiseptic solution
- H2-receptor antagonists (H2-blockers)
- Broad-spectrum prophylactic antibiotics
- Spontaneous breathing trials

(Klompas, Branson, Eichenwald, et al. 2014)

## Ventilator-Associated Pneumonia Infection and Control Prevention Bundles and Initiatives

The Institute for Healthcare Improvement in the United States developed the concept of a "bundle" to help HCWs care for patients during specific treatments. A bundle is a structured way of improving care and patient outcomes. They are a small, straightforward set of evidence-based interventions, which when performed collectively and reliably, have proven to improve patient outcomes. Studies have shown that the use of a group of evidence-based interventions can achieve better outcomes for ventilated patients (including adult, pediatric, and newborn patients) (Resar, Pronovost, Haraden, et al. 2005). Boxes 2.4-1 through 2.4-3 show examples of bundles for VAP prevention that are easily applicable in LMIC settings. It is up to the individual facility to decide the best elements to include in the VAP prevention bundle based on the findings of the performance measures and prioritization of the interventions.

Box 2.4-1. Components of a VAP prevention bundle for adult patients

**VAP Prevention Bundle: Adult**

1. Elevate the head of the bed more than 30–45°.
2. Provide daily sedative interruptions to allow HCWs to evaluate when the patient is ready to have the breathing tube removed.
3. Provide regular oral care:
    - Brush teeth, gums, and tongue every 4 hours
    - Moisturize oral mucosa and lips every 2–4 hours
    - Use an oral antiseptic such as chlorhexidine gluconate (0.12%) rinse twice a day.
4. Use specific endotracheal tubes (tubes that enter the trachea) to facilitate suctioning of secretions.
    - Use orotracheal (by mouth) rather than nasotracheal (by nose) intubation when possible.
    - If available, use a cuffed endotracheal tube with an endotracheal cuff pressure of 20cm H2O and in-line (part of a closed system) or subglottic suctioning.
5. Make the patient mobile as quickly as possible, even when still attached to the breathing machine.

*Adapted from*: Armstrong Institute for Patient Safety and Quality n.d.; CDC 2004; Tablan, Anderson, Besser, et al. 2004; Klompas, Branson, Eichenwald, et al. 2014

Box 2.4-2. Components of a VAP prevention bundle for pediatric patients

**VAP Prevention Bundle: Pediatric**

1. Elevate the head of the bed 30–45°.
2. Assess readiness to extubate daily, using spontaneous moderate breathing trials in patients without contraindications.
3. Provide regular oral care (i.e., tooth brushing or gauze if no teeth).
4. Avoid unplanned extubation.

*Sources*: Klompas, Branson, Eichenwald, et al. 2014; Institute for Healthcare Improvement n.d.

Box 2.4-3. Components of a VAP prevention bundle for NICU patients

**VAP Prevention Bundle: Neonates in NICU**

1. Perform hand hygiene and put on gloves before touching any patient.
2. Oral care every 3–4 hours with sterile water.
3. Evaluate patient's readiness to extubate daily.
4. Manage patients without sedation, if possible.

*Adapted from*: New Hanover Regional Medical Center n.d.; Klompas, Branson, Eichenwald, et al. 2014

## Monitoring and Surveillance of Infections Related to Healthcare-Associated Pneumonia (including VAP)

### Steps in the HAP Surveillance Process

1. Decide which procedures to monitor (consider areas with ventilated patient [e.g., ICUs] and the facility IPC risk assessment).
2. Define the numerator and denominator: for VAP surveillance, the numerator is the number of cases of VAP, and the denominator is the number of ventilator-days during the same time period. For example, numerator: the total number of VAP in the ICU in a month/denominator: the total number of ventilator-days during that month. For HAP surveillance (non-VAP), the numerator is the number of patients with HAP, and the denominator is the number of patient-days during the same time period.
3. Establish the definition to be used to identify cases.
4. Develop a process to identify cases (e.g., monitor positive sputum cultures, conduct daily rounds for all patients on a ventilator, communicate with the clinical team in areas of interest to help find cases for further review).
5. Perform surveillance systematically.
6. Collate data and prepare reports.
7. Initiate quality improvement activities, as necessary.

For additional information on developing an HAP surveillance program, see Volume 2, Section 3, Chapter 1: Introduction to Surveillance of Healthcare-Associated Infections.

## SUMMARY

The use of mechanical ventilators is increasing among newborn, pediatric, and adult patients in low- and middle-income countries. VAP is one of the most common HAIs, resulting in increased healthcare costs and increased mortality among intubated patients on mechanical ventilators. Applying specific prevention measures recommended in this chapter, including proper compliance with recommended IPC practices, will help reduce the risk of VAP.

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# CHAPTER 5: PREVENTING HEALTHCARE-ASSOCIATED INFECTIOUS DIARRHEA

### Key Topics

- Common risk factors and causes of healthcare-associated infectious diarrhea
- Preventing transmission of healthcare-associated diarrhea

## BACKGROUND

Diarrhea is a common symptom of a gastrointestinal (GI) tract infection and is generally defined as the passage of three or more loose or liquid stools per day. GI infections can be caused by bacteria, viruses, or parasites and are spread through contaminated food or water or from person to person due to poor hygiene practices. Untreated infectious diarrhea can cause dehydration from loss of body fluids and electrolytes. Severe dehydration can lead to death. Dehydration can be treated with oral rehydration salts solution (clean water, salt, and sugar) or IV fluids. Controlling the spread of healthcare-associated infectious diarrhea should be a key area of focus for IPC.

Diarrhea in hospitalized patients can often have non-infectious causes including:

- Medications, such as antibiotics
- Procedures, such as endoscopy, nasogastric feeding, x-ray studies using barium, enemas
- Disease processes, such as HIV
- Psychological stress

Although non-infectious diarrhea is a common complication of hospitalization, it does not require treatment with antimicrobials.

Healthcare-associated infectious diarrhea is defined as diarrhea with an infectious origin that begins on or after the third calendar day of hospitalization (the day of hospital admission is calendar Day 1). The term “healthcare-associated diarrhea” used in this chapter refers to infectious diarrhea.

Healthcare-associated diarrhea can result in prolonged hospital stays, increased costs, mortality, and, in some cases, death, but it can be prevented by applying simple IPC practices. It is one of the most common hospital-associated infections in children. In addition, the emergence and spread of *Clostridium difficile* is a growing problem among hospitalized adults worldwide (Polage, Solnick, Cohen, et al. 2012; WHO 2002).

### Epidemiology

Organisms causing diarrhea are often transferred to susceptible people via hands contaminated from direct contact with feces or indirectly from contact with contaminated (usually not visible) articles. This is known as the fecal-oral route.

Situations that favor the spread of infection via the fecal-oral route in healthcare facilities include:

- Person-to-person contact by HCWs (such as caring for a patient with diarrhea, not washing hands, and then helping a patient eat)
- Inadequately cleaned patient care equipment and environments where surfaces, such as toilets, bedrails, and toys, remain contaminated
- Contaminated food prepared in the hospital kitchen or brought from home
- Contaminated fluids, such as drinking water, infant formula, or tube feeds
- Person-to-person contact by patients, such as children passing on the illness through touching while playing together
- Inadequately high-level disinfected or sterilized medical instruments that enter the GI tract (e.g., endoscopes)

## Microbiology

Healthcare-associated infectious diarrhea is common in low- and middle-income healthcare facilities. Data on causative agents are limited due to limited laboratory facilities. Common pathogens implicated include Shigella spp, Salmonella spp, E. coli, rotavirus and toxigenic Staph aureus. *Staphylococcus aureus*; norovirus, which was identified in 63% of outbreaks in a recent study; and rotavirus, which is very common in both low- and high-income settings, particularly in pediatric patients (Bolyard, Tablan, Williams, et al. 1998; Lopman, Reacher, Vipond, et al. 2004; Polage, Solnick, Cohen, et al. 2012; WHO 2002).

### Bacterial Gastroenteritis

Bacteria that commonly cause hospital outbreaks, mostly gram negative (e.g., *Salmonella, E. coli*, *Shigella*, *Campylobacter*), have varying degrees of virulence and can cause diarrhea or dysentery (diarrhea with pain, mucus, and blood in stool). Some are normal flora or colonize the gut, but some serotypes of these can cause infections (e.g., *E. coli* O157:H7). Some cause disease by releasing enterotoxins (e.g., *E. coli* O157:H7; *C. difficile*). Outbreaks occur via fecal contamination of hands, from food that is not cooked properly, or from contaminated water. If the healthcare facility kitchen staff do not follow prevention measures (such as those described in Volume 1, Chapter 11: Food and Water Safety) outbreaks can easily occur. Similarly, hand hygiene among HCWs and patients helps prevent outbreaks of GI infection.

### Rotavirus

Rotaviruses are the most common community causes of diarrhea in children under five, making up 15%–25% of diarrheal disease cases identified in children at treatment centers in LMIC. The virus can survive on inanimate surfaces, is easily spread, and may become endemic in healthcare facilities. Because it is highly infectious, during nursery outbreaks, nearly all infants will become infected (WHO 2008). Prolonged shedding of the virus in stool may occur in both immunocompetent and immunocompromised children and the elderly.

## Noroviruses (Norwalk and Caliciviruses)

Rapid identification and immediate implementation of interventions are important in preventing serious outbreaks of norovirus. If clinical laboratory tests are not available, Kaplan's clinical and epidemiologic criteria can be used to determine if an outbreak might be caused by norovirus.

Kaplan's criteria:

- Vomiting in more than half of symptomatic cases
- Mean (or median) incubation period of 24 to 48 hours
- Mean (or median) duration of illness of 12 to 60 hours
- No bacterial pathogen isolated in stool culture

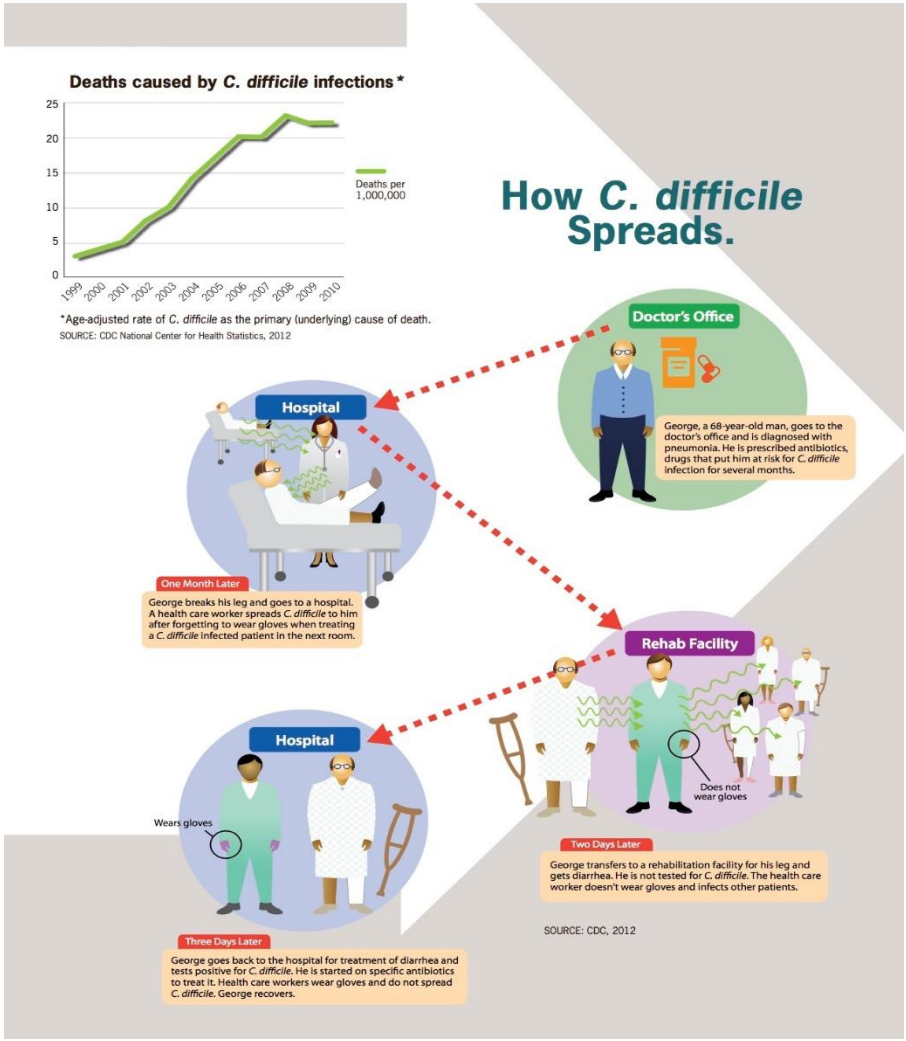
(MacCannell, Umscheid, Agarwal, et al. 2011)

Noroviruses may be easily aerosolized and may be inhaled from areas heavily contaminated with feces or vomit. Cohorting of affected patients to separate airspaces and toilet facilities may help interrupt transmission during outbreaks.

### Clostridium difficile

The use of antibiotics is associated with some types of healthcare-associated diarrhea, especially *C. difficile* (figure 2.5-1). In high-income countries, *C. difficile* is the most common cause of healthcare-associated infectious diarrhea (Polage, Solnick, Cohen, et al. 2012). *C. difficile* is a spore-forming, toxin-producing bacterium. The illness was previously known as "antibiotic-resistant diarrhea" or "pseudomembranous colitis." It is now being increasingly reported in LMIC (Alrifai, Alsaadi, Mahmood, et al. 2009; Garcia, Samalvides, Vidal, et al. 2007).

Figure 2.5-1 How C. difficile is spread




*Source*: CDC 2012

## Risk Factors for Healthcare-Associated Diarrhea

Patient risk factors for healthcare-associated diarrhea include extremes of age (newborns and the elderly); poor nutrition; impaired immunity; decreased gastric acidity; disruption of normal GI function from medical or surgical conditions; and altered, protective microorganisms in the gut, which occur from antibiotic treatment. High levels of antibiotic use disrupt helpful, protective bacteria normally living in the gut, leaving the person at risk for infection with microorganisms that cause some types of diarrhea.

Outbreaks in healthcare facilities can include common, unusual, or opportunistic pathogens. Illnesses and treatments that compromise the immune system put patients at risk of infection from organisms that do not usually bother healthy people (opportunistic). In hospitalized patients, infectious diarrhea may present in unexpected ways, such as by becoming prolonged or more severe due to decreased immunity or other risk factors. Immunocompromised patients may shed the viruses or bacteria in stool for prolonged periods.

## Prevention of Healthcare-Associated Infectious Diarrhea

### Preventing Transmission of Healthcare-Associated Diarrhea from Patients

Prevention and control of healthcare-associated diarrhea includes breaking the disease transmission cycle typical for GI infections (fecal-oral route). Actions include:

- Performing hand hygiene at the recommended WHO "5 Moments" using either ABHR or soap and water.
- For outbreaks situations with *C. difficile* and norovirus, the use of soap and water for hand hygiene is more effective (Dubberke, Gerding 2011).
- Educating patients and family members about hand hygiene (how to perform and the importance) and providing a means for them to perform hand hygiene (such as at the bedside and in patient toilets).
- Using standard precautions to choose appropriate PPE for situations when contact with vomit, stool, or items contaminated with these are likely. This would include the use of gloves to protect hands, long-sleeve gowns and aprons to protect clothing, and face and eye protection to protect the eyes, nose, and mouth when splashes are expected. Remember that standard precautions assume that every patient is potentially infectious.

**Note:** Hand hygiene for staff and patients is the single most important practice to prevent outbreaks of healthcare-associated diarrhea.

- Using contact precautions empirically to isolate diapered and incontinent patients with diarrhea until laboratory results are available.
- For norovirus: Wearing a surgical mask may be of benefit to prevent the inhalation of aerosolized virus from areas heavily contaminated with feces or vomit. Cohorting of affected patients to separate airspaces and toilet facilities may help interrupt transmission during outbreaks.
- Using contact precautions for all patient and/or cohorting to control institutional outbreaks.
- Cleaning frequently touched surfaces, equipment, patient areas, and toilet areas rigorously and regularly.
- For *C. difficile:* Clean with a bleach-containing disinfectant (or other cleaning agents effective against *C. difficile* spores).
- Using recommend methods for laundering healthcare textiles.
- Following recommend waste management practices.

### Preventing Transmission of Healthcare-Associated Diarrhea from Healthcare Facility Staff

**Clinical Staff**

Clinical staff with symptoms of diarrhea, with or without fever, nausea, vomiting, and abdominal pain, should be excluded from all patient care duties for the duration of their illness. They are more infectious during active disease. They should return to duties only after they have fully recovered from the symptoms. Persistent carriage (asymptomatic excretion) occurs with some infectious organisms, but once HCWs have clinically recovered and are having formed stools, they pose a minimal risk of transmission and do not need to be excluded from work in clinical areas if they have good hygiene and use standard precautions. They should comply fully with hand hygiene because they may continue to shed the bacteria or virus in their stool and thus spread infection even after symptomatic recovery. (See Volume 1, Chapter 13: Infection Prevention and Control Aspects of Occupational Health in Healthcare Settings.)

If laboratory services are available, clinical staff should return to duty caring for patients at high risk or with severe diseases (neonates, elderly persons, and immune-compromised patients, such as cancer patients, premature infants and patients with HIV/AIDS) only after appropriate microbiological testing and clearance (Bolyard, Tablan, Williams, et al. 1998; WHO 2008).

**Food Service Personnel**

Food service staff with diarrhea symptoms, with and without fever, nausea, vomiting, and abdominal pain, should be excluded from all kitchen duties for the duration of their illness. They should receive medical care and return to work only when cleared by the occupational health department or designated medical staff in consultation with the IPC team and in accordance with local laws and regulations (WHO 2008). Systems for identifying symptomatic food service personnel should be in place to prevent ill persons from working in the food services area. (See Volume 1, Chapter 11: Food and Water Safety.)

## Introduction to Management of an Outbreak of Diarrheal Illness in a Healthcare Facility

Preventing outbreaks by minimizing the risks of food- or waterborne infections is cost-effective. Management of outbreaks can be expensive because outbreaks require additional resources to stop the spread and treat cases. The successful management of outbreaks of diarrhea in healthcare facilities usually requires several simultaneous actions. (See Volume 2, Section 5, Chapter 1: Principles of Public Health Emergency Preparedness and Outbreak Management for Health Care Facilities.) In many cases, the cause of an outbreak will not be found but the outbreak will be halted by improving infection control measures.

### Managing Outbreaks of Diarrheal Illness

The following actions should be taken in an outbreak of diarrheal illness at a healthcare facility.

Determine if there is an outbreak:

- Consider whether the cases appear clinically to have the same illness (or different manifestations of the same disease), if possible.

- Collect clinical specimens from cases if there is a lab available to process them.
- Determine whether there is an outbreak by comparing the new rates of infection with the normal background activity of the disease, if known.
- Identify factors common to all or most cases (e.g., food-related, time of exposure, contact with an infected person, recent farm visit, contact with animals, working as a food handler).
- Conduct interviews with initial cases (Appendix 2.5.A. Diarrhea Source Survey Form).
- Conduct an observation of practices and infrastructure on site:
    - Ensure that hand hygiene supplies are in place and hand hygiene is being performed by staff and patients.
    - Ensure that environmental cleaning (see Volume 1, Chapter 9: Environmental Cleaning) is thorough and frequently performed and that a suitable cleaning agent (active against the suspected cause) is used at the recommended dilution.
    - Ensure that there is adequate PPE (see Volume 1, Chapter 5: Personal Protective Equipment) for staff caring for patients with diarrhea.
    - Ensure the correct disposal or decontamination of contaminated materials (such as linens, equipment, and medical devices).
    - Ensure that staff with diarrhea do not work.
    - Ensure that correct food-handling practices are performed (see Volume 1, Chapter 11: Food and Water Safety).
    - Eliminate potential contaminates to the hospital water supply (see Volume 1, Chapter 11: Food and Water Safety).
- Additional actions that may be required to halt the outbreak include:
    - Group patients with the same symptoms or GI illness together (cohort) and place on contact precautions if resources allow.
    - Place all patients on contact precautions.
    - Do not allow sharing of equipment or staff with new or uninfected patients.
    - Provide separate space and separate staff (extra staff may be needed) to care for affected infants in the nursery or NICU during outbreaks (see Volume 2, Section 4, Chapter 5: Preventing Maternal and Newborn Infections in Healthcare Settings).
    - Discharge affected and unaffected patients early if their care can be managed at home.
    - Stop admitting new patients until the outbreak is controlled in situations in which other methods do not limit the outbreak (WHO 2008).

## SUMMARY

Healthcare-associated diarrhea is a commonly experienced HAI in all healthcare settings. The pathogens vary between settings, with *C. difficile* being the most common in high-income settings but being increasingly reported in LMIC. Infections with rotavirus and norovirus commonly occur in all settings. However, simple IPC interventions, such as hand hygiene, environmental cleaning, food and water safety, and appropriate patient education activities, can have a great impact on reducing harm to patients from acquiring infectious diarrhea from their hospital stay.

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# CHAPTER 1: INTRODUCTION TO SURVEILLANCE OF HEALTHCARE-ASSOCIATED INFECTIONS

### Key Topics

- Characteristics and types of surveillance for HAIs
- Purposes of conducting surveillance
- Prioritizing surveillance for HAIs
- Designing HAI surveillance program
- Implementing the program
- Data analysis and feedback
- Performance improvement

## BACKGROUND

HCWs do not intend patients to suffer any harm in the course of, or as a result of, their care. Providing essential information to staff on HAIs occurring in the areas where they work allows them to explore possible causes and develop strategies to improve IPC practices and prevent HAIs. Surveillance has been shown to be a powerful tool to achieve this objective. Bonita et al. (2006) define health surveillance as "the ongoing systematic collection, analysis, and interpretation of health data essential for planning, implementing and evaluating public health activities."

Surveillance for HAIs is a systematic way to gather information (data) to describe the occurrence and distribution of HAIs. HAI surveillance includes the collection, compilation, analysis, interpretation, and distribution of information about HAIs. Box 3.1-1 provides examples of how surveillance data can be used to measure patient harm.

Box 3.1-1. Examples of surveillance data measuring patient harm

- 20 out of every 100 patients who undergo a C-section (20%) and 5 out of every 100 patients who undergo an appendectomy (5%) develop an SSI.
- On March 23, 2018, 6 of the 30 patients in the labor and delivery ward have an HAI (prevalence of 20%) compared with 3 of the 30 patients (prevalence of 10%) in similar wards.
- The rate of hospital-acquired BSI (sepsis) in the newborn nursery is 5 per 1,000 patient-days at this healthcare facility but other healthcare facilities in the region have a rate of 1 per 1,000 patient-days.

Studies have shown that healthcare facilities with effective HAI surveillance systems and strong IPC programs have reduced the occurrence of patient harm from HAIs (Ellingson et al. 2014; Haley et al. 1985). However, healthcare facilities in many LMIC do not have systems for HAI surveillance.

According to WHO, 66% of countries do not report HAI surveillance data (WHO 2011). The data that do exist show that limited-resource settings have higher rates of HAI than high-income countries: 1 in every 10 patients develops an HAI, which is about double the rate for high-income countries

(Rosenthal et al. 2014; WHO 2011). This chapter provides information for IPC staff to develop surveillance programs appropriate to the available resources.

## Characteristics of Effective Surveillance

For surveillance to be effective, it is critical that:

- Surveillance is based on sound epidemiological and statistical principles. (See Volume 2, Section 3, Chapter 2 Basic Epidemiology and Statistics for IPC.)
- Data are properly collected and analyzed.
- Information is shared in a timely manner with those who can act to improve IPC practices and quality of care. Efforts to improve practices and decrease HAI are a critical part of the surveillance plan.

## Types of Surveillance

Surveillance activities can be outcome- or process-oriented.

- Outcome surveillance: monitoring of specific HAIs (e.g., SSIs, CAUTIs, diarrhea).
- Process surveillance: monitoring of patient care practices, including IPC practices (e.g., compliance with hand hygiene, timing of prophylactic antibiotics during surgery, use of aseptic technique for central line insertion).

Surveillance can be continuous or periodic.

- Continuous: data are collected continuously on a routine basis.
- Periodic, when data are collected at intervals, such as one month each quarter or one quarter per year.

Surveillance can be active or passive (box 3.1-2):

- Active surveillance is the identification of HAIs by trained personnel who proactively look for HAIs using multiple data sources. Active surveillance is conducted by trained staff using standardized case definitions and is more accurate than passive surveillance.
- Passive surveillance of HAIs refers to the identification of HAIs by patient care providers, such as physicians or nurses, who may not be formally trained in surveillance and may not consistently use standardized surveillance case definitions to identify HAIs (Heipel, et al. 2007).

Box 3.1-2. Examples of active and passive surveillance

- Active surveillance: Trained staff conduct rounds on the ward to look for signs and symptoms of BSIs post-childbirth.
- Trained staff review wound culture results from the laboratory and medical records of C-section patients for positive wound cultures and signs and symptoms of infection according to the definition to identify SSIs.

- Passive surveillance: The neonatal intensive care staff report the number of cases of sepsis that occurred last month.

## Purpose of Conducting Surveillance for HAIs

Surveillance can help guide IPC activities by providing data on outcomes and processes. Surveillance should respond to the facility's actual needs.

- Outcome surveillance helps the IPC team determine baseline rates of HAI; identify the occurrence of infections above the baseline (expected) rates; detect and report notifiable diseases to the public health authorities; and detect and investigate clusters, outbreaks, and exposures, including emerging infectious diseases.
- Process surveillance helps the IPC team observe HCWs' practices to ensure compliance with policies and best practices; provide information to help guide performance improvement activities; assess the effectiveness of IPC measures; and meet the safety standards required by the health department and other regulatory agencies.

Surveillance is valuable for planning the allocation of resources because it can reveal whether and where HAIs are occurring and the size and causes of the problem. Resources can then be focused on areas with high rates of HAI.

**Note: An effective surveillance program includes the collection and analysis of data so that the data can be shared with key staff to inspire them to fix problems. Without sharing of data, surveillance efforts may be wasted.**

Surveillance can be used to monitor and evaluate improvement efforts. Performing surveillance before, during, and after efforts to prevent harm and improve PS can inform staff about the effectiveness of their efforts.

## Steps for Conducting Surveillance in a Healthcare Facility

### Prioritize Surveillance Activities

Depending on the planned scope of activities, surveillance of HAIs requires: clinical staff time (the larger the effort, the more staff time will be required for data collection, management, and analysis); laboratory diagnosis support (more advanced surveillance systems require higher-quality support to identify organisms causing infections and patterns of resistance to antimicrobials); well-designed data collection tools; and data management (the more complex the surveillance, the more data will be collected and need to be entered and analyzed for the information to be useful).

Surveillance for all types of infections is rarely done in any setting. Prioritizing surveillance activities is essential for effective allocation of resources to maximize the benefits of reducing HAIs among patients admitted to healthcare facilities. This is important in all settings but especially in low- and middle-income settings where resources are scarce. When planning surveillance, priority areas are:

- High-risk areas, such as intensive care and postoperative units
- High-risk patient populations, such as immune-compromised patients and neonates

- High-risk procedures (varies depending on the scope of the setting)
- Diseases present in the community with potential to rapidly spread through the hospital

Although the extent of surveillance activities depends on available resources, the prioritization and focus for any facility are ideally based on a risk analysis. (See Appendix 5.2.C in Volume 2, Section 5, Chapter 2: Managing Infection Prevention and Control Program.)

### To set priorities, the healthcare facility team should:

- Review available HAI data and prioritize what they want to include in surveillance during the initial stages. Globally, surveillance of HAIs focuses on SSIs, CAUTIs, CLABSIs, and VAP, but other types of HAIs may be appropriate.
- If data are limited, carry out an assessment to identify key HAIs in the facility and, based on local needs, decide which HAIs to include in surveillance.
- Start surveillance activities with just one HAI and add other HAIs based on observed priorities and needs.
- Select wards or areas (e.g., ICUs) with the highest number of HAIs or most serious complications from HAIs.
- Select procedures based on the risk of complications and number performed. For example, a maternity hospital may choose to begin surveillance with SSIs following C-sections (most frequently performed and high risk of infection) and later add other procedures (e.g., hysterectomy).

Basic surveillance can be conducted without a large infrastructure or many additional resources (box 3.1-3).

#### Box 3.1-3. Examples of surveillance activities for healthcare facilities with limited resources

These examples of surveillance activities are appropriate for facilities that are starting surveillance and those with limited resources. They can help prevent all HAIs.

- Develop a plan to assess whether staff have access to soap and water and towels to dry their hands or ABHR. Monitor hand hygiene practices. Use surveillance data to improve compliance. (See Volume 1, Chapter 4: Hand Hygiene.)
- Ensure that patient care practices are performed according to the best available evidence (i.e., use standard precautions for all patients). (See Volume 1, Chapter 3: Standard and Transmission-Based Precautions.)
- Ensure adherence to recommended IPC practices, such as sterilization or high-level disinfection of all items that come into contact with normally sterile tissue. (See Volume 1, Chapter 7: Decontamination and Reprocessing of Medical Devices.)
- Monitor compliance with recommended practices for certain high-risk procedures, such as inserting and caring for central venous catheters. (See Volume 2, Section 2, Chapter 3: Preventing Intravascular Catheter-Associated Bloodstream Infections.)
- Monitor employees' exposure to infections and needle-stick injuries and use the data to develop plans. to reduce exposures.

## Decide whether to monitor an outcome or a process measure

Once the specific type of surveillance activities needed by the facility has been prioritized, a determination will need to be made about whether to conduct surveillance on the type of infection (outcome), or on a process designed to prevent that infection, or both.

## Select appropriate indicators

It is best to use indicators that have been validated or are commonly used because they will allow results to be compared with those from similar facilities.

**Examples of indicators used for IPC include:**

- HCWs' compliance with hand hygiene guidelines (the proportion of compliant hand hygiene opportunities)
- The SSI rates following C-sections, per 100 C-sections
- The CAUTI rates per 1,000 catheter-days

## Consider benchmarks and goals

Benchmarks are a helpful reference against which a facility's surveillance data can be compared. Internal benchmarks can be used to compare IPC surveillance data for a given period with earlier data (baseline data). External benchmarks allow a facility to compare its data with those from other facilities, either regionally, nationally, or internationally (Al-Saed, et al. 2013).

Table 3.1-1 provides a list of organizations that provide HAI rates for benchmarking and their advantages and disadvantages.

Table 3.1-1. Sources and advantages and disadvantages of recognized benchmarks

| Source of Recognized Benchmarks | Advantages | Disadvantages |
|---|---|---|
| WHO: Report on the Burden of Endemic Health Care-Associated Infection Worldwide: Clean Care Is Safer Care; pages 14 and 19. https://apps.who.int/iris/bitstream/handle/10665/80135/9789241501507_eng.pdf?sequence=1 | Includes low-income countries separately, good crude estimates | Results obtained by differing methods and case definitions, not risk-adjusted, limited data available from low-income countries |
| International Nosocomial Infection Control Consortium (INICC): http://www.inicc.org | Uses standardized definitions similar to National Healthcare Safety Network (NHSN)/CDC, includes under-studied, low-income countries | Lack of non-ICU and SSI data, no risk adjustment, included data may not reflect the respective country |
| CDC, National Healthcare Safety Network (NHSN): http://www.cdc.gov/nhsn/about.html | Includes ICU and non-ICUs, uses complex and frequently changing NHSN/CDC definitions, large data set, risk adjusted | No non-device associated infections |
| European Centre for Disease for Disease Prevention and Control (ECDC): http://ecdc.europa.eu/en/Pages/home.aspx | Large data set, risk-adjusted | Lack of non-ICU data, definitions used not popular outside of European countries |

*Source*: Al-Saed et al. 2013

When choosing a benchmark, it is important to ensure that the benchmark is relevant to the setting. Consider using WHO's low- and middle-income country data (table 3.1-2) or data from the International Nosocomial Infection Control Consortium (INICC). The IPC team should review data from various sources before selecting a benchmark and consider risk adjustment. Healthcare facilities should aim at achieving HAI rates that are lower than the chosen benchmark.

Table 3.1-2. Device-associated HAIs and device utilization in adult medical-surgical ICUs

| WHO benchmarks | CLABSI rates (range) per 1,000 central line days CAUTI | Rates (range) per 1,000 central line days CAUTI Rates (range) per 1,000 catheter days | VAP rates (range) per 1,000 ventilator days |
|---|---|---|---|
| High-resource countries (1995–2010) | 3.5 (2.8–4.1) | 4.1 (3.7–4.6) | 7.9 (5.7–10.1) |
| Low-resource countries (1995–2010)[a] | 12.2 (10.5–13.9) | 8.8 (7.4-10.3) | 23.9 (20.7-27.1) |

CLABSI: central line-associated bloodstream infection; CAUTI: catheter-associated urinary tract infection; VAP: ventilator-associated pneumonia

[a] WHO estimates are from all types of adult ICUs and include both catheter-related and catheter-associated BSIs and UTIs.

*Adapted from*: WHO 2011

**Note:** The eventual goal for all healthcare facilities should be to achieve zero rates (no infections) for all HAIs and 100% compliance with recommended IPC practices. An interim goal can be to achieve rates lower than the chosen benchmark.

## Define the Denominator

The denominator refers to the number of total possible events needed (WHO 2002). In HAI surveillance, use of the standard HAI denominators will allow rates to be compared with other facility rates. (See Volume 2, Section 3, Chapter 2: Basic Epidemiology and Statistics for IPC.)

**Types of denominators (incidence surveillance)**

- **Patient-days at risk:** The number of patients present on the ward each day, added together (usually added for each month, quarter, or year)
- **Device-days:** The number of patients with a device on the ward each day (e.g., urinary catheter), added together (usually added for each month, quarter, or year)
- **Procedures:** The number of cases of a particular type of surgery performed (e.g., C-section)

**Event:** The number of occurrences of a certain type of event (e.g., live birth, admission to the facility, patients treated at the HIV clinic)

**Denominator Examples**

- **SSI following C-section:** All pregnant women who undergo a C-section in the healthcare facility. This can be calculated on an ongoing basis, if it is continuous surveillance; or for the time period of interest, if it is periodic surveillance. It can be done retrospectively from the review of an OT register, or prospectively by keeping/collecting data on each pregnant woman undergoing a C-section. The same approach can be followed to list the denominator for SSIs following any surgical procedure.
- **CAUTI:** The number of device-days with a urinary catheter. Device-days for CAUTI can be calculated by counting the number of patients in either a ward or the whole healthcare facility who have an indwelling catheter on that day, counted at a fixed time each day, either on a routine basis or for a specific time period of interest, and maintaining a denominator list. Rather than the number of patients who have an indwelling urinary catheter inserted, the number of days patients have a device (the urinary catheter) is used as the denominator to better calculate the time patients are exposed to the risk of catheters. It is a more sensitive measure.
- **BSI (sepsis):** The number of patient-days at risk of contracting a BSI. Patient-days for BSI can be calculated by counting every infant in the nursery at about the same time each day and entering into a list either a daily manual count or a census number from the medical records. This will give the number of patient-days over a desired time frame. This information is needed because infants are at risk for healthcare-associated sepsis every day they are in the hospital, not just at the single time when they are admitted.

## Define the Numerator by Using a Case Definition

The numerator for HAI surveillance is the number of times the infection of interest (e.g., SSI) occurs in the population at risk during a specific time interval. (See Volume 2, Section 3, Chapter 2: Basic Epidemiology and Statistics for IPC.) Numerator data are collected by using a written, standardized surveillance case definition to determine which cases are included and which are not.

- A surveillance case definition is a set of uniform criteria used to define a disease for public health surveillance.
- Use standard case definitions for HAI where possible.
- Use country-specific surveillance case definitions where they exist so that results can be benchmarked with other local facilities.
- The CDC National Healthcare Safety Network (NHSN) has developed detailed case definitions, which are regularly updated. For the most up-to-date HAI surveillance case definition criteria, see: https://www.cdc.gov/nhsn/pdfs/pscmanual/pcsmanual_current.pdf.
- Lab-based components of surveillance case definitions may not be achievable in limited-resource settings; therefore, adaptation to local needs and diagnostic and lab capacity may be needed. Examples from WHO (2002) include:
    - SSI: Any purulent discharge, abscess, or spreading cellulitis at the surgical site during the month after the operation
    - Intravascular catheter infection: Inflammation, lymphangitis, or purulent discharge at the insertion site of the intravascular catheter

Irrespective of the definitions you choose, they must be applied in the same manner to each case to ensure consistency in the numerator data collection and to calculate rates over time and for comparison (APIC 2014; Rosenthal, et al. 2014; WHO 2002; WHO 2009).

## Design and Develop the Process for Monitoring the Chosen Event

**Time period (incidence surveillance)**

Determine the time period for data collection, which could be a month, a quarter (periodic incidence surveillance), or continuously (incidence surveillance). Based on available resources, needs, and scope, the surveillance could be continuous (ongoing as a routine activity) or periodic (occurring for a specific period of time on a regular basis). Box 3.1-4 provides some examples.

Box 3.1-4. Examples of surveillance time periods

**Continuous monitoring**—surveillance is ongoing throughout the time frame:

- All patients who had a C-section for SSI
- All patients with a central venous catheter for BSI
- All babies on the NICU

**Periodic monitoring**—surveillance occurs at predetermined intermittent intervals to manage resources:

- All patients who had a C-section for SSI for 3 months (part of each year)
- All patients with a central venous catheter for BSI for 1 month in every 3
- All babies admitted to the NICU for BSI (sepsis) for 6 months of the year

## Case Identification

Determine if potential cases in the facility are best identified based on signs and symptoms, laboratory results, or a combination of these.

Laboratory-based case finding is often the easiest method. Potential cases are triggered by a positive lab result from clinical or surveillance specimens; for example, a review of all blood or wound cultures for positive results. However, this may not be feasible in settings with limited microbiology capacity or where cultures are not reliably taken when infection is suspected.

Finding potential cases by searching for clinical signs and symptoms of infection can be more time-consuming. Potential cases are identified during daily rounds, discussions with the HCWs caring for the patients, or review of the medical records. This may be the best method in settings where microbiology data are often lacking.

## Prospective or Retrospective Surveillance

Determine if the situation at the facility is best suited for prospective or retrospective surveillance methods based on the quality of existing data and available resources.

Prospective surveillance data are collected in the present time, following the patients through his/her hospital course, looking for potential HAIs. It can be more reliable than other methods if documentation is poor, but requires more resources because all patients need to be followed to identify HAIs.

Retrospective surveillance reviews patient data once potential infections been identified (e.g., by positive culture). Retrospective surveillance requires fewer resources, but will not be effective if medical record documentation is less then comprehensive.

## Number of Observations (for process measure surveillance)

Based on the process selected for surveillance and the time allocated for data collection, the team will need to determine the number of observations to be made. For example, a healthcare facility may decide to monitor hand hygiene compliance on each ward for 20 minutes, once each week, aiming for 40 observations every week. Or the team may decide to monitor the OT staff's use of proper PPE once every month, aiming for 25 observations per month. The larger the number of observations, the more reliable the results will be. The number of observations will also depend on available resources. These examples are not relevant for outcome surveillance, in which all events should be captured during the predetermined time frame.

## Data Collection Plan

An ideal data collection plan will include details on the following:

- **Data elements:** Data elements will depend on the outcome or process being monitored. Collect **only** those data elements that will facilitate analysis and decision making for interventions. It may require a short trial to be sure that all needed elements are collected.
    - For outcome surveillance, data elements for patients with HAI should include, at a minimum, the patient identifier, admission date, device insertion/procedure date, elements of the case definition (signs, symptoms, results, and diagnoses) (to determine whether the case definition has been met), and date of infection. Other data may also be appropriate (such as demographic information and specific risk factors), but these will be determined by the type of HAI and resources available to gather and manage these data.
    - For process surveillance, data elements depend upon the process being monitored.
- **Data collection tools:** Prepare or adapt data collection tools for the numerator and denominator for the HAI or the IPC practice selected for surveillance. There are standardized data collection tools available for most common HAIs—SSI, BSI/CLABSI, UTI/CAUTI, and HAP/VAP. Depending on the scope and the need, the facility should adapt available tools for collecting data for both the numerator and denominator.
- **Data collectors:** Appropriate people to collect data should be selected based on the type of surveillance and frequency of data collection. IPC staff often collect surveillance data;

however, data collectors can be clinicians specially assigned for data collection or can be healthcare providers in the facility. Data collectors should be trained in correctly completing the data collection forms in a standardized manner.

- **Data collection methods:** Data collection methods will depend on several factors and the decisions made about the type, frequency, and outcomes or processes included in surveillance. Methods can be paper-based or electronic. Data can be collected by regularly visiting the site or by reviewing paper or electronic records.
- **Data sources:** These include records, reports, registers, and logbooks where specific data can be found. As an example, chart reviews of patients' cases can provide information on numerators, and OT case records or daily census reports can provide information on denominators.
- **Data management:** This is a method of receiving and collating data collection forms, and of filing and storing (electronic or manual) the data collected. The people responsible will need to be identified and assigned the tasks. Forms should be reviewed to ensure completeness and accuracy. There should be a database into which data are entered to allow for data analysis and reporting. (This could be a simple, paper-based template, logbook, or a Microsoft Excel-based template, or more advanced statistical software.) If data are collected on paper forms, decide whether the data then need to be entered into a computerized database. At a minimum, a logbook or line list should be kept of infections (numerator) and denominator so that rates can be calculated.
- **Data sharing:** Develop a plan and decide who will collate data, prepare reports, and share data with relevant parties. Volume 2, Section 3, Chapter 2: Basic Epidemiology and Statistics for IPC in this manual contains a detailed section on data sharing with examples and instructions on how to prepare tables, graphs, and charts (APIC 2014; CDC 2006).

## Implement Surveillance Activities

Once planning for surveillance is complete, the healthcare facility should be ready to implement surveillance activities.

Data collection is a key component of surveillance of HAI or IPC processes. Carry out data collection using standardized data collection tools for the numerator and denominator. Collect data retrospectively or prospectively, as planned.

**For outcome surveillance:**

- Ensure that all cases that qualify for the numerator and all patients that qualify as the at-risk population (denominator) are appropriately recorded and reviewed. Continue data collection, or if periodic surveillance has been planned, stop when the time period ends (month, quarter, etc.).
- Enter all information from the completed tools into the database on a regular basis to avoid loss of information on completed forms. If data are collected electronically, ensure regular backup of data on two different devices.

**For process surveillance:**

- Complete the data collection forms following the plan and data collection method. Process surveillance may include direct observation of clinical practices for data collection (e.g., observing hand hygiene monitoring) or a review of the records could also be used if such records are maintained (e.g., monitoring correct timing of dressing changes). Ensure that the number of planned observations is made.

## Analyze and Report Data

- After the data are collected and entered into the database, collate, clean, and review individual data for any obvious errors and outliers. Conduct data analysis using a software program or a simple calculator and statistical formulas to derive mean, median, mode, percentage, proportion, or incidence density rates. The data should be cleaned (checking data and correcting or removing errors) and analyzed to calculate rates and prepared for sharing with key personnel as laid out in the plan.
- A surveillance report may be a written document or a presentation and, at a minimum, should contain a description of the surveillance activity (e.g., SSI in women undergoing C-section in the healthcare facility, CLABSI from date to date, compliance with surgical attire guidelines before entering the OT for surgery). It should contain the goals and objectives of performing surveillance.
- Description of outcomes and processes selected for surveillance and the standard surveillance case definitions used.
- Information on the numerator and denominator as absolute numbers, and other descriptive data, such as mean, median, mode, etc. For example:
    - CLABSI: Of the 3,000 device-days (number of days in which patients at the facility had a central line in place—denominator) during the year, there were nine cases of CLABSI (numerator).
- Rates, percentages, and comparisons with the chosen benchmark (e.g., standardized infection ratio [SIR])
- Graphs and/or tables describing the findings that are easy to understand.
- A description of recommended actions based on the findings of the surveillance data analysis. (See Volume 2, Section 2, Prevention of Common Healthcare-Associated Infections.)

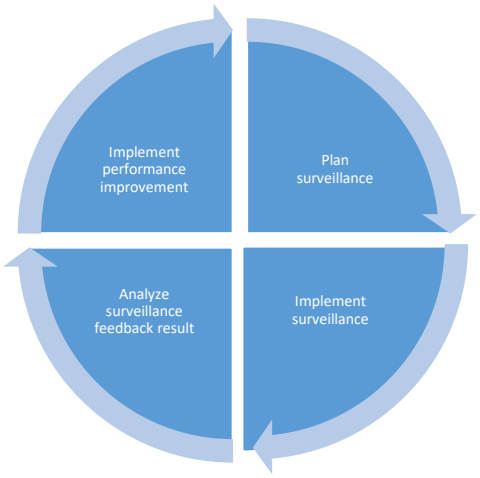
Share the report with all stakeholders; HCWs, the management team, and other stakeholders can help design interventions according to the surveillance plan. Surveillance findings should be shared with the HCWs during staff meetings on a routine basis. Keep the report brief and focus on key findings and messages for improvement.

## Initiate Quality Improvement Activities

After reviewing surveillance data and reports, determine what performance improvement activities should be undertaken. Use process measure surveillance data to identify gaps in practice and guide performance improvement activities. Process and outcome surveillance can be described as a circular

process (figure 3.1-1), which is part of improving the quality of patient care, in this case by preventing infections. Quality improvement should be an ongoing activity that uses data to inform interventions to improve PS. (See Volume 2, Section 5, Chapter 2: Managing IPC Programs.) (WHO 2002)

Figure 3.1-1. Surveillance process




*Adapted from*: Deming 1993; WHO 2002

For example: The healthcare facility IPC team shares the findings of the process measure surveillance for compliance with hand hygiene after removing gloves. Although the target was 85% compliance, the actual compliance was 45%. The IPC team carries out the analysis to find out the cause for the lack of compliance. As a result of the findings, the healthcare facility manager places ABHR stations close to the points of care so that HCWs can perform hand hygiene immediately after removing gloves, after patient care, and before moving to the next patient. Performance after the changes is measured, and hand hygiene after removing gloves is now 70%. The process is repeated.

## Tips for Carrying Out Outcome Surveillance

- Make institutional decisions about implementing surveillance of HAIs in the facility based on a facility IPC risk assessment.
- Establish a surveillance technical group, which could be a subgroup within the IPC team.
- Follow national guidelines on surveillance of HAIs, if one is available. If national guidelines are not available, use international guidelines.
- Use standardized case definitions.
- Review and adapt data collection tools, as appropriate.
- Decide on approaches for surveillance (e.g., active vs. passive, outcome vs. process).
- Train key staff in surveillance of HAIs.
- Orient all clinical staff on surveillance of HAIs and their roles and responsibilities.

- Allocate resources for data collection, data entry, data compilation, data analysis, and reporting.
- Conduct surveillance.
- Carry out a detailed analysis of the findings and identify the gaps. Perform gap analysis to identify the root causes of any gaps.
- Organize periodic meetings to review the findings.
- Design and develop interventions to changes practices and processes.
- Monitor compliance with interventions.

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# CHAPTER 2: BASIC EPIDEMIOLOGY AND STATISTICS FOR INFECTION PREVENTION AND CONTROL

### Key Topics

- Basic statistical concepts and methods used to analyze and report IPC data
- Descriptive statistics used for describing HAIs
- Importance of sharing IPC data with key staff
- Data visualization methods and techniques for effective data sharing
- Basic epidemiology for interpreting IPC literature

## BACKGROUND

IPC staff need to have a basic understanding of the key principles of statistics as they relate to IPC to understand and describe IPC data. Using basic statistical techniques to analyze data will help a facility understand and describe its infection rates and trends over time. IPC staff need to know what data to collect, and how to collect and analyze them. They need to know how to interpret results, present results to key stakeholders, and use data to encourage and guide behavior change. IPC staff should also be able to understand IPC research in journal articles.

## Basics of Epidemiology

As a science, epidemiology has contributed to the improvement of the health of populations around the world. It plays a major role in the identification, mapping, and prevention of emerging diseases. One of its first contributions occurred in the 1850s in London when John Snow, considered to be one of the founders of epidemiology, traced an outbreak of cholera to a public water pump. He did so by mapping the locations of where people who had the disease lived and worked and public water pumps where those with cholera obtained their water. Snow noticed that on the map, houses of people with cholera clustered around one pump; after he presented his data to local authorities, the pump was disabled and the outbreak ended (CDC 2012). Table 3.2-1 presents an explanation of the definition of epidemiology.

Table 3.2-1. Definition of epidemiology

Epidemiology is the study of the distribution and determinants of health-related conditions or events in specified populations, and the application of this study to the prevention and control of health problems.

| Term | Explanation |
|---|---|
| Study | Can include surveillance, observation, hypothesis testing, analytic research, and experiments. |
| Distribution | The analysis of patterns/diseases according to the characteristics of person, place, and time. |

| | |
|---|---|
| Determinants | Factors that bring about a change in a person's health status. These are factors that cause a healthy person to become sick or cause a sick person to recover. Determinants can include both causal and preventive factors. Determinants can be biological, chemical, physical, social, economic, genetic, or behavioral. |
| Health-related conditions or events | Include disease, cause of death, behaviors, positive health states, and use of health services. |
| Specified populations | Include a group of people with a common characteristic, such as gender, age, or use of a certain medical service. |
| Application to prevention and control | The primary goals of public health—to promote, protect, and restore health. |

*Adapted from*: Aschengrau, Seage 2020; Bonita, Beaglehold, Kjellstrom, 2006; Last 2001

## Basic Statistical Concepts

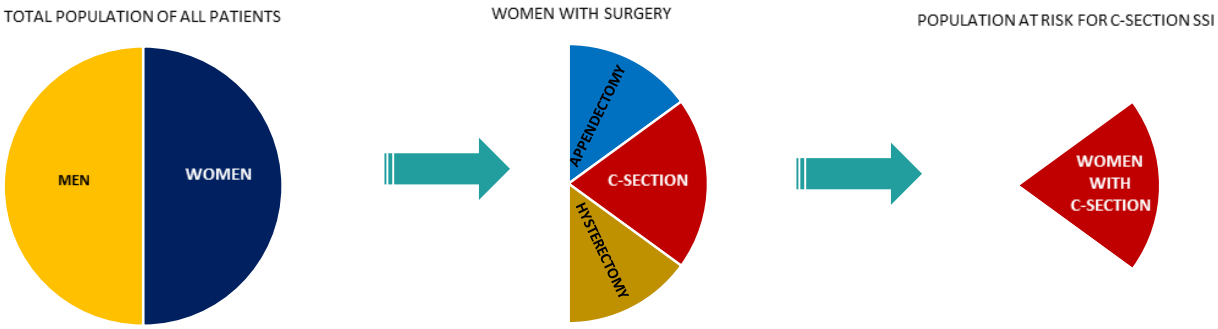
### Populations

As a science, epidemiology is concerned with the health of populations, rather than focusing on the health of individuals. Populations can be defined based on how permanent their membership is. Fixed populations have permanent members who are usually defined by a life event. Once someone is a member of a fixed population, the person will be a member of this population for life. Populations can also be transient, with members joining and leaving the population over time. These are called dynamic, or open, populations (Aschengrau, Seage 2020).

In the context of a healthcare facility, the population can be both fixed and dynamic, depending on the situation. The population of patients visiting a healthcare facility for treatment is an example of a dynamic population, and those admitted to the hospital for a few days is also an example of a dynamic population because patients are admitted and discharged every day. Patients who underwent any surgical procedure during the last calendar year or patients who had an indwelling catheter during the past 10 days are examples of fixed populations because no new member can be added or removed from this population.

Patients who are at risk of developing a specific HAI are called the "at-risk" population for that HAI. This population will be the denominator when rates of a specific HAI are calculated. For SSI rates, all patients who had any surgery during the time period for which the rates are being calculated make up the "at-risk" population for SSI following all surgery. In a study of SSI rates following C-section, all women who give birth by C-section are the "at-risk" population for SSI following C-section (figure 3.2-1). Other patients, both men and women, who received other surgeries are not part of the "at-risk" population for SSI following C-section.

Figure 3.2-1. Determining the population "at risk" for a C-section SSI




*Adapted from*: Bonita Beaglehold, Kjellstrom, 2006

## Inferential and Descriptive Statistics

Being able to analyze populations at risk using basic statistical methods can increase the success of an IPC program by providing a deeper understanding of the problem. There are two types of statistics: both inferential and descriptive statistics are useful in understanding and describing IPC data.

**Inferential statistics** are used to draw general conclusions about the concerned population, based on studies conducted on a small subset of people (a sample), if the study was properly designed and conducted. A sample size should be calculated by applying recommended statistical methods and the sampling of the study population should be obtained in such a way that the key characteristics of the sample are as close as possible to the whole population. Therefore, conclusions from studies that are designed with the correct methodology, although conducted on a small sample, can be applied to a larger population. The use of inferential statistics is a common practice because it is usually not feasible to study a whole population. For example, the beneficial effect of prophylactic antibiotics before surgery for prevention of SSI was observed in an appropriately designed study of a small sample of patients. Based on the findings, it was concluded that all patients who undergo surgery should receive perioperative prophylactic antibiotics for the prevention of SSI.

Odds ratios and relative risks are used to describe the association between an intervention and an outcome during a study to make generalized recommendations. Detailed discussion of each of these is beyond the scope of this chapter; more information on these measures can be found in the Bibliography at the end of this chapter.

**Descriptive statistics** use numbers to describe characteristics of a specific dataset. Descriptive statistics help in summarizing trends and patterns and include discrete and continuous values. Discrete data contain only whole numbers and fall into specified categories (e.g., race or cause of death). Continuous data can have a range of values along a continuum (e.g., height or weight). Rates, such as infection rates, are considered continuous data because they can contain decimals and are on a continuum. Descriptive statistics are most commonly used for describing surveillance data, for both outcomes and processes.

Descriptive statistics include measures of central tendency (the middle of a distribution), which compare different values in a dataset with the central value. A central tendency describes a typical experience (central value) for the group (e.g., patients, HCWs). Descriptive statistics are used routinely to describe data about an event (infections, compliance with IPC, etc.).

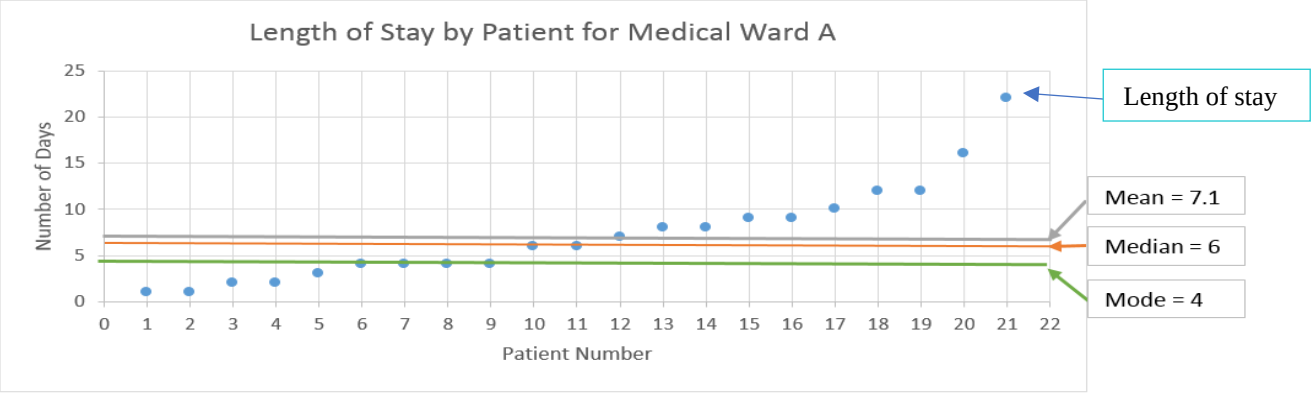
The mean, median, and mode (figure 3.2-2) are the most commonly used central values for describing observed values (e.g., infection) in a dataset. Central values are used to summarize data in a single value, such as the age of people affected by an outbreak.

**The mean** is the average number of all values in a dataset. If there are a few extremely large or small values (called outliers) in a series of data, the mean could be artificially higher or lower and may be misleading. Mean is not a sensitive measure to describe the central tendency of a dataset.

**The median** is the value in a dataset in which half of the values in the dataset are above it and half of the values are below it. Unlike the mean, the median is not affected by extreme outliers in the dataset. Although the median is useful as a descriptive measure, it is not often used for further statistical manipulations.

**The mode** is the most frequently occurring number in a dataset. Mode can be used to describe, for example, which day of the week people prefer to come to a vaccination clinic, the typical number of doses of a vaccine or medicine, or the number of days a patient is on a device. Like the median, the mode is useful as a descriptive measure, but it is not often used for further statistical manipulations. A dataset with two values occurring equally frequently is called bimodal and a dataset with more than two modes is called multimodal.

Figure 3.2-2. Mean, median, and mode in a dataset



## Calculating Mean, Median, and Mode

### Calculating the Mean

Table 3.2-2. Length of stay for patients in medical ward A

| Patient | Length of stay (days) |
|---|---|
| **1** | 4 |
| **2** | 10 |
| **3** | 12 |
| **4** | 22 |
| **5** | 2 |
| **6** | 6 |
| **7** | 8 |
| **8** | 6 |
| **9** | 3 |
| **Total days: 73** | |

The mean is calculated by adding up all of the values in the dataset (table 3.2-2) and then dividing by the number of values in the dataset. The dataset in table 3.2-2 has nine values. To calculate the mean, add the nine values:

*4 + 10 + 12 + 22 + 2 + 6 + 8 + 6 + 3 = 73*

Then, divide 73 by the number of values in the dataset, which is 9.

*73/9 = 8.1 days*

The mean length of stay is 8.1 days. This number indicates that, on average, a patient stays in the hospital for 8.1 days. A healthcare facility manager could use this to evaluate if such a stay is justified or if the quality of care needs to be improved so that the mean length of stay can be reduced to achieve cost savings and reduce the risk of HAI.

The mean length of stay is 8.1 days; however, six of the nine values in the dataset are below 8.1. This is because the mean has been affected by the outlier of 22.

### Calculating the Median

The median is calculated by lining up the values in the dataset in ascending or descending order and finding the middle value. The median is not affected by any outlier value. To calculate the median of this dataset, first rearrange the values in ascending order. The organized dataset now looks like that in table 3.2-3.

Table 3.2-3. Length of stay for patients in medical ward A in ascending order

| Patient | Length of stay (days) |
|---|---|
| **5** | 2 |
| **9** | 3 |
| **1** | 4 |
| **6** | 6 |
| **8** | 6 |
| **7** | 8 |
| **2** | 10 |
| **3** | 12 |
| **4** | 22 |

Once the individual values in the dataset are organized in ascending order, apply the formula for calculating the median: median = ($n$+1)/2, where $n$ is the number of individual values in the dataset.

With this formula, if $n$ is an odd number, the middle value will fall on a single observation and that value is the median. If $n$ is an even number, the middle value falls between two observations; the average of the two adjacent values will be the median.

In the dataset above, there are 9 values so $n$ = 9 and the median will be (9+1)/2 = 5. The fifth value of the dataset is the median, which is Patient 8, with a length of stay of 6 days. Therefore, the median length of stay for this dataset is 6 days. The extreme outlier of the 22-day admission did not affect the median.

### Calculating the Mode

The mode is the most frequently appearing value in the dataset. Sometimes datasets can have more than one mode. In the dataset in table 3.2-3, every value appears once, except 6 days, which occurs twice. The mode is 6 days because it is the most frequently appearing value in the dataset.

## How to Interpret the Mean, Median, and the Mode for the Length of Stay

Mean, mode, and median allow us to present multiple values in a dataset using just three numbers. Mean takes into account all values in a dataset and generates a single value that can be used to compare one dataset with another. Mean gets skewed by extremely large or small values, but still allows comparison. Describing the range along with the mean allows for a better interpretation of the dataset. For example, a mean of 8.1 days with a range of (22–2 = 20) 20 days indicates that there is a greater variability in the dataset and not all values are close to the mean. On the other hand, the median (6 days), which is the middle value of the dataset, is not affected by outliers. In the above example, if 2 and 22 were not included in the calculation, the mean would still be close to 6 days. The mode is the value that occurs most frequently in a dataset and shows that, most frequently, patients stay in this facility for 6 days.

## Measuring Variability

Measures of variability look at how the values in the dataset are distributed around the mean. Range, deviation, standard deviation, and variance are all measures of variability (table 3.2-4). Most of these measures of variability are not used in day-to-day reporting of data related to IPC. However, the range is the exception.

The range of values—the difference between the smallest and largest values—is commonly calculated for an IPC dataset. For instance, you may want to calculate the range of lengths of stay to help further investigate how long patients tend to stay in the healthcare facility. Another example is the range of the number of days patients have an indwelling urinary catheter in place before developing a CAUTI.

### Calculating the Range

Range is calculated by subtracting the smallest number in the dataset from the largest number.

In the dataset in table 3.2-3, Patient 5 had the shortest length of stay (2 days) and Patient 4 had the longest length of stay (22 days). To calculate the range, subtract the shortest length of stay from the longest length of stay: 22 days–2 days = 20 days.

The range of length of stay for these patients was 20 days. More precisely, the length of stay for these patients ranged from 2 to 22 days.

Table 3.2-4. Measures of disease variability

| Term | Explanation |
|---|---|
| Range | A value that shows the difference between the highest and lowest values in a dataset. |
| Variability | The spread of values in a dataset. If variability is small, all values are close to the mean. If variability is large, the values are spread out and are not close to the mean. Variability is measured using range, variance, and standard deviation. |

| | |
|---|---|
| Deviation | A value that shows the spread of each individual value from the mean of the overall dataset. A negative deviation means that the individual measurement is less than the mean, a positive deviation means that the individual measurement is greater than the mean, and no deviation means that the individual measurement is the same as the mean. |
| Standard deviation | A measure of the dispersion (spread) of raw values that reflects the variability of values around the mean value of the dataset. It gives more emphasis to larger deviations and less emphasis to smaller deviations. Means should be reported with their standard deviations. The values of standard deviations convey how widely and narrowly the values are distributed around the mean. |
| Standard error of the mean | A measure used for comparative purposes, the standard error of the mean is the standard deviation adjusted for by the sample size. It is used in calculating confidence intervals. |
| Variance | A way of measuring the variability of values included in a dataset. Standard deviation is more frequently used to measure variability than variance. |

*Source*: APIC 2014c

## Measuring Disease Occurrence

IPC surveillance will produce a dataset of raw numbers (e.g., number of patients with SSIs, number of patients who had an indwelling urinary catheter and developed a urinary tract infection). Although this is helpful and necessary information, the raw numbers may be misleading because they do not allow for comparison or indicate if there is truly a problem. For example, even if two sites each reported 10 SSIs last month, they cannot be compared unless the data on the at-risk population (the denominator) are available. The standalone count of events needs to be put into context by including the populations from which it came—the at-risk population. For example, at the first site, 50 patients received surgery, whereas 100 patients received surgery at the second site. Using the number of SSIs as the numerator and the total number of patients who received surgery (i.e., the at-risk population) as the denominator to calculate ratios, proportions, and rates allows the sites to be compared: the second site had lower rates of infection (10/100 or 10%) than the first site (10/50 or 20%).

**Rates** measure the probability of a particular event, such as an infection or death, occurring in a population. Rates help expand the focus from the numerator and give perspective. A critical part of calculating rates is to know how to identify the numerator and denominator. Calculating rates over a period of time allows rates to be compared.

**The numerator**, in the calculation of a rate, is typically the number of times the event occurred during a specific time interval. For HAIs, this usually represents the number of a specific type of infection identified over a time period.

**The denominator** for calculating rates (e.g., for HAIs) is the population at risk, or the number of patient-days of risk, during the same interval used for collecting data about the numerator. For IPC processes (e.g., hand hygiene), the denominator would be the number of possible infection prevention (IP) opportunities for that process (e.g., hand hygiene opportunities). Picking the right denominator is important when measuring disease occurrence. Picking the wrong denominator can lead to inaccurate rates and, thereby, to a wrong conclusion about what is truly occurring in the population.

A **time** parameter is needed when determining rates to identify the time period during which infections (or events) and the population at risk are counted. The time parameters must be the same period used for counting both the numerator and the denominator.

A **constant** is used to put the result into a uniform quantity so that comparisons between rates can be made. The constant is selected based on how frequently the event occurs; generally, it is globally agreed on. For example, SSI is expressed as percentages (per 100); CAUTI as the number of urinary tract infection per 1,000 catheter-days; and hand hygiene compliance as the percentage of hand hygiene opportunities.

To summarize, there are three important things to remember when calculating a rate:

- The numerator and denominator must reflect the same population—cases that are in the numerator must also be counted in the denominator.
- All cases in the denominator are eligible to be considered for the numerator.
- Counts in the numerator and denominator must cover the same time period.

(APIC 2014b).

### Example of a Rate Calculation

**Calculating SSI rates following C-section at District Hospital**

**Numerator**: Number of women who delivered by C-section who had an SSI during a given period of time at the health care facility:

14 SSIs following a C-section during April 2016

**Denominator**: All women who delivered by C-section (population at risk) during the same period at the health care facility:

140 C-sections during April 2016

**SSI rates following C-section = numerator/denominator x constant**

14/140 x 100 = 10% during April 2016

The SSI rate following C-section during April 2016 at District Hospital was 10%.

## Measuring Disease Frequency

Incidence and prevalence are the most common ways to measure disease frequency. Incidence measures the new occurrence of a disease or event, whereas prevalence is the total number of cases of a particular disease in a given population (Aschengrau, Seage 2020).

### Incidence

Incidence measures new cases of a disease or condition that occur in a specified population over a given time period, and therefore looks *only* at new cases. Other terms used to express incidence include attack rate, risk, and probability of getting a disease. Incidence generally refers to the rate at

which new events occur in a population. Incidence takes into account the variable time period during which individuals are disease-free and, thus, "at risk" of developing disease.

The numerator for calculating incidence is the number of new events that occur in a defined time period. The denominator is the population at risk of experiencing the event during the time period (Bonita, Beaglehold, Kjellstrom, et al. 2006).

**Formula for calculating incidence**:

$$\textbf{Incidence} = \frac{\text{No. of new cases of a disease in a specific period of time}}{\text{No. of persons at risk of developing the disease during the specified period of time}} \times \text{Constant (100; 1,000; or 100,000)}$$

For example, to calculate the incidence of SSIs following C-sections, the numerator will be the women developing an SSI after a C-section over a defined period of time and the denominator will be the women who had a C-section during the same time period. (See Volume 2, Section 3, Chapter 1: Introduction to Surveillance of Healthcare-Associated Infections on how HAIs, including SSIs, are defined.) Any woman who is included in the denominator (all women having C-sections) must have the potential to become part of the numerator (developing a SSI following a C-section).

There are many different types of incidence rates calculated in the IPC setting (table 3.2-5).

Table 3.2-5. Commonly used IPC metrics

| Incidence rates | How to calculate |
|---|---|
| SSI rates, postpartum sepsis rates | (# of infections/# of procedures) x 100 procedures |
| CLABSI rates | (# of CLABSIs/# of central line-days) x 1,000 central line-days |
| Catheter-associated urinary tract infection rates | (# of CAUTIs/# of indwelling urinary catheter-days) x 1,000 urinary catheter-days |
| Ventilator-associated pneumonia rates | (# of VAP/# of ventilator-days) x 1,000 ventilator-days |
| Multidrug-resistant organism (MDRO) rates (e.g., MRSA rates) | (# of MDRO infections/# of patient-days) x 1,000 patient-days |
| Healthcare associated-BSI (sepsis), healthcare-associated pneumonia, etc., rates | (# of infections/# of patient-days) x 1,000 patient-days |
| *Clostridium difficile* rates* | (# of *C. difficile* infections/# of patient-days) x 10,000 patient-days or 1,000 patient-days |

* *C. difficile* rates may use a constant of either 1,000 or 10,000, but whichever is used, it should be used consistently.
*Source: Curless, Ruparelia, Thompson, et al. 2018*

The formula used for calculating infection rates can also be used for calculating rates of correct performance of a desired action, such as hand hygiene (table 3.2-6). For example, the numerator is the number of times hand hygiene is correctly performed by HCWs and the denominator is the number of opportunities hand hygiene should have been performed based on WHO's *My 5 Moments for Hand Hygiene*.

Table 3.2-6. Calculation of hand hygiene compliance

| Incidence rates | How to calculate |
|---|---|
| Hand hygiene compliance rates (i.e., hand hygiene performed correctly when indicated) | Compliance (%) = $\frac{\text{Opportunities}}{\text{Performed actions}} \times 100$ |

*Source:* Adapted from WHO 2009

### Incidence Density

A specific type of incidence rate frequently used in IPC is incidence density (table 3.2-7). Incidence density is the occurrence of new events (e.g., cases of an infection) that arise during observation of total person-time at risk. This is a more sensitive measure of incidence than just considering the size of the population at risk because it takes into account the period of time the population was exposed to the risk. The denominator for incidence density is the sum of person-time at risk accumulated by each member of the population at risk. The rates are described as number of infections/period of exposure to the risk (for example, days). This means that the longer a person is considered at risk, the more time the person will contribute to the denominator for incidence density. In healthcare IPC measures, person-time at risk is usually represented using patient-days or device-days. For example, in determining CLABSIs, the denominator is central line-days. Each patient contributes 1 day to the denominator for each of the days that he or she has a central line in place. A patient who has a central line in place for 5 days is at risk of getting a CLABSI for 5 days and will contribute 5 central line-days to the denominator (Aschengrau, Seage 2020).

**Incidence density** = Number of cases or events during observation time period/(Total person-time for the population) x constant

### Example: Calculating Incidence Density Rate for CLABSI

Table 3.2-7. Number of central line-days in April

| Patient | Number of days patients had a central line while in the healthcare facility in April |
|---|---|
| 1 | 4 |
| 2 | 30 |
| 3 | 22 |
| 4 | 16 |
| 5 | 2 |
| 6 | 19 |
| 7 | 7 |
| 8 | 14 |
| 9 | 28 |
| **Total central line-days** | **142** |
| **Total number of CLABSIs during April 2016** | **2** |

The numerator for calculating incidence density for CLABSI is 2—total number of CLABSIs during April 2016.

The denominator for calculating incidence density is 142—the number of days that patients had a central line in place.

The constant typically used for device-associated rates is 1,000 device-days.

The CLABSI incidence density for April 2016 = (# new CLABSIs/# central line-days) x constant = (2/142) x 1,000 central line-days = 14.08.

The facility had a CLABSI rate of 14.08 infections per 1,000 central line-days in April 2016.

The simple incidence rate (compared with the incidence density) in this case would be 2/9 patients x (1,000) = 222.22 per 1,000 admissions.

As with other measurements, these numbers should be compared with previous facility rates, rates for similar facilities, and other benchmarks. The incidence rate (222.22 per 1,000 admissions) does not consider the length of time central lines were in place and, therefore, will miss a very important fact that the longer the patient is on a central line, the higher the probability of developing a CLABSI. This is captured by the incidence density rate (14.08 per 1,000 central line-days).

**Prevalence**

Prevalence of a disease or condition is the number of existing cases. It represents the proportion of the total population that has the disease or condition. Prevalence accounts for **all existing** cases. This is an important difference from incidence because incidence looks only at new cases of the disease or condition. Prevalence is an effective measure to express the burden of disease in a population (Aschengrau, Seage 2020).

There are two main types of prevalence (box 3.2-1):

- Point prevalence
- Period prevalence

Point prevalence refers to the proportion of the total population at risk that has the disease at a specified point in time. In contrast, period prevalence refers to the proportion of the at-risk population that has the disease over a specified interval of time. Both point prevalence and period prevalence look at the number of existing cases of disease or events.

Box 3.2-1. Point and period prevalence

**Point prevalence**

(Number of existing cases of disease/Total at-risk population) at a given point in time
(e.g., on April 1, 2016)

**Period prevalence**

**(**Number of existing cases of disease/Total at-risk population) over a specified period of time
(e.g., during April 2016)

The difference between point prevalence and period prevalence is in the time interval that they address. Point prevalence studies give a snapshot of the burden of disease at a specific point in time, whereas period prevalence studies are able to show the burden of disease over a longer time period. Prevalence ranges from 0 to 1, or it can be expressed as a percentage by multiplying by 100.

**Formula for calculating prevalence:**

$$\textbf{Prevalence} = \frac{\text{No. of existing (old and new) cases of a disease in a specific period}}{\text{No. of persons at risk of developing the disease during this period}} \times \text{Constant (100; 1,000; or 100,000)}$$

**Example: Point Prevalence of Infection in a Healthcare Facility**

On April 1, 2016, there were 120 patients in a medical ward in a healthcare facility; 7 of these patients currently had a GI infection.

**Point prevalence** = 7 (number of cases of GI infections on April 1, 2016, among patients in the medical ward)/120 (number of patients in the medical ward on April 1, 2016, in the healthcare facility) x 100

7/120 = 0.05833 x 100 = 5.83%

The point prevalence of GI infections among patients admitted to the healthcare facility on April 1, 2016 was = 5.83%.

**Example: Period Prevalence of Infection in a Healthcare Facility**

During the calendar year 2016, 900 C-sections were performed at a tertiary hospital. The preoperative assessment revealed that 150 women had diabetes (both Types I and II).

**Period prevalence** = 150 (women undergoing C-section having diabetes during 2016)/900 (pregnant women delivering by C-section) X 100

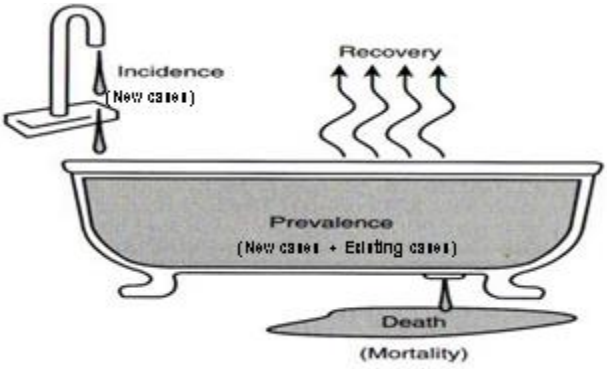
150/900 = 0.1666666 x 100 = 16.66%

During calendar year 2016, the period prevalence of Types I and II diabetes among women who had a C-section at this tertiary care hospital was 16.66%.

**Choosing to Use Incidence or Prevalence**

Figure 3.2-3 shows the relationship between incidence and prevalence. Incidence, new cases, is depicted by the new water entering the bathtub. Prevalence is shown by the level of water currently in the bathtub. This includes water that is entering the tub and water that was already in the tub. Prevalence includes all disease cases at a given time, both the new cases and existing cases. Water leaves the tub via evaporation or via the drain. In the figure, the water that evaporates can be thought of as patients who have recovered, and the water that leaves via the drain can be thought of as patients who have died. Patients who have recovered from the event or patients who have died are not counted when determining prevalence.

Figure 3.2-3. The relationship between incidence and prevalence




*Source*: Kachajian 2017

Prevalence gives more precise information on the burden of disease, whereas incidence provides more precise information on the risk of occurrence of disease in a population. Prevalence is often used by program managers to allocate resources to manage cases, whereas incidence is often used to assess the risk of infection and take preventive measures to reduce the risk. The difference between incidence and prevalence is summarized in table 3.2-8. Table 3.2-9 compares the advantages and disadvantages of calculating incidence and prevalence.

Table 3.2-8. Comparing incidence and prevalence

| Incidence | Prevalence |
|---|---|
| Used to measure the "risk" of a disease or an event occurring in a population. | Used to measure the "burden" of disease in a given population. |
| It is mainly used to measure acute disease conditions, but it is also used for chronic diseases. Often used in studies of causation. | Estimates the probability of the population being ill at the period of time being observed. |
| Measures new cases of a disease/an event in a population at risk of developing the disease/event. | Measures existing cases of a disease/an event either at a point in time or over a period of time in a population. |
| Numerator includes only new cases of a disease/an event. | Numerator includes all existing cases of a disease/an event including old and new cases. |
| Denominator is the number of people in the population at risk during a specified time period. It can be the person-time of exposure if calculating incidence density. | Denominator is the number of people in the population at risk at or during the specified time. |

*Source*: Bonita, Beaglehold, Kjellstrom 2006

Table 3.2-9. Advantages and disadvantages of calculating incidence and prevalence in IPC

| Measure | Advantages | Disadvantages |
|---|---|---|
| Prevalence | Ideal for capturing overall picture at a point in time | Can be influenced by the duration of the patient's stay |
| | Less resource-intensive | Results may not always be statistically significant in small hospitals or units |
| | Requires less time | Can be challenging to determine whether an infection is still "active" on the day of the study |
| | Less expensive to conduct | |

| Measure | Advantages | Disadvantages |
|---|---|---|
| Incidence | Ideal for targeted surveillance over time | More resource-intensive |
| | Can effectively detect differences in infection rates | Can be expensive |
| | Useful for inter-hospital and inter-ward comparisons | Can be time-consuming to collect data over a longer period of time |
| | Helpful for tracking trends over time | |

*Source*: WHO 2002

Besides incidence and prevalence, there are additional measures of disease frequency used in public health and hospital epidemiology (table 3.2-10). A detailed discussion of these measures is beyond the scope of this chapter; more information on these measures can be found in the Bibliography at the end of this chapter.

Table 3.2-10. Additional measures of disease frequency used in public health

| Measure of disease frequency | Explanation |
|---|---|
| Crude mortality rate | Total number of deaths from all causes<br>per 100,000 population per year |
| Cause-specific mortality rate | Number of death from a specific cause<br>per 100,000 per year |
| Age-specific mortality rate | Number of deaths from all causes for individuals in a specific age category<br>per 100,000 population per year in the specific age category |
| Infant mortality rate | Number of deaths of infants less than 1 year of age<br>per 1,000 live births per year |
| Morbidity rate | Number of existing or new cases of a particular disease or condition<br>per 100 population |
| Attack rate | Number of new cases of disease that develop (in a given time period)<br>per number of population at risk at the start of the time period |
| Case fatality rate | Number of deaths per number of cases of disease |

*Adapted from*: Aschengrau, Seage 2020

## Standardized Infection Ratio

The standardized infection ratio (SIR) is a summary measurement that compares the number of reported HAIs among a group of patients to the number of predicted or expected infections, based on a standard population. SIRs are risk-adjusted, so they incorporate specific patient risk factors or facility risk factors that may lead to an increased occurrence of disease. Risk adjustment is a statistical process used to adjust for a variation in outcomes that occurs due to differences in risk factors or specific characteristics (The Joint Commission 2016). These risk factors are elements that may impact the number of infections reported in a healthcare facility, such as the number of beds at a facility, whether a hospital is associated with a medical school, and the high community-onset prevalence rate (e.g., the rate of infections that occur $\leq 3$ days after admission) (CDC 2021; Dudeck, Weiner, Malpiedi, et al. 2013).

Standardized infection ratios are usually calculated by a national-level body. Each SIR is procedure/specialty-specific and based on risk factors for facility type (e.g., type and size of facility)

and patients (e.g., duration of surgery, age). The SIR is a comparison of observed HAIs and predicted or baseline HAIs, usually based on data from previous years.

**SIR = Observed HAIs/Predicted HAIs**

SIR > 1: The number of infections is above the baseline, which indicates the need for interventions to reduce the number of HAIs.

SIR = 1: The number of infections is the same as the baseline, which indicates the need for further improving interventions to reduce the HAIs such that the SIR is less than 1.

SIR < 1: The number of infections is below the baseline, which indicates that the HAI prevention interventions are working and should be further strengthened and continued. The goal is zero HAIs.

**Note:** The SIR is **NOT** a rate; it compares one number to another and is referred to as a value. To calculate SIRs, baseline data from comparable facilities are needed to predict the number of expected cases in a facility.

Examples: If a district hospital has a CLABSI rate of 3 per 1,000 central line-days and the national data predict 2 CLABSIs per 1,000 central line-days, the SIR for CLABSIs for the facility is: SIR = 3/2 = 1.5. This means that the CLABSI infection rate in this district hospital is 1.5 times the predicted national average and steps need to be taken to reduce infection rates (CDC 2021).

Many LMIC are working to report national HAI rates that can be used for calculating SIRs at the facility level. If national rates are not available, data from previous years or from comparable facilities can be used to track HAI prevention progress over time.

## Data Feedback and Sharing

Data feedback mechanisms and data sharing techniques are important because IPC results are most effective when they are shared in a timely manner. All results based on data analysis should be shared soon after the data are collected so that meaningful and timely interventions can be implemented. This presents a unique challenge with surveillance data on HAIs because it takes days or weeks to perform the surveillance itself.

When sharing IPC data, it is important to consider how to best present the data so that the desired message is most effectively communicated. Different data should be shown in different ways. For example, some data are best shown in a graph, whereas other data are best shown in a table. It is also important to take into account with whom the data are being shared and the goals of the data sharing. Not everyone will have a background in statistics; therefore, the data should be clearly presented and easy to understand to maximize the effectiveness of the data sharing.

Tables, graphs, and charts are all common ways to share IPC data:

- A table is a set of data arranged in rows and columns, detailing various elements of the data.
- Graphs show quantitative (i.e., measurable) data and are useful in showing data over long periods of time.

- Charts, such as pie charts, are useful in comparing the magnitude of data or in showing pieces of the whole picture.

(APIC 2014c)

(See Appendix 3.2.A. Visual Displays of Data for further information.)

## Using Epidemiology to Drive Policy

Epidemiological data can be helpful in influencing health practices and policies, both at the facility level and at local and national levels. Good data collection and analysis of findings can help healthcare facilities understand where PS risks are occurring and can help a facility prioritize resources for IPC. Tracking IPC data over time can show when there is a true increase or decrease in HAIs. This information can then be used to change practices and policies in the healthcare setting.

It is important to share IPC data with key stakeholders, including ward-level staff, providers, and facility leadership. Data sharing should always be transparent. Share both the good results and the areas where immediate improvements are needed, and initiate actions based on the interpretation of the data. Make sure to let those who helped implement a successful intervention know that their hard work led to a change in practice. This will encourage ward staff to continue prevention efforts and let facility leadership know the value of the IPC team. It will also help create positive relationships between the IPC team and others at the facility.

## Understanding IPC Literature and the Basics of Epidemiological Studies

Reading IPC literature (journal articles) and understanding the findings of relevant research studies allow IPC staff to practice more effectively. Epidemiological studies are commonly designed to look at the causes of a condition or an event, effectiveness of prevention interventions, and treatments of disease. These studies are conducted not only to measure characteristics of the study's subjects, but also to make generalizations about applying the finding to the larger population from which these subjects came. IPC literature may provide information on a new prevention method or on an evidence-based prevention practice that has been shown to be effective at reducing HAI rates. The literature may also include information on HAI rates at similar facilities that can be used for comparison with current facility rates. Therefore, it is important to have a basic understanding of how the studies were conducted and how to interpret any major findings (Aschengrau, Seage 2020; CDC 2012).

Epidemiological studies consist of observational and experimental studies. The purpose of these studies is to identify and quantify the relationship between an exposure (e.g., to an intervention, such as a new drug, a new approach to manage a medical condition, counseling for clients in the community, or risks, such as exposure to an infection) and a health outcome (e.g., incidence of a disease, uptake of services). In each study there are at least two groups, one of which serves as a comparison or control group.

The article titled "Chlorhexidine bathing and healthcare-associated infections: a randomized clinical trial," was an experimental study that compared the outcomes of a group of patients who were bathed daily with disposable cloths impregnated with 2% chlorhexidine (the exposure) with those of a group of patients (the control group) who were bathed daily with non-antimicrobial cloths (Noto, Domenico, Byrne, et al. 2015).

- **Observational studies** do not include any manipulation of variables or exposures by the investigator. Examples of observational studies are investigations of the incidence of healthcare-associated viral respiratory infections on pediatric wards with single or shared rooms, or observations of SSIs among all patients who undergo surgery and a report of the SSI rates. The investigator does not manipulate variables but just observes the outcome and reports the results.
- In **experimental studies,** the investigator manipulates one or more of the variables or exposures. An example of an experimental study is an assessment of hand hygiene compliance before and after an educational training session. The goal of this study would be to determine if the educational session had any impact on hand hygiene compliance rates.

Experimental studies, when appropriately designed, are considered to be the gold standard and yield the most reliable data. However, there are often reasons, including ethical issues, that experimental studies cannot be performed. In these circumstances, observational studies are commonly used. For example, an investigator may want to look at how the case fatality rate changes if patients are given antibiotics, compared with patients from whom antibiotics are withheld. Although an experimental study would yield the most reliable data, it would be unethical to purposely withhold antibiotics from patients when antibiotics are known to effectively reduce mortality, so the investigator conducts an observational study instead. For example, a retrospective study could be conducted of all cases of sepsis to determine the outcomes of those who were given antibiotics as part of their care and those who (for some naturally occurring reason) did not receive antibiotics.

The main types of observational studies used in epidemiology are cohort studies and case-control studies (table 3.2-11).

Table 3.2-11. Summary of epidemiological studies

| Type of study | Study characteristics |
|---|---|
| Experimental | Studies ways to prevent or treat diseases/events; investigator actively controls which subjects receive the agent or exposure under study and tracks the outcome of the individual or community. |
| Observational | Studies causes, preventions, and treatments of diseases/events; investigator passively observes an exposure as nature takes its course.<br>• **Cohort study**: Examines multiple health effects of an exposure; subjects are defined according to their level of exposure and subjects are followed over time to determine the outcome—if disease or an event occurs.<br>• **Cross-sectional study**: Examines the relationship between exposure and disease prevalence in a defined population at a single point in time.<br>• **Case-control study**: Examines multiple exposures in relation to a disease or event: subjects are defined as cases (those who have the event or disease) and controls (those who do not have the event or disease) and their exposure history is investigated and compared.<br>• **Ecological study**: Examines the relationship between exposure and disease with population-level disease and exposure, rather than individual level of disease and exposure. |

*Adapted from:* Aschengrau, Seage 2020

The IPC literature contains statistical terms that assess the strength of association (relationship) between the risk factor (exposures) and the outcome (a disease). Commonly used terms describing

the strength of association include the odds ratio, relative risk, confidence interval, p-value, and statistical significance. Other terms describe factors that could have influenced the strength of the association, including bias, confounding, and chance. Table 3.2-12 provides a high-level summary of the measures that can be used to interpret and understand the literature.

Table 3.2-12. Statistical terms used in IPC literature

| Term | Explanation |
|---|---|
| Odds ratio (OR) | OR is used to compare the likelihood of an event occurring among an exposed group and an unexposed group. It is typically used to describe the results of the analysis of an exposed/intervention group and an unexposed/non-intervention group.<br><br>An OR of 1.0 means that the likelihood of an event/effect occurring among both exposed and unexposed groups or intervention and non-intervention groups is the same. An OR of > 1.0 means that the likelihood of an event/effect occurring in the exposed/intervention group is higher than in the non-intervention group. An OR of < 1.0 means that the likelihood of an event/effect occurring in the intervention group is less than in the non-intervention group.<br><br>For example, one study reported that compliance with hand hygiene among HCWs in a facility when ABHR was available has an OR of 2, which means that HCWs who had ABHR available were twice as likely to perform hand hygiene as HCWs in a facility where ABHR was not available (Lindsjö, Sharma, Mahadik, et al. 2015). |
| Relative risk (RR) | RR compares two groups' risk of developing a disease or other health event. The groups are often differentiated by demographic factors, such as gender or age. They can also be an exposed and unexposed group. For example, RR is the risk of the intervention group (those receiving chlorhexidine bathing) developing a disease (an HAI) compared with the risk of the non-intervention group (those not receiving chlorhexidine bathing) developing a disease.<br><br>RR provides information about the strength of the association between an exposure and an outcome. It shows how much higher or lower the chance of the outcome is among people who are exposed, compared with people who do not experience the exposure.<br><br>An RR of 1.0 indicates that both groups have the same risk of developing the outcome. For example, there is no difference in the risk of developing an HAI among those who received chlorhexidine bathing and those who did not (Noto, Domenico, Byrne, et al. 2015).<br><br>A RR of > 1.0 means that the risk of the exposed group developing disease is greater than among those not exposed. For the chlorhexidine bathing intervention, it means that there is no protective effect and it may result in increased risk of developing an HAI.<br><br>A RR of < 1.0 means that there is a protective effect from the exposure. |

| Term | Explanation |
|---|---|
| P-value | P-value is used to determine whether the likelihood of an observed association (relationship) or difference could have occurred by chance. A P-value of 0.05 means that the likelihood that the observed association or difference occurring by chance is 5 out of 100 or 5%. A p-value of 0.05 or less means that the observed association is real and not by chance.<br><br>If one conducts such studies 100 times, it is very likely that 95 times one will notice a similar association or difference observed in the study with a P-value of less than 0.05. For example, a P-value of 0.0025 is considered to be statistically significant (the exposure affected the outcome) if a P-value of < 0.05 is used as the cutoff for statistical significance. |
| Statistical significance | Statistical significance describes the results of an experimental study that shows that the observed association or the difference is real and has not happened by an error. When study results are statistically significant, it is unlikely that the results could have occurred by chance alone.<br><br>In describing surveillance results (both rates of HAIs and compliance with IPC practices), typically a P-value of < 0.05 is used to designate that a finding is statistically significant (unlikely to have occurred by random chance).<br><br>For example, if in an ABHR study the OR of 2 for compliance with hand hygiene when ABHR was available had a P-value of < 0.05, it means that one can be assured that the increase in compliance was real and not by chance. |
| Confidence interval (CI) | CIs are used to estimate precision. A wide CI indicates less precision; a narrow CI indicates higher precision. In any experimental study, a large sample size will give narrow CIs. CIs do not determine statistical significance, but are often used as a proxy for statistical significance. If the CI does not overlap the value of 0.00, the findings are considered to be statistically significant.<br><br>In epidemiology, a 95% CI is a range of values that you can be 95% certain contains the true value. It is typically used to demonstrate 95% confidence that the specified interval includes the true value.<br><br>For example, a 95% CI of (1.56–1.70) indicates that if one performs a similar study taking 100 additional samples, one can be 95% certain that the CI will contain the true value and will be statistically significant. |
| Bias | Bias is any systemic error in the design, conduct, or analysis of a study that results in a mistaken estimate of an effect of an exposure/intervention. There are various types of bias. Selection bias and observation bias are the two main types. A selection bias can occur if there are systematic differences in how each group (exposed and unexposed) is selected for the study. For example, if the selection method results in selecting a greater number of older persons for the exposed group and a greater number of younger people for the unexposed group, the age difference may influence the results of a study.<br><br>Another bias is information bias, which can result when a researcher does not include some key information in the report that leads to a different interpretation of data and results. |

| Term | Explanation |
|---|---|
| Confounding | Confounding occurs when the relationship between two variables is distorted by a third variable that is related to both of the original variables. It is a mixing of effects between an exposure, an outcome, and a third variable (the confounding variable). This can impact the conclusions you are able to draw between the original two variables.<br><br>For example, while studying CAUTI rates among both male and female patients, it was observed that rates in female patients were twice as high as rates in males. However, on further analysis of the data, it was observed that student nurses in training inserted indwelling urinary catheters in more than 80% of the female patients. When further analysis was made to compare only the patients for whom trained providers inserted catheters, the rates were not much different. Therefore, providers' training was a confounding factor. |
| Random error | Random errors lead to a false association between the exposure and the outcome, when the association is really only occurring by chance. This can lead one to believe there is a statistically significant difference between the two variables, when in reality, there is not. Random error is reduced by increasing precision and ensuring good study design. A study can increase its sample size to increase precision and protect against random error. |

*Sources*: Aschengrau, Seage 2020; CDC 2012; Rothman 2012; Szumilas 2010

## SUMMARY

Using basic statistical methods and techniques to analyze data will help a facility understand its infection rates and trends over time. Calculating basic rates, incidence, and prevalence are all useful for understanding IPC performance in the healthcare setting. The IPC team that has a basic understanding of hospital epidemiology and statistics can interpret and share data effectively. The IPC team should be able to share data in a clear, concise, and effective way to use the data to influence behavior and guide change. All results based on data analysis should be shared soon after the data are collected so that meaningful and timely interventions can be implemented. Reading IPC literature (journal articles) and understanding the findings of relevant research studies allow IPC staff to practice more effectively.

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# CHAPTER 1: SAFE SURGERY AND SAFE PRACTICE IN THE OPERATING ROOM

**Key Topics**

- The proven safe surgical care standards
- The operating room and associated risks for patients and the staff
- Instruments as a cause of most injuries in the operating room
- Avoiding injuries from sharps and designing a safe operating room

## BACKGROUND

Surgical care has been an essential component of healthcare everywhere for over a century. As the incidences of traumatic injuries, cancers, and cardiovascular disease continue to rise, the impact of surgical intervention on public health systems will grow. Surgery is often the only therapy to alleviate disabilities and reduce the risk for death from common conditions. Each year, millions of people undergo surgical treatment due to traumatic injuries, pregnancy-related complications, and malignancies. Annually, major operations are performed for about 234 million people across the world. This means that roughly one operation is done for every 25 people, a situation which obviously indicates that the safety of care is of great public health importance. Contrary to the fact that surgical procedures are intended to save lives, it is embarrassing to often witness unsafe surgical interventions causing substantial harm instead. Mortality from general anesthesia alone is reported to be as high as one in 150 people in parts of sub-Saharan Africa. Infections and other postoperative morbidities are also serious problems prevailing around the world. Moreover, given the previously estimated rates of major complications and death following in-patient surgery, it is postulated that even using a conservative estimate, seven million patients suffer from complications of surgery, one-half of which were preventable. Given the ubiquity of surgery, these facts have significant negative impacts on the healthcare provider and the service too. Safe surgery is a surgery culminating in no harm and/or exposure to any avoidable risk for the patient and/or the provider.

WHO's Safe Surgery Checklist (Appendix 4.1.A) has improved compliance with standards and decreased complications from surgery in eight pilot hospitals selected for evaluation. In different healthcare institutions, ranging from small district hospitals to large medical centers in diverse geographical settings, the use of a 19-item checklist was found to noticeably reduce the complications and mortality associated with a variety of surgical procedures by 30%. For instance, the rate of major inpatient complications dropped from 11% to 7%, and the in-patient death rate following major operations dropped from 1.5% to 0.8%. Interestingly enough, the effect was of similar magnitude in both high- and low-/middle-income countries. The checklist has been designed to be simple to use and applicable in many settings. It is actively being used and is pervasive in operating rooms around the world (WHO, 2009).

Monitoring and evaluation of outcomes is an essential component of surgical care. In this regard, many facilities and departments are already engaged in this process. Additional data collection in this case is neither recommended nor encouraged if such a system is already in place and proves useful to the clinicians and staff as a means of improving the quality of care. However, in hospitals

where results of surgical care are not routinely tracked and postoperative complications are not recorded, or where surveillance mechanisms have not been sufficient to identify poor practices, WHO highly recommends that a monitoring system be established. As a means of surgical surveillance at hospital and practitioner levels, data on death on the day of surgery and postoperative in-hospital deaths should be collected systematically by facilities and clinicians. When combined with operative volume, such information provides departments of surgery with information on day-of-surgery and postoperative in-hospital mortality rates. Mortality rates can help surgeons identify safety shortfalls and provide guidance to clinicians for improvements in care. Moreover, for those facilities with the capacity to do so, SSI rates and the surgical Apgar score are also important outcome measures. In addition to deaths and complications, process measures can be incorporated in the evaluation system to identify safety lapses and areas for improvement. Improved compliance has been associated with better outcomes and may identify weaknesses in the system of care delivery. The Safe Surgery Checklist is now used in Ethiopia in a few hospitals by a few surgeons. It is being promoted, but not consistently used by the members of the Society of Surgeons or Society of Anesthesiologists. As far as monitoring and evaluation of surgical care is concerned, postoperative complications were to be recorded on the surgery report; however, they are not always recorded or routinely tracked in the facility report, nor are surveillance mechanisms sufficient to identify poor practices in place.

The Safe Surgery Guidelines focus on two main points:

1. 1. The implementation of the Safe Surgery Checklist.
2. 2. The monitoring and evaluation of surgical outcomes.

## The Implementation of the Safe Surgery Checklist

The checklist involves the coordination of the operating team—the surgeons, anesthetist, and nurses—to discuss key safety checks before specific phases of perioperative care: a “Sign In” before induction of anesthesia; a “Time Out” before skin incision; and a “Sign Out” before the team leaves the operating room. Many of the checks are already being practiced routinely in some institutions, but strangely, few operating teams accomplish them all consistently, even in the most advanced settings.

Surgical care is complex and involves dozens of steps that must be optimized for individual patients. To minimize unnecessary loss of life and serious complications, the operating team formulated 10 basic essential objectives that are congruent with WHO’s Safe Surgery Guidelines. In any surgical case:

1. The team will operate on the correct patient at the correct site.
2. The team will use methods known to prevent harm from administration of anesthetics, while protecting the patient from pain.
3. The team will recognize and effectively prepare for life threatening loss of airway or respiratory function.
4. The team will recognize and effectively prepare for risk of high blood loss.

5. The team will avoid inducing an allergic or adverse drug reaction for which the patient is known to be at significant risk.
6. 6.The team will consistently use methods known to minimize the risk for SSI.
7. The team will prevent inadvertent retention of instruments and sponges in surgical wounds.
8. The team will secure and accurately identify all surgical specimens.
9. The team will effectively communicate and exchange critical information for the safe conduct of the operation.
10. Hospitals and public health systems will establish routine surveillance of surgical capacity, volume, and results.

## Monitoring and Evaluation of Surgical Outcomes

The monthly facility report should include data on:

1. Death on the day of surgery must be recorded by the facility and the clinician.
2. Postoperative in-hospital deaths must be recorded by the facility and clinician.
3. The frequency of compliance with:
    - Marking of the operative site by the surgeon.
    - Performance of an anesthesia safety check of the machine and medications.
    - Use of pulse oximetry throughout the administration of anesthesia in all cases.
    - Objective evaluation of the airway.
    - Use of sterility indicators to ensure adequacy of sterility practices.
    - Administration of prophylactic antibiotics within an hour before skin incision (if indicated).
    - Verbal confirmation of patient, site, and procedure immediately before incision with all team members present.
    - Preoperative team briefing to discuss clinical concerns, operative plan, and other critical issues.
    - Postoperative team debriefing to discuss problems during the case and concerns for recovery and management of the patient.

## Safe Practices in the Operating Room

In the past decade, awareness of the risk of exposure to blood and body fluids containing HIV, HBV, and most recently HCV, have created a new era in surgical IP practices. Just as patients must be protected from wound contamination and infections, providers should also be protected from intra-

operative injuries and exposure to patients' blood and other body fluids. The operating room is clearly one of the most hazardous environments in the healthcare delivery system. By definition, surgery is invasive. Occasionally, instruments designed to penetrate a patient's tissue could accidentally also inflict harm/injure to the provider. Bleeding (only reasonable amounts) is unavoidable; therefore, blood is likely to be seen everywhere. Speed is quite essential in the operating room because emergency situations can occur at any time and interrupt routines. Under these circumstances, preventing injuries and exposure (to infectious agents) is challenging.

The science of safety in the surgical unit in a large specialty hospital or a freestanding primary healthcare clinic has not kept up with the urgent need for prevention strategies. Nevertheless, most of the recommendations in this chapter have been found to be worthwhile and deserve consideration.

Preventing infections following an operation is a complex process that begins in the operating room by preparing and maintaining a safe environment for performing the surgery. Surgical aseptic techniques are designed to create such an environment by controlling the four main sources of infectious organisms: the patient, surgical staff, the equipment, and the operating room environment. Although the patient is often the source of surgical infections, the other three sources are important and should not be overlooked.

Specific techniques are required to establish and maintain surgical asepsis for making the surgical environment safer, including:

- Patient considerations: skin cleaning pre-operatively, skin antisepsis, and wound covering.
- Surgical staff considerations: hand hygiene (handwashing and/or hand rub and hand rubbing with waterless, alcohol-based antiseptic agents); use and removal of gloves and gowns.
- Equipment and room preparation considerations: traffic flow and activity patterns, housekeeping practices and decontamination, cleaning and either sterilization or high-level disinfection of instruments, gloves, and other items.
- Environmental considerations: maintaining an aseptic operating field and using safer operating practices and techniques.

For reasons of convenience, the traffic, the flow, equipment processing, and room preparation requirements are discussed in other chapters. The focus of this chapter is on improving the surgical environment (operating room), especially the practices and techniques that make surgery safer for both the patient and staff.

## The Surgical Environment

The operating room has special characteristics that increase the chance of accidents. Staff often use and pass sharp instruments without looking at the instrument or letting the other person know what they are doing. The workspace is too confined for some members of the team to be able to see what is going on in the operative field. Moreover, there is a real need for speed, and there is the added stress of anxiety, fatigue, frustration, and even anger. As with other mishaps, the exposure to blood is often abrupt and happens without being noticed, usually not until gloves are removed. In some cases, blood enters the eyes of the person operating, further increasing the risk of infection with bloodborne pathogens.

## Instruments Causing Injuries

In hospitals, the vast majority of injuries from sharp edged materials occur in the operating room. Scalpel and suture-needle injuries are the most frequent. Many other sharp edged instruments can cause direct physical injuries or indirectly inflict harm by tearing gloves, resulting in exposure to blood. Below are a few more surgical instruments and articles that can cause harm:

- Hypodermic needles
- Wire sutures
- Laparoscopy and surgical drain trocars
- Orthopedic drill bits, screws, pins, wires, and saws
- Needle point cautery tips
- Skin hooks and towel clips
- Sharp-pointed scissors and sharp-tipped mosquito forceps
- Dissecting forceps
- Sharp-toothed tenaculi
- Broken medication ampoules
- Spinal needles
- Sharp bone edges and bone fragments

## When Do Injuries Occur?

Most often, scalpel injuries occur when:

- Putting on and taking off the disposable blade.
- Passing the scalpel hand to hand between team members.
- Cutting (e.g., in using fingers to hold or spread tissue or cutting toward the fingers of the surgeon or assistant).
- Using the scalpel (before and after): leaving it on the operative field, dropping it on your own or the assistant's foot, and reaching for scalpels sliding off the drapes.
- Placing the scalpel in an over-filled sharps container or a poorly located container.

Most often, suture needle injuries occur when:

- Loading or repositioning it in the needle holder.
- Passing the needle hand to hand between team members.
- Suturing: using fingers to hold tissue or to guide the needle, sewing toward the surgeon or assistant and holding back other tissues by the surgeon or assistant.

- Tying with the needle still attached or left on the operative field.
- Using the needle (before and after): leaving it on the operative field, dropping it on your own or the assistant's foot, and reaching for suture needles or needles loaded in the needle holder sliding off the drapes.
- Placing needles in an over-filled sharps container or a poorly located container.

Almost all of these injuries can be easily avoided with the following simple measures:

- Use small Mayo forceps (not fingers) when holding the scalpel blade, when putting it on or taking it off or loading the suture needle. (Alternatively, use disposable scalpels with a permanent blade that cannot be removed.)
- Always use tissue forceps, not fingers, to hold tissue when using a scalpel or suturing.
- Use a "hands-free" technique to pass or transfer sharps (scalpel, needles, and sharp-tipped scissors) by establishing a safe or neutral zone in the operative field (see below).
- Always remove sharpened materials from the field immediately after use.
- Make sure that containers for sharp materials are replaced when they are only three-quarters full, and place containers as close to where sharp materials are being used as conveniently possible (i.e., within arm's reach).

### The "Hands-Free" Technique for Passing Surgical Instruments

A safer method of passing sharp instruments (scalpels, suture needles, and sharp scissors) during surgery is called the "hands-free" technique, which has been recommended. This technique for keeping sharp edged materials away is cheap, simple to use, and ensures that the surgeon, assistant, or scrub nurse never touches the same instrument at the same time (Bessinger 1988). Instruments passed with the hands-free technique (other than those listed above) include anything sharp enough to puncture a glove (e.g., trocars, sharp-tipped mosquito forceps, and loaded needle holders). Using the hands-free technique, the assistant or scrub nurse places a sterile or high-level disinfected kidney basin or other suitable small container on the operative field between her/himself and the surgeon. The container is designated as the safe or neutral zone in which sharp materials are placed before and immediately after use. Various items, such as basins, mats, or trays, including part of a sterile instrument stand or a designated area on the operative field, have been used as the safe zone. To avoid dulling of scalpel blades, use a plastic container or place a sterile cloth in a metal container. For example, the assistant or scrub nurse alerts the surgeon that a sharp instrument has been placed in or on the safe zone, with the handle pointing toward the surgeon, by saying "scalpel" or "sharp" while placing it there. The surgeon then picks up the instrument and returns it to the container after use, this time with the handle pointing away from her/him. Another way to do this is to have the assistant or scrub nurse place the instrument in a container and pass it to the surgeon. The surgeon picks up the instrument out of the container, which is left on the field until the surgeon returns the instrument to it. The assistant or scrub nurse, in turn, lifts up the container and returns it to the Mayo stand.

## Designing Safer Operations

- Using the least dangerous instrument or device that will effectively accomplish the task, while at the same time minimizing risks to the patient and surgical team, should be a goal of any operation.
- Simple things, such as a brief pre-operative discussion on how sharp materials should be held by the surgeon, assistant, or scrub nurse, can be very helpful. Still another is the need for the surgical team to review how to make each step in the operation safer, starting from securing the towel drapes around the proposed incision with non-perforating towel clips to using blunt-tipped needles for closure of all layers except the skin (CDC, 1997; Dauleh, Irving, Townell 1994). Other examples of instruments that protect the surgical team without sacrificing patients' safety or staff performance are listed in table 4.2-1. Moreover, the use of hand-held straight suture needles to close skin incisions is especially dangerous with a reported injury rate of 17%, much higher than those with curved needles held in a needle holder (Davis 2001).
- Anesthesiologists, radiologists, and others who close small incisions after placement of vascular catheters or cut-downs should be made aware of this hazard.

The risk associated with assisting or being the scrub nurse in surgery may be reduced by anticipating (preferably knowing) the needs of the surgeon for each step of the operation in advance. Where procedures are short (30 minutes or less) and/or surgical steps are straightforward, such as D & C or cesarean section, this can be accomplished by developing checklists that lay out each step (or task) of the operation in the order of performance (i.e., from skin incision to closure). Reviewing the checklist with the surgical team just before starting the case and pointing out where deviations may be necessary will make the proceedings of the planned surgery smooth and less risky. An additional advantage of this review is that it can help protect patients from possible further injuries or increased blood loss.

Table 4.2-1. Reducing the risk of exposure

| FUNCTION | SAFER | LESS SAFE | LEAST SAFE[1] |
|---|---|---|---|
| **Skin incision** | cautery | disposable scalpel | scalpel with removable blade |
| **Cutting** | scissors, blunt tip or cautery probe | scissors, sharp tip | scalpel |
| **Hemostasis** | blunt suture needles staples or cautery | sharp suture needles | wire sutures |
| **Sponging with gauze while using a scalpel** | surgeon does sponging; assistant only retracts | assistant sponges but only by request | assistant sponges spontaneously (no communication) |
| **Retraction** | blunt retractor | sharp retractor | fingers or hands |
| **Sharps transfer** | Neutral Zone | hand-to-hand (communication) | hand to hand (no communication) |
| **Surgical gloves** | double gloving | single pair of gloves or double gloving with reprocessed gloves | single pair of reprocessed gloves, |
| **Closing peritoneum (small, 2–3 cm incision)** | do not close | purse-string closure using tissue forceps to grasp needle | purse-string closure using fingers to grasp needle |

[1] Should be avoided if at all possible.

*Source*: FMOH 2012

## Blunt Needles for Suturing

The range of "bluntness" in commercially available blunt-tipped needles varies. Their bluntness ranges from minimal (no extra effort needed to use them) to very blunt (does not penetrate tissue, such as fascia and requires conscious effort). Minimally blunt needles can be used for closure of all layers from fascia to skin. Intermediate blunt needles, on the other hand, require some additional conscious effort to close fascia, but are safer to use. Very blunt needles are seldom used except when operating deep in the pelvis where the needle must be retrieved with fingers. The technique for using blunt needles is as follows:

**STEP 1:** Use a strong needle holder and lock it fully.

**STEP 2:** Position the needle in the mid-curve, rather than three-quarters of the way back to prevent slippage or bending the needle. (This is usually not necessary when using minimally blunt needles.)

**STEP 3:** Grasp and hold the tissue to be sutured with tissue forceps to make it easier for the needle to go through the tissue being sutured. In general, the blunter the tip, the more important it is to follow these three steps.

## Making the Surgical Environment Safer

The responsibility for making today's operating rooms safer extends beyond concern for the well-being of the patient to all healthcare staff forming the surgical team. The approaches to making operations safer outlined in this chapter are simple and practical. The key to success is to apply the principles and practices in an integrated and consistent manner with daily attention to details and support at all levels of the healthcare system.

## SUMMARY

The responsibility for making today's operating rooms safer extends beyond concern for the well-being of the patient to all healthcare staff forming the surgical team. The approaches to making operations safer outlined in this chapter are simple, practical, and have been documented over a 10-year period. The key to success is to apply the principles and practices in an integrated and consistent manner with daily attention to details and support at all levels of the healthcare system.

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# CHAPTER 2. INFECTION PREVENTION AND CONTROL IN INTENSIVE CARE UNITS

### Key Topics

- Characteristics of ICU patients and settings
- Devices commonly used for ICU patients
- Transmission of infection in the ICU
- Role of the HCW in transmitting infection in the ICU
- Best practices and key components
- General interventions for IPC in the ICU
- Strategies for health facilities to support IPC in the ICU

## BACKGROUND

Patients admitted to ICUs may have several conditions that increase the risk of infections. Although recommended IPC practices are the same for the ICU as for other areas of a health facility, HCWs in the ICU need to be especially vigilant in their compliance with recommended IPC practices. Although ICUs account for a relatively small proportion of hospitalized patients, infections acquired in the ICU account for more than one fifth (20%) of all infections acquired in healthcare facilities (WHO 2011). This is especially relevant in low-resource settings where it is estimated that almost all patients (up to nine of every 10 ICU patients) admitted in an ICU suffer at least one HAI during their stay in an ICU. This is two to three times higher in settings with fewer resources than those in higher-income settings (WHO 2011). Moreover, the risk of these patients getting an infection related to medical devices used during their care (device-associated infection) is as much as 13 times higher than those in higher-income settings. This drastically adds to the discomfort, level of care required, and often contributes to cause of death of already dangerously ill patients. However, infections related to an ICU stay are largely preventable. By following evidence-based IPC practices, HCWs can prevent HAIs in ICU patients.

### Characteristics of ICU Patients and Settings

The ICU provides a setting in which close monitoring and constant care is provided to patients, including those transferred from other units of the healthcare facility, with life-threatening conditions (e.g., major trauma, serious infection, life-threatening heart conditions, respiratory failure, complex or complicated surgery, or premature birth). ICU patients are often old or very young, and have impaired immunity and poor nutritional status, which put them at higher risk of infection.

**Access:** Access to the ICU by non-authorized staff and visitors is often limited or controlled.

**Staffing:** To provide a high level of care, ICUs are staffed with more nurses (higher nurse to patient ratio) than ordinary wards so that each patient can receive more attention. ICU staff are specially trained to care for critical patients.

**Layout:** ICUs are often set up so that all or most beds are visible from the nurses' station to facilitate the observation of patients. There is also typically more patient-care equipment at the bedside of each patient (e.g., multiple infusion pumps, cardiac and continuous vital sign monitors, warming or cooling equipment, hemodialysis machines, and devices assisting breathing [such as ventilators]). Therefore, the space required for each patient is greater than in ordinary wards.

**Procedures:** ICU patients require frequent vital sign monitoring and ongoing medical assessment. Procedures (such as central venous catheter insertion, intubation, and surgery) and diagnostics (such as X-ray, ultrasound, endoscopy) are often performed at the bedside. These procedures occur more frequently and can often be urgent or emergent. However, in the ICU, the need for urgent procedures can be somewhat anticipated by monitoring the patient's condition and, therefore, can be more controlled than similar situations on an ordinary ward.

## Devices Commonly Used for ICU Patients

Patients in the ICU tend to have multiple medical devices for monitoring and interventions. These depend on the type of ICU and the condition of the patients. Examples of invasive devices include:

- Vascular devices: peripheral and central venous catheters
- Indwelling urinary catheters
- Nasogastric tubes and gastrostomy tubes
- Invasive cardiac monitoring
- Mechanical ventilation with endotracheal tubes or tracheostomy tubes
- Wound drains
- Intracranial external ventricular drains

Invasive medical devices greatly increase a patient's risk of developing an infection because they provide a direct entry route for microorganisms into the sterile parts of a patient's body and bypass the body's normal defenses against infection. The risk for infection increases with the length of time that each device is in place.

## Transmission of Infection in the ICU

### Risk Factors for Infection in ICU Patients

ICU patients are at risk of infection related to:

- Extremes of age
- Presence of critical illness or trauma
- Presence of underlying disease, such as diabetes, cancer, renal failure
- Impaired natural defense mechanisms of the body

- Presence of invasive medical devices (e.g., endotracheal intubation, urinary catheterization)
- Frequent medical procedures
- Frequent and prolonged use of antibiotics creating antibiotic resistance
- Prolonged ICU stay

## Sources of Infection

In the ICU, the sources of infection are similar to those in ordinary wards. However, typical ICU patients are more vulnerable and receive more hands-on care. There are more opportunities for transmission. Infection in ICU patients includes:

- The hands of HCWs and other care givers
- Patient's own existing infections, colonization, or normal flora spreading to other body sites
- Other patients in the ICU
- The ICU environment and patient-care equipment (e.g., invasive medical devices, thermometers, humidifiers), which can have an increased presence of MDROs
- Medications (IV fluids, oral liquid medications, flushes, etc.), including topical medications (e.g., antiseptics)
- Medical supplies (gauze, dressings, ventilator tubing, giving sets, etc.)

## Infection Entry Points

Patients in the ICU typically have multiple entry points for microorganisms to enter the body; invasive medical devices and procedures provide increased opportunities for pathogens to bypass the normal defenses of the skin and respiratory and urinary tracts.

## Infections in the ICU

In the ICU, patients are closely monitored, providing the opportunity to identify and treat infections early; however, there are some challenges:

- Early signs of infection may be subtle or obscured by the patient's illness or underlying conditions (e.g., premature birth).
- Results from microbiology testing may be delayed.
- Empiric use of antibiotics until the culture results are available, often for ongoing treatment in settings without a microbiology laboratory.
- Infection with MDROs and non-availability of antimicrobial susceptibility testing.

- Patients colonized with a MDRO in the ICU continue to transmit infection to other patients without ever developing signs and symptoms, many times causing outbreaks involving a large number of patients.

## Role of the HCW in Transmitting Infection in the ICU

The most crucial element in reducing infections in the ICU is the staff.

- All staff in the ICU, be it clinical or supporting staff, can transmit infection by not complying with recommended hand hygiene practices and other standard precautions. Even small breaches in IPC in emergency situations are enough to transmit infections to patients with already poor immune status.
- Chronic staff shortages, with one staff person taking care of several patients simultaneously, overwhelms the staff and reduces compliance with recommended IPC practices, including hand hygiene.
- Experienced and trained ICU staff should have mastered the basics of complex ICU procedures and equipment and be able to incorporate IPC techniques in their workflow. Infections often occur in ICUs during periods when HCWs who are less familiar with the setting start working in an ICU.

## Best Practices and Key Components

The key practices to reduce HAIs among ICU patients are the same as for all patient populations, but in the ICU, it is essential to follow these recommendations strictly and vigilantly.

- Apply standard precautions to each patient at each encounter: perform hand hygiene; use PPE; practice injection safety; wear a mask for performing spinal procedures; clean and disinfect thoroughly; and practice respiratory etiquette.
- Use transmission-based precautions for specific patients with suspected or known infection or colonization with selected microorganisms, including the use of isolation rooms and cohorting.
- Prevent device-associated infections by decreasing the use of invasive medical devices (limit use, remove as soon as possible) and inserting and maintaining devices using care bundles.
- Practice the rational use of antibiotics.
- Provide adequate patient spacing by maintaining a minimum of 2 meters (6 feet) between beds in the ICU.
- Establish a workflow that separates “clean” from “dirty.”

Use tools that help ensure that IPC practices are maintained as part of the workflow for every patient.

## Implementation

### General Interventions for IPC in the ICU

Implementation of practices to reduce HAIs among ICU patients requires strict and vigilant application of the IPC practices used for all patients. ICU staff need to be experts on incorporating IPC practices in all aspects of the ICU workflow at all times.

### Standard Precautions

Use standard precautions, including hand hygiene, for each patient at each encounter. (See Volume 1, Chapter 3 on Standard and Transmission-Based Precautions.)

- Perform hand hygiene.
- Use PPE according to a risk assessment for each patient encounter. Note: standard use of head cover, gowns, or shoe covers for entry into the ICU is not an IPC requirement.
- Practice injection and sharps safety: one needle and syringe, one patient, one time. Wear a mask for performing spinal procedures (e.g., lumbar puncture).
- Clean and disinfect thoroughly.
    - Clean patient-care equipment between uses on patients.
    - Clean the area around the patient, including high-touch surfaces thoroughly and frequently.
    - Clean, disinfect, and sterilize instruments, supplies, equipment, and medical devices used for each ICU patient as appropriate for their type according to the Spaulding category. (See Volume 1, Chapter 7 on Cleaning, Disinfection, and Sterilization.)
    - Dispose of single-use items after use for the patient or follow the healthcare facility guidelines for reprocessing single-use devices.
- Practice respiratory hygiene and cough etiquette.
    - Maintain an appropriate distance from patients who have cough.
    - Consider promoting staff influenza vaccination by providing or requiring it. (See Volume 1, Chapter 13 on Occupational Health.)
- Process reusable textiles as recommended. (See Volume 1, Chapter 8 on Laundry Services.)
- Follow waste management guidelines.

### Transmission-Based Precautions

Apply transmission-based precautions (contact, droplet, or airborne) for specific patients with suspected or known infection or colonization with microorganisms known to spread from person to person in healthcare facilities (i.e., epidemiologically significant). (See Volume 1, Chapter 3 on Standard and Transmission-Based Precautions.)

- Use isolation rooms, when available, and prioritize or use adaptations described in Volume 1, Chapter 3: Standard and Transmission-Based Precautions.
- In situations with multiple patients with the same infection, practice cohorting (e.g., respiratory virus season, outbreak, endemic MDROs). Prioritize or use adaptations described in Volume 1, Chapter 3: Standard and Transmission-Based Precautions.

## Patient Spacing

Ideally, each patient is cared for in an individual room (single-patient rooms) for reasons of safety, privacy, and infection control.

- Space the standard critical care bed for an adult ICU patient a minimum of 1.5 meters (4 feet) apart at the head and foot of the bed and a minimum of 2 meters (6 feet) on each side.
- Ensure that there is adequate space between patients to contain the necessary equipment. If more than one patient is housed in a room, create a separate workspace around each patient and use droplet transmission-based precautions.
- Overcrowding puts patients at increased risk for HAI.

## Workflow

Workflow in the ICU with multiple patients should be designed to avoid cross contamination of equipment and other supplies. Some considerations are:

In open ICUs, designate a patient zone where the environment of one patient ends and the next begins to facilitate patient-specific hand hygiene, putting on and removing PPE, equipment disinfection, and environmental cleaning. For example, the border of each patient zone may be defined by the privacy curtain, privacy screen, or a line painted on the floor.

When conducting patient care, complete the care of one patient, perform hand hygiene, and then commence the care of another. During "rounds," be aware of performing hand hygiene and cleaning equipment between contact with patients, e.g., during daily medical rounds, vital sign rounds, and medication rounds.

When conducting patient care, work from the cleanest to the dirtiest during each episode of care. For example, if you need to dress the central venous catheter and empty the urinary catheter, perform the central venous catheter dressing first and then the urinary catheter care. Perform hand hygiene following of WHO *5 Moments* during patient care. (See Volume 1, Chapter 4: Hand Hygiene.)

Use a central storage area to store medications, feeds, patient supplies, and cleaned equipment. Do not store them at the bedside or in patient-care areas. Bring a small amount of supplies to the bedside for use during a single shift or single day. They are easily contaminated by splashes, sprays, and contaminated hands of HCWs. If possible, physically separate clean supplies and equipment from patient-care areas (e.g., a wall, a screen). Avoid storing anything in open containers in patient-care areas (e.g., swabs, cotton, instruments).

Prepare medications and feeds away from patient care areas to prevent contamination. This is especially critical if using multi-dose vials or containers (i.e., substances that are not used up by one patient dose and will later be used for another patient), medication vials, large bottles of antiseptic, formula feeds, distilled water, saline for flushes, and topical medications. Avoid using multi-dose vials or containers, if possible, but if used, exercise extreme care to prevent cross contamination.

- Never take them to the bedside.
- Perform hand hygiene and the pour off a small amount for immediate use.
- Once opened, label with date and time of expiry.

Follow the guidelines for cleaning and disinfecting patient care items. Non-critical items, such as thermometers, forceps, scissors, etc., should be cleaned and disinfected by wiping with alcohol or 0.5% chlorine solution. Avoid keeping these items in disinfectant solutions between uses because these solutions quickly become contaminated and instead of disinfecting, become a source of cross infection, especially if the items are not cleaned after each use before returning to the soak.

Thoroughly clean and disinfect common procedure rooms and dressing rooms after each use. They have been implicated as a source of cross contamination. Perform procedures and dressing at the bedside, if possible.

Avoid using shared equipment simultaneously for two patients, such as portable suction devices or IV poles.

Thoroughly clean, disinfect, and sterilize equipment used consecutively on multiple patients according to the Spaulding classification (e.g., use of thermometer, scales, portable X-ray, ultrasound).

Avoid placing supplies or equipment by sinks or using bench tops by sinks as preparation areas. Sink drains in the ICU have been known to harbor biofilm inhabited by MDROs. When the sink is used, the sink drain contents can splash at least 1 m (3 feet), contaminating the surrounding areas.

## Patient Care

Excellent patient care promotes the immune function, maintains the natural defense mechanisms, and prevents additional entry points for infection.

- Maintain cleanliness with regular bathing and linen changes.
- Protect patients and care equipment from insects and vermin, if present.
- Perform regular skin care, mouth care, perineal care, and wound care.
- Perform care of invasive devices.
- Change incontinent patients regularly.
- Perform regular care of pressure areas.
- Ambulate the patient early and as often as possible.
- Encourage and assist deep breathing exercises.

- Enhance nutrition (blood glucose control, enteral feeds, parental feeds).
- Use antibiotics rationally.
- Enhance pain control.
- Provide sedation holidays.
- Decrease stress created by noise, lights, pain, etc.

### Visitor Management

In general, access to the ICU area should be limited to authorized staff and visitors to admitted patients. The needs of the patient and the family are considered along with IPC and other space and workflow considerations described above.

In general, ICU visitors should be controlled, with the following IPC considerations:

- Educate family/visitors regarding hand hygiene and other IPC practices, especially if they are assisting with the care of patients.
- Educate visitors about the ICU policy for visitors' use of PPE for patients on contact, droplet, or airborne precautions.
- Screen visitors for potential infectious illnesses, such as draining wounds, fever, diarrhea, and respiratory infection.
- Restrict entry of ill visitors to the ICU.

## Interventions for the Prevention of Device-Associated Infections in the ICU

Medical devices, although lifesaving or necessary for care, create significant additional risk of infection to the ICU patient. HCWs should be aware that invasive devices easily become contaminated during insertion and care. When devices are accessed or handled frequently, even small breaches in IPC will lead to infection. HCWs in the ICU can protect patients by:

- Only using invasive medical devices when absolutely necessary for care (not for the convenience of the HCW).
- Actively removing devices as soon as possible and strictly.
- Vigilantly incorporating basic IPC practices in the insertion and care of invasive medical devices.
- Incorporating elements of IP bundles in care.

(For implementation details, see Volume 2, Section 2, Prevention of Common Healthcare-Associated Infections.)

## Interventions for the Prevention of Specific Types of HAIs in the ICU

### Healthcare-Associated Pneumonia

Healthcare–associated pneumonia is common in ICUs for unventilated patients due to their reduced level of consciousness, lack of mobility, anesthesia, pain, immune suppression, and other factors. Strict and vigilant IPC practices can help prevent healthcare–associated pneumonia in the ICU. (See Volume 2, Section 2, Chapter 4: Preventing Healthcare-Associated Pneumonia.)

### Surgical Site Infections

SSI is the most common type of HAI in countries with limited resources, is often caused by MDROs, and has high rates of mortality. ICU patients are especially vulnerable, including the potential for a high burden of MDROs in the ICU environment. However, by preparing patients pre-operatively and following evidence-based IPC practices in the ICU after surgery, HCWs can prevent SSIs in ICU patients. (See Volume 2, Section 2, Chapter 1 on Preventing SSI.)

- **Preoperative ICU Care:** When possible, educate patients, control infections, control underlying illness, optimize nutrition, and perform recommended skin cleaning before the procedure.
- **Post-operative ICU care:** Perform strict hand hygiene, deliver aseptic wound care, manage drains using IPC for invasive devices, educate patients about IP, optimize nutrition, maintain glucose control, and enhance immune function as much as possible.

### Preventing Infections from Bedside Procedures

In ICUs, procedures usually reserved for the OT may be performed at the ICU bedside if emergent or if the patient is too unstable to be transported. All IPC and aseptic techniques appropriate for the type of procedure must still be followed for procedures performed at the bedside. However, settings outside the OT may not have the environmental controls in place to maintain a level of surgical asepsis expected for such a procedure and, therefore, the patient is at an increased risk of infection. The following are some controls that HCWs can implement in the ICU to reduce transmission of microorganisms during invasive bedside procedures:

- Only perform bedside procedures when necessary.
- Manage activity and traffic in the area to reduce airborne dust particles and bacteria.
    - Divert traffic in open units
    - Exclude visitors and unnecessary personnel
    - Postpone cleaning activities in the area
    - Postpone bed making, bed baths, and changing of linens
- Keep doors and windows closed during the procedure or use physical barriers, such as screens.
- Ensure that all staff in the patient zone are wearing appropriate PPE for the procedure (for example, the same PPE as in the OT for a surgical procedure or that is recommended for central venous catheter insertion).

- Abide by strict surgical asepsis as if in the OT.

## Multidrug-Resistant Organism Colonization and Infection

Globally, the proportion of HAIs in ICUs caused by MDROs is increasing and in some limited-resource settings, gram negative bacteria are almost always MDROs. The ICU is a known reservoir of MDROs and so ICU patients are at risk of contracting healthcare-associated MDRO infections during their ICU stay. By carefully following evidence-based IPC practices, HCWs can prevent transmission of MDROs among ICU patients. The following practices, in addition to strict and vigilant IPC practices described in this chapter, help prevent the transmission of MDROs in the ICU:

- Adhere to standard precautions, including hand hygiene, and follow contact precautions. (See Volume 1, Chapter 3: Standard and Transmission-Based Precautions.) The IPC team should make hand hygiene stations available at key places in the facility and support staff to comply with WHO's *5 Moments* of hand hygiene.
- Isolate and identify patients with MDROs by putting a sign outside the room or on the bed.
- Use contact precautions routinely for all patients infected with target MDROs and for patients who are colonized with MDROs. Use gloves and gowns for all patients infected with MDROs.
- Base the duration of contact precautions on the individual MDRO:
    - Continue contact precautions indefinitely in the case of an MDRO outbreak.
    - Discontinue contact precautions in non-outbreak situations when three or more surveillance cultures for the targeted MDRO are repeatedly negative over the course of a week, or two cultures when the patient has not received an antimicrobial agent for several weeks.
- Provide a single room for patients infected with MDROs. If single rooms are not available, cohort patients with the same MDROs in the same room or wards. If it is not possible to cohort patients in a separate room, place patients in rooms with patients who are at low risk for acquiring MDROs.
- Have dedicated non-critical items to use on individual patients who are colonized or infected with MDROs.
- Carry out environmental cleaning and disinfection in the patient care area focusing on frequently touched surfaces.
- Ensure that staff responsible for waste management wear recommended PPE to collect, transport, store, treat, and dispose of waste materials from patients infected with MDROs.
- Conduct routine chlorhexidine bathing of patients in the ICU for the prevention of infections from VRE, infections from central venous catheters, and SSIs related to ventilator use.

- Do not use mupirocin nasal ointment with antimicrobial prophylaxis on a routine basis for the prevention of MRSA colonization; it should only be used during the outbreaks of MRSA in the ICU.

### Screening ICU patients for MDROs

MDROs might be associated with either symptomatic illness (i.e., clinical disease or infection) or asymptomatic carriage (i.e., colonization).

- Collect samples from single or multiple body sites for microbiological cultures for surveillance purposes from ICU patients. The findings of the microbiological culture will help identify patients who require decolonization. Facilities may decide to carry out active surveillance by screening all or select patients. Collect samples based on your facility's guidelines for carrying out active surveillance. This decision is made by the leadership and the infection control department, and depends on factors that include the local significance of the organism and the resources available for sample processing, isolation of positive patients, and eradication protocols. If active screening is conducted, HCWs should:
    - Collect adequate samples on all target patients according to facility policy.
    - Place patients on contact precautions in a timely manner per the facility policy and remove only when "cleared" on return of the surveillance results.
    - Perform hand hygiene.
    - Abide by contact precautions.
    - Educate patients and visitors about hand hygiene, contact precautions, and preventing MDROs.

## Additional Information for Facility Leaders

### Strategies for Health Facilities to Support IPC in the ICU

Health facilities can use the following strategies to facilitate effective IPC in the ICU:

- Facility leaders actively and openly support and communicate IPC messages and the expectation that staff conduct care in ways that decrease the risk of HAI in ICUs.
- Perform a facility risk assessment to determine the priority activities for HAI prevention in ICUs, among other settings, and the IPC risks. In most facilities, and especially when resources are limited, expenditures on interventions to improve care must be prioritized. Although it depends on the situation at each facility, prevention of HAIs in ICUs should be one of the top priorities. This is based on ICUs typically having the highest level of device use in the facility, some of the highest risk patients, and therefore, the highest rates of HAI.
- Provide resources for infection control, using the various models available for structuring an IPC program.
- Assign ICU-based champions or link nurses to facilitate the spread of IPC practices, including prevention of HAIs.

- Provide resources for the ongoing education of patient and family attendants in infection control topics.
- Implement interventions to improve the appropriate use of antibiotics.

### Strategies for Health Facilities to Prevent HAIs in the ICU

- Provide written guidelines/policies for HCWs. These may include policies specific to IPC in the ICU and also those across the scope of ICU care, stating appropriate IPC aspects. Guidelines should be in the form of clear written policies available in the ICU and easily accessible to staff. They should be accompanied by staff training.
- Train HCWs on the insertion, care, and maintenance of invasive medical devices, prevention of MDROs, and other IPC aspects of ICU care. Training should occur in a systematic way using a competency-based methodology. Training should occur before caring for an ICU patient or before the first performance of a procedure, as applicable, as well as periodically, such as annually.
- Ensure that only trained, competent staff work in the ICU.
- Ensure that adequate staffing for the ICU census, with the ability to flex up when needed.
- If possible, limit ICU occupancy to a capacity and staffing for safe care.
- Monitor hand hygiene compliance in the ICU and implement a multimodal strategy for improving hand hygiene.
- Provide supplies necessary for IPC and locate them conveniently.
- Prioritize the use of IPC resources, such as gloves, PPE, invasive medical devices, and other supplies only to those patients meeting the indications.
- Provide resources for the collection of data on one or more outcome (HAI prevalence or incidence) and/or process measures (e.g., compliance with elements of a prevention bundle, compliance with hand hygiene). This may be done either as a baseline to guide interventions, periodically, or continually to monitor the burden of HAIs in ICUs.
- Report results of data collection to ICU-based staff who are caring for patients.

### Strategies for ICUs with Ongoing Issues

For areas with ongoing issues despite implementing the above IPC recommendations, consider the following:

- Conduct in-depth investigation of each HAI identified and use the data to focus interventions on root causes.
- Analyze the data to focus interventions on the root causes.
- Conduct routine review meetings to review compliance, competence, and availability of supplies, and ICU HAI rates.

- Develop/adapt/use procedures and tools/job aids to remind HCWs to perform the expected IPC practices.

## SUMMARY

Patients admitted to ICUs may have several conditions that increase the risk of infections. ICU patients are often old or very young, and have impaired immunity and poor nutritional status. In addition, patients in the ICU tend to have multiple invasive medical devices for monitoring and interventions which put them at higher risk of infection. Practices to reduce HAIs among ICU patients include: application of standard precautions and transmission-based precautions for specific patients with suspected or known infection; decreasing the use of invasive medical devices; and practicing the rational use of antibiotics. Moreover, HCWs can play significant role in preventing HAIs among ICU patients by following evidence-based IPC practices.

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# CHAPTER 3: CLINICAL LABORATORY SERVICES

**Key Topics**

- Laboratory-acquired infections
- Common routes of exposure to laboratory-acquired infections
- Laboratory biosafety
- Safe practices for all laboratories
- IPC practices for specific laboratory procedures

## BACKGROUND

The clinical laboratory is a unique area of the healthcare facility in which the types of biological materials handled, along with the practices, procedures, and equipment used, can place the HCW at risk of occupational infection if recommended precautions are not taken. Error, accident, or carelessness in the handling of specimens and pathogens is the cause of most laboratory acquired infections. Infections, such as brucellosis, TB, typhoid, hepatitis, streptococcal infections, and others are known to have been acquired from the laboratory.

Laboratory-acquired infections (LAIs) are healthcare-associated infections resulting from the performance of laboratory activities by staff regardless of how they occurred. Laboratory workers who handle blood or potentially infectious body fluids are at some risk of accidental injury or exposure. Most at risk among them, however, are the staff working in clinical laboratories or research units isolating or handling pathogenic microorganisms (e.g., vaccine development).

Before the emergence of HIV/AIDS and the re-emergence of multi-drug resistant TB in the 1990s, little progress was made in reducing LAIs. In the United States, for example, the annual incidence of such infections was about 3 per 1,000 laboratory workers (Grist, Emslie 1991). Lately, however, interest in biosafety efforts were renewed, and also gave way to an increasing compliance among HCWs. In contrast, the situation is quite different in developing countries. For example, a recent research reports indicated that among 44 clinical laboratories in Karachi, Pakistan, only two (4.5%) laboratories used gloves and only seven (16%) used disinfectants. Moreover, only seven laboratories (16%) had access to an incinerator (Mujeeb, Adil, Altaf, et al. 2003).

For clinical and research laboratories with microbiological capacity, specific types of IPC practices and laboratory techniques are required, including appropriate containment equipment, facilities, and procedures used by the laboratory staff for specific microorganisms, depending on the biosafety risk level. Biosafety guidelines are designed to prevent LAIs and to contain hazardous agents. An understanding of the levels of biosafety helps laboratory staff understand the occupational risks, safe work practices, laboratory design, the use of PPE, and appropriate waste management.

### Laboratory-Acquired Infections

LAI is an infection obtained through laboratory or laboratory-related activities as a result of work with infectious biological agents. LAIs due to a wide variety of bacteria, viruses, fungi, and parasites

have been described. Although the precise risk of infection after an exposure remains poorly defined, surveys of LAIs suggest that Brucella species, Shigella species, Salmonella species, Mycobacterium tuberculosis, and Neisseria meningitidis are the most common causes. Infections due to the bloodborne pathogens (HBV, HCV, and HIV) remain the most common reported viral infections, whereas the dimorphic fungi are responsible for the greatest number of fungal infections that could occur in laboratories.

## Routes of Exposure That Can Result in LAIs

LAIs result from occupational exposure to infectious agents. Infections acquired from pathogenic organisms in the laboratory setting occur by several types of exposure. The following are the most common routs of exposure:

**Inhalation:** Mixing, grinding, or blending an infectious agent or flaming a transfer loop can generate aerosols (airborne droplets) possibly inhaled by unprotected workers. Pathogens can be inhaled when snap-closing specimen containers, dispensing or pipetting infectious fluids, or centrifuging infectious material in open buckets. Infectious aerosols can also be formed and inhaled following breakages or spillover of infectious fluids. Breakages in centrifuges can be particularly hazardous if the centrifuge is opened before the aerosols have settled.

**Ingestion:** Workers can be exposed through:

- Unconscious hand-to-mouth contacts
- Placing contaminated articles (pencils) or fingers (when biting fingernails) in the mouth
- Eating, drinking, or smoking in the laboratory or failing to use proper hand hygiene (neglecting to wash hands or to use a waterless, alcohol-based antiseptic hand rub before and after eating)
- Mouth pipetting (13% of accidental LAIs are associated with this practice)

**Puncture wounds:** Accidental injury with sharps (scalpel blades and contaminated broken glassware), or needles (suture needles and pricking needles) are the leading causes of LAIs. A puncture wound does not usually result in excessive bleeding; the wound created also closes quickly on its own.

**Contamination of skin and mucous membranes:** Splashes and sprays of contaminated fluids onto mucous membranes of the mouth; nasal cavity and conjunctivae of the eyes; and hand-to-face actions can lead to the transmission of pathogenic organisms.

**Infected laboratory animals:** These are potential sources of biohazards. They transmit infection by making cuts and scratches or by producing infective aerosols during laboratory experiments.

### Factors Contributing to Laboratory Accidents

Several factors contribute to various laboratory accidents. Some of these factors are intrinsic (i.e., associated with the individual practitioner) and the majorities are extrinsic factors.

These factors include:

- Poor training

- Lack of concentration
- Carelessness and negligence
- Overwork and fatigue-emergency conditions
- Untidy and noisy working environment

## Laboratory Biosafety

WHO describes this is as containment principles, technologies, and practices implemented to prevent unintentional exposure to pathogens and toxins, or their accidental release (WHO 2004).

The term "containment" is used in describing safe methods, facilities, and equipment for managing infectious materials in the laboratory environment where they are being handled or maintained.

**Biosafety level (BSL) guidelines** are a combination of primary and secondary containment and safety guidelines designed for use in microbiology laboratories and bacteriology research units functioning at four levels (BSL-1 to BSL-4) of increasing risk:

- **BSL-1** is the lowest level of containment and microbiologic safety guidelines and is entirely based on standard laboratory practices. These guidelines are recommended for those working with microorganisms, such as *Bacillus subtilis,* that are not known to cause infections in healthy adults.
- **BSL-2** is generally applied in bacteriology laboratories working with agents (e.g., Salmonella species) associated with human diseases of varying severity. When standard microbiologic practices are applied, the agents may be handled on open benches, especially if primary barriers, such as facemasks, gowns, and examination gloves, are used when appropriate. The use of biosafety cabinets (BSCs) and safety centrifuges may be necessary.
- **BSL-3** is aimed at containing hazardous microorganisms primarily transmitted by airborne route (aerosols and droplets), such as TB or varicella (chicken pox). Laboratory staff working in these situations must be trained on the use of appropriate equipment, including suitable ventilation systems and the use of BSCs.
- **BSL-4** is designed for use where agents causing life-threatening or untreatable diseases are present, such as hemorrhagic fever viruses (e.g., Ebola Virus Disease [EVD]), which potentially affect the laboratory staff via the airborne route. Trained workers using level III BSCs or wearing full-body, air-supported positive pressure suits must perform all procedures in these laboratories. Moreover, the facility itself must be totally isolated from other laboratories and have specialized ventilation and waste management systems.

## Safe Work Practices and Recommended Infection Prevention Practices for Laboratory Workers

Laboratory workers in hospitals and clinics handling blood products, potentially contaminated body fluids, or specimens containing pathogenic microorganisms, need to be aware of the potential hazards

of these infectious agents and materials. They need to know how to protect themselves, fellow workers, and the environment, in general.

Most hospital or clinic laboratories are defined as BSL-1 or BSL-2 units. Prevention of occupationally-acquired infections in these laboratories consists of staff conscientiously using the basic practices prescribed for all HCWs, namely, hand hygiene (handwashing or the use of an antiseptic hand rub). Similar to the other healthcare staff, lab workers are to practice them before and after eating or contact with infectious materials, and the use of protective gloves, facemasks, and gowns. Due to the fact that the infectious agents lab workers may encounter are classified as low or moderate risk, special containment practices are not required (i.e., these agents are not a significant risk to the environment and can be disposed of as any other infectious hospital waste).

For the staff working in bacteriology laboratories or microbiologic research units (BSL-3 or BSL-4), containment of hazardous agents to protect the environment is an added requirement for the safe handling of these infectious agents. As described above, the requirements of BSCs and other PPE (e.g., full-body, air-supported positive pressure suits) largely depend on the type of organisms being handled. The staff must be fully trained in their use.

### Requirements for safe laboratory practice include:

- Appropriate laboratory design (superstructure, furniture, and space)
- Adequate light, water, sewage, ventilation, and electrical facilities
- Waste disposal facilities
- Appropriate storage of facilities
- Use of safety devices and bio-safety cabinets
- Restricted access to laboratories

### General Laboratory Safety Procedures

A few general laboratory practices can significantly decrease the chance of accidents in the research laboratory. Procedures to follow when working in any laboratory include:

- Wear new examination gloves when handling blood, body fluids, and/or specimens containing pathogenic microorganisms.
- No eating, drinking, or smoking is permitted in the laboratory.
- Food should not be stored in refrigerators used for clinical or research specimens.
- No mouth pipetting is permitted; use proper mechanical devices instead (e.g., suction bulbs).
- Do not open centrifuges while still in motion.
- Always cover the end of blood collection tubes with a cloth or paper towel or point them away from anyone’s face when opening.

- Decontaminate work surfaces daily or when contaminated (e.g., after spills, with a 0.5% chlorine solution).
- Wear protective face shields or masks and goggles if splashes and sprays of blood, body fluids, or fluids containing infectious agents are possible.
- Wear heavy-duty or utility gloves when cleaning laboratory glassware.
- Use puncture-resistant and leak-proof containers for sharps.
- Place infectious waste materials in plastic bags or containers.
- Immunization against highly infectious agents, such as HBV

## Infection Prevention and Control for Specific Laboratory Procedures

### Phlebotomy/Blood Draw

Drawing blood from veins of patients (phlebotomy) is often performed by laboratory staff. Staff drawing blood should follow best practices and local IPC policies and protocols to protect the HCWs from exposure to bloodborne pathogens (e.g., HBV, HCV, HIV, and hemorrhagic fever viruses) and the patients from the risk of HAIs. HCWs performing phlebotomy should be trained and competent in performing the procedure.

Appropriate supplies for IPC during a blood draw include:

- Required supply of laboratory sample tubes for the tests requested:
    - Store dry and upright in a rack.
    - Ensure that the rack containing the sample tubes is close to the HCW, but away from the patient, to avoid its being accidentally tipped over.
    - Collect blood in vacuum-extraction blood tubes (preferred), sterile glass or plastic tubes with rubber caps, or glass tubes with screw caps (least preferred).
- A sterile glass or bleeding pack (collapsible) if large quantities of blood are to be collected.
- *Well-fitting*, non-sterile disposable gloves; (NEVER use the same pair of gloves on more than one patient).
- Blood-sampling devices of various sizes, preferably a vacuum-tube holder with needle that will allow filling of multiple sample tubes without withdrawing the needle or other safety-engineered devices or needles:
    - Use new, single-use, disposable equipment (syringes, needles, and lancets for every patient).
    - Do not use auto-disable syringes (a disposable syringe with a fixed needle that automatically is disabled after a single use) for phlebotomies.
- A new or cleaned tourniquet
- ABHR

- 70% alcohol swabs for skin disinfection:
    - Do not presoak and store swabs due to risk of contamination.
- Gauze or cotton-wool ball to be applied over the puncture site
- Laboratory specimen labels
- Writing equipment
- Laboratory forms
- Leak-proof transportation bags and containers
- A puncture-resistant sharps container:
    - Place the sharps container close by and in a location where no reaching will be necessary to place the sharp in the container.
    - Do not overfill containers; empty when three-quarters full.

## Safe Handling of Specimens

- Improper collection, transport, and handling of specimens present a risk of infection to HCWs and laboratory staff.

## Specimen Containers and Labels

- Use robust plastic (preferred) or glass containers that do not leak when the cap or stopper is correctly applied to collect specimens.
- Use disposable specimen containers when possible.
- Clean material from the outside of the container before transporting the specimen.
- Label containers correctly and clearly so that they can be easily identified.
- Place specimen requests or specification forms in separate, preferably waterproof, envelopes to protect them from contamination.

## Transporting Specimens Within the Healthcare Facility

- Collect all laboratory specimens using standard precautions, including wearing gloves when touching the specimens and performing hand hygiene afterward.
- Use carrying containers, such as boxes or baskets fitted with racks to transport specimens.
- Specimen containers should remain upright to avoid accidental leakage or spillage.
- Carrying containers should be made of material that is easily cleaned (metal or plastic) and autoclavable or resistant to the action of chemical disinfectants.
- Regularly decontaminate transport containers.

## Receipt of Specimens

- Designate a specific room or area for receiving specimens if the laboratory receives a large number.
- Specimen bags should not be opened by reception staff.
- Staff who receive and unpack specimens should be aware of the potential hazards involved, and should be trained to follow standard precautions.
- Have suitable disinfectants for spill cleanup available for use when needed.
- Opening specimen tubes and sampling contents:
    - Primary specimen containers should be opened in a BSC, if available, or cover the end of blood collection tubes with a cap, cloth, or paper towel, and point them away from a person's face when opening.
    - Wear gloves, eye, and mucous membrane protection (goggles or face shield), and a plastic apron over protective clothing.
    - Grasp the stopper through a piece of paper or gauze to prevent splashing.
    - Handle fixed and stained blood, sputum, and fecal samples for microscopy as potentially infectious; use forceps, store them appropriately, and decontaminate and/or autoclave them before disposal.
    - The fixing process does not necessarily kill all organisms or viruses on the smears.
    - Always open ampoules of freeze-dried (lyophilized) infectious materials in a BSC because the contents may be under reduced pressure and the sudden inrush of air may aerosolize some of the contents:

        1. Decontaminate the outer surface of the ampoule.
        2. Make a file mark on the tube near to the middle of the cotton or cellulose plug, if present.
        3. Hold the ampoule in alcohol-soaked cotton to protect hands when breaking it at the file scratch.
        4. Remove the top gently and treat as contaminated material.
        5. If the plug is still above the contents of the ampoule, remove it with sterile forceps.
        6. Add liquid for resuspension slowly to the ampoule to avoid frothing.
- If freezing, store ampoules of infectious materials only in mechanical deep-freeze cabinets, on dry ice, or in the gaseous phase above the liquid nitrogen. Avoid immersing in liquid nitrogen because cracked or imperfectly sealed ampoules may break or explode on removal.

## Safe Laboratory Bench Workspace

- Keep the area neat, clean, and free of materials that are not pertinent to the work.
- Fit open windows with insect-proof screens.
- Decontaminate work surfaces promptly after any spill of potentially infectious material and at the end of the workday.

- Decontaminate materials, specimens, and cultures before disposal or cleaning for reuse.
- Follow applicable national and/or international regulations for packing and transportation of samples.
- Decontaminate before sending contaminated equipment for servicing or repair.

## Use of Pipettes and Pipetting Aids

- Always use a pipetting aid. Pipetting by mouth is prohibited.
- Use mark-to-mark pipettes when possible because they do not require expulsion of the last drop.
- Use cotton plugs in all pipettes to reduce contamination of pipetting devices.
- Prevent hazards, dispersal, and aerosolization.
- Avoid blowing air through liquid-containing infectious agents.
- Avoid mixing infectious materials by alternating suction and expulsion through a pipette.
- Avoid forcibly expelling liquids from pipettes.
- Use an absorbent material on the work surface to absorb material dropped from a pipette; this material should be disposed of as infectious waste after use.
- Use devices for opening septum-capped bottles that allow pipettes; syringes fitted with hypodermic needles must not be used for pipetting.
- Place the discarded container for pipettes in the BSC when available (not outside it).
- To decontaminate contaminated pipettes, completely submerge them in a suitable disinfectant placed in an unbreakable container and leave the pipettes in the disinfectant for the recommended length of time before disposal or washing and sterilization for reuse.

## Separation of Serum

- Only properly trained staff should separate serum.
- Wear recommended PPE: gloves and eye and mucous membrane protection.
- Minimize splashes and aerosols by using practice.
    - Blood and serum should be pipetted carefully, not poured.
    - Refer to guidance on pipette use in the Use of Pipettes and Pipetting Aids section in this chapter.
- Place discarded single-use specimen tubes containing blood clots, etc. (with caps replaced) in suitable leak-proof containers for autoclaving and/or incineration.
- Ensure that suitable disinfectants for cleanup of splashes and spillages are available when needed.

### Use of Centrifuges

Satisfactory mechanical performance is a prerequisite of microbiological safety in the use of laboratory centrifuges.

- Operate centrifuges according to the manufacturer's instructions.
- Place centrifuges so that laboratory staff can see into the bowl to place trunnions and buckets correctly.
- Use centrifuge tubes and specimen containers made of plastic (preferred) or thick-walled glass for use in the centrifuge. Inspect for defects before each use.
- Securely cap (screw capped preferred) tubes and specimen containers for centrifugation.
- Use BSCs for loading, equilibrating, sealing, and opening centrifuge buckets.
- Paired by weight and, with tubes in place, correctly balance buckets and trunnions.
- Follow the manufacturer's instructions for the amount of space that should be left between the level of the fluid and the rim of the centrifuge tube.
- Use distilled water or alcohol (propanol, 70%) for balancing empty buckets; saline or hypochlorite solutions should not be used because they corrode metals.
- Only use sealable centrifuge buckets (safety cups) for microorganisms in Risk Groups 3 and 4.
- Take care to ensure that the tube is not overloaded when using angle-head centrifuge rotors, to prevent leaks.
- Inspect daily the interior of the centrifuge bowl for staining or soiling at the level of the rotor. If staining or soiling are evident then the centrifugation protocols should be re-evaluated.
- Inspect daily centrifuge rotors and buckets for signs of corrosion and for hair-line cracks.
- Decontaminate buckets, rotors, and centrifuge bowls after each use and store in an inverted position to drain the balancing fluid.

## SUMMARY

The clinical laboratory is a unique area of the healthcare facility in which the types of biological materials handled, along with the practices, procedures, and equipment used, can place the HCW at risk of occupational infection if recommended precautions are not taken. The strict use of safe work practices and IPC recommendations in laboratories protects staff from LAIs. Biosafety guidelines are designed to guide the prevention of LAIs and to contain biohazardous agents. Laboratory staff should understand occupational risks, safe work practices, laboratory design, use of appropriate PPE, and waste management. Laboratory staff also need appropriate supplies and equipment to work safely.

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# CHAPTER 4: INFECTION PREVENTION AND CONTROL IN BLOOD BANK AND TRANSFUSION SERVICES

### Key Topics

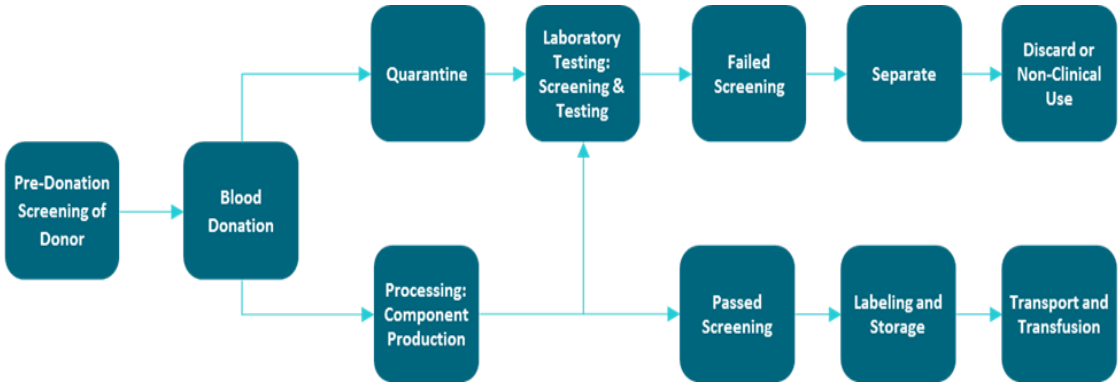
- Risks of blood transfusion service to donors, HCWs, and blood transfusion recipients
- Preventing infection in donors, HCWs, and blood transfusion recipients
- Components of safe blood bank services, from donation to transfusion
- Activities at the blood bank and transfusion services, and infection prevention and patient safety practices

## BACKGROUND

Transfusing patients with blood and blood components has been used as a treatment for more than 200 years. When blood transfusions occur safely, they can save lives and are an important medical treatment. However, overuse or inappropriate management can lead to acute or delayed complications and transmission of infectious diseases. It is estimated that 108 million units of donated blood are collected globally each year (WHO 2022).

The responsibility for safety at blood donor sessions and in the laboratory rests with everyone who works there even if a specific person is assigned overall responsibility for ensuring safety. It is the duty of every member of staff to carryout procedures in a responsible way to avoid endangering the safety of themselves or anyone else (WHO 2009). The steps from donation to transfusion of blood are illustrated in figure 4.4-1.

Figure 4.4-1. The steps from donation to transfusion of blood




## Protecting Donors, HCWs, and Recipients

### Protecting Donors

Risk to the donors can be reduced by following best practices for IPC to prevent infection at the blood collection site and exposure to bloodborne pathogens.

HCWs should follow standard precautions during each donor contact and procedure, including:

- Performing hand hygiene before and after each donor contact or procedure according to WHO's *5 Moments for Hand Hygiene*. (See Volume 1, Chapter 4: Hand Hygiene.)
- Wearing a new pair of non-sterile gloves for each procedure or patient
- Wearing other PPE, including face shield and gown, as indicated
- Preparing the skin at the blood collection site using an appropriate antiseptic
- Using a sterile, single-use blood-collection device
- Using aseptic techniques
- Following safe injection and sharps safety practices
- Disinfecting work surfaces after every donor procedure
- Cleaning and disinfecting tourniquets and other equipment
- Appropriately disposing of waste materials

## Protecting HCWs

Any staff working in blood banks and transfusion services are at risk of exposure to pathogens in blood in several ways, including while collecting the donor specimen, during testing, when infusing blood/blood components, and when disposing wastes of blood collection and transfusion materials.

As part of IPC best practices, laboratory staff and HCWs can reduce their risk of accidental exposure to bloodborne pathogens by practicing the following measures while collecting donor blood and during testing, processing, transporting, and transfusing blood/blood components:

- Following standard precautions
- Performing hand hygiene before and after each patient contact or procedure
- Wearing a new pair of non-sterile gloves for each procedure or patient
- Conducting a risk assessment and wearing additional PPE accordingly
- Using safety devices when available (closed collection systems, safety needles, etc.)
- Practicing sharps safety
- Disinfecting work surfaces and cleaning up spills of blood and body fluids with 1% chlorine solution or other disinfectants. (See Volume 1, Chapter 9: Environmental Cleaning.)
- Following protocols for exposure to body fluids and reporting incidents
- Transporting blood in a safe manner in labeled washable containers
- Disposing of waste as recommended

## Protecting Transfusion Recipients

Risk to the transfusion recipient can be reduced by following best practices in IPC to prevent infection of the blood components and infection acquired from intravascular devices.

**At the time of donation:**

- Encourage the use of voluntary, unpaid donors
- Screen donors for risk factors for infectious diseases
- Adhere strictly to the inclusion and exclusion criteria for donors
- Perform hand hygiene before and after each donor or procedure
- Wear a new pair of non-sterile gloves for each donor or procedure
- Perform appropriate skin cleansing of the donor site
- Use closed-system, sterile, single-use blood-collection devices and follow other injection safety guidelines
- Use aseptic techniques
- Disinfect work surfaces and patient care equipment

**After the blood is collected:**

- Transport the blood in clean containers with the recommended cold chain
- Test the blood unit without entering the closed collection system
- Screen the blood for recommended infectious diseases
- Quarantine the blood until screening results have returned
- Exclude blood that is positive for infectious disease markers
- Document the progress of blood throughout the process
- Maintain appropriate temperature-controlled storage conditions
- Transfuse or discard the blood unit within the recommended period

**When transfusing blood and blood products:**

- Follow standard precautions
- Wear a new pair of non-sterile gloves for each patient contact
- Perform hand hygiene before and after each patient contact
- Use aseptic techniques
- Insert and maintain IV devices as recommended

- Use sterile single-use equipment
- Practice injection safety
- Perform recommended checks before and monitor during transfusion
- Start and complete the transfusion within the recommended time period
- Stop the transfusion immediately if an adverse reaction occurs
- Document and collect samples for transfusion reactions

## Steps for Blood Bank and Transfusion Services

There are eight steps, starting from screening to transfusion of blood or blood products:

1. Screening and informing blood donors and obtaining their consent
2. Collecting blood from screened donors
3. Quarantining blood and blood components
4. Performing screening tests for infectious diseases on blood components
5. Releasing blood and blood components from quarantine
6. Storing and transporting donated blood
7. Testing and cross-matching recipients' blood before transfusion
8. Transfusing blood and blood components

## Screening and Informing Blood Donors and Obtaining Their Consent

Effective blood transfusion begins with the collection of safe blood from healthy blood donors. In Ethiopia, 60% to 65% of blood donors are family members and/or replacement donors (Ethiopia Red Cross Society 2008 data). These donors have been identified and reported as unsafe because they carry a very high risk of transfusion transmitted infections (TTIs). Therefore, it is advisable that each blood bank or transfusion service have a pool of regular and non-remunerated donors for safer blood.

- Obtain a complete medical history and conduct a physical examination of each donor. (This should include any medical problems, behaviors, or events that put a person at risk of being infected or transmitting a serious disease to the person receiving the transfusion.)
- Before blood collection, the elements of the donation process should be explained to the potential donor in simple and easy to understand language.
- Explain the risks of venipuncture and the potential adverse responses to drawing 400 to 500 ml. of blood.
- Explain the laboratory tests that will be performed and how exactly the donor will be informed about the test results, including any medical abnormalities.

- Perform routine laboratory tests, including hemoglobin or hematocrit and screening for HIV, HBV, HCV, syphilis, and malaria.
- Complete a written informed consent form that should be filled for each donor.

## Collecting Blood from Screened Donors

1. Make sure that the following items are available:
    - Blood collection set consisting of sterile plastic bag containing a sufficient amount of anticoagulant for the quantity of blood to be collected
    - IV tubing and large gauge hypodermic needles
    - Pair of sterile or high-level disinfected (HLD) surgical gloves
    - Clean tourniquet or blood pressure cuff
    - Antiseptic solution and sterile or clean gauze squares or cotton swabs
    - Surgical tape
    - Towel to place under the patient's hand or forearm
    - Basin of clean warm water
    - Soap
    - Clean dry towel to wash patient's arm if visibly soiled
    - Plastic bag or leak-proof covered waste container for disposal of contaminated items
    - Puncture-resistant sharps container
2. Explain the procedure to the donor.
3. Identify the best vein for inserting the IV needle (a prominent large and firm vein).
4. Put the tourniquet or blood pressure cuff on the upper arm about 9 cm above the antecubital space to confirm that the vein is visible and then release the tourniquet or cuff.
5. If the venipuncture site is visibly soiled, first wash it with soap and clean water, and dry with a clean cloth, or ask the donor to wash the forearm.
6. Wash hands and dry them with a new paper towel or air dry (alternatively use alcohol hand rub 5 ml and rub both hands vigorously until dry).
7. Place the donor's arm on a clean towel and cleanse an area about 3 cm in diameter with an antiseptic solution. Use a circular motion outward from the proposed needle insertion site over the vein. (If using povidone iodine or other iodophors, allow two minutes for the antiseptic to take full effect).
8. Do not touch the area after applying the antiseptic solution.

9. Put the tourniquet or blood pressure cuff on the upper arm again; raise the pressure up to 40 to 60 mm of mercury while collecting the blood.
10. Put sterile or HLD surgical gloves on both hands.
11. Insert the hypodermic needle into the vein without touching the skin, if possible; release the tourniquet or cuff and then secure the needle by placing a short piece of tape across the blood collection tubing below the area cleansed with antiseptic.
12. When the required amount of blood has been obtained, remove the needle without touching the barrel or tip of the needle and place it in a puncture-resistant sharps container.
13. Cover the insertion site with 2 x 2 cm gauze square; apply pressure until bleeding stops and secure the gauze square using 1 or 2 pieces of surgical tape.
14. Before removing gloves, place any blood-contaminated waste items in a plastic bag or leak- proof and covered waste container.
15. Wash hands or use an antiseptic hand rub, as above.
16. Let the donor remain resting on a bed or in the donor chair for several minutes.
17. Provide the donor with something to drink and eat.
18. Tell the donor to drink more fluids during the next 24 hours and avoid alcohol or smoking until more food has been eaten. Ask the donor to lie down if there is dizziness or a nauseating sensation.

### To Avoid Contamination of Collected Blood:

- Maintain appropriate storage conditions (stored at 1 to 6$^{o}$C and monitor the temperature every four hours).
- Test the blood unit without entering the closed collection system.
- Infuse or discard the blood unit within a short period once the closed system has been opened.

## Quarantining Blood and Blood Components

Blood components should be held in quarantine until screening test results are available and not be released for transfusion unless the results of all screening tests are negative.

### Managing Quarantine

- Store unscreened blood in a storage refrigerator in a separate room from that for screened blood.
- Document the location of each unit of blood and its eventual fate as it moves through the system.

Before placing unscreened blood in quarantine, cross-check labeling of the blood unit and the samples taken for screening tests so that blood components from that unit can later be matched with the screening test results.

- Designate a person(s) with authority to accept and release blood products from quarantine.
- Keep the quarantine storage refrigerator locked to prevent accidental release.
- For each access to the quarantine storage, log the person, date, and time of access and what was added or taken.

## Performing Screening Tests for Infectious Diseases on Blood Components

In addition to ABO blood group and Rhesus factor type, laboratory staff should always adhere to the national screening strategy when conducting screening tests on blood. WHO (2009) recommends that all blood be tested for at least the following:

- HIV-1 and HIV-2—screening for a combination of HIV antigen-antibody or HIV antibodies (as per WHO recommendation using latest generation of testing)
- Hepatitis B—screening for hepatitis B surface antigen (HBsAg)
- Hepatitis C—screening should be performed using an HCV antibody immunoassay or a combination HCV antigen-antibody immunoassay
- Syphilis (*Treponema pallidum*)—screening using specific assays, such as *T. pallidum* hemagglutination assays (TPHA) and enzyme immunoassay (EIA) for treponema antibodies

**Other Screening:**

Malaria: Screening is done with direct detection of parasite by thick film or antigen assays, which detect a lower level of parasites.

**Note: When evaluating the inclusion of additional diseases, include only if:**

- There is a proven risk of transmission of infection to recipients
- The transmission carries a significant disease risk
- An appropriate screening assay is available

## Releasing Blood and Blood Components from Quarantine

When blood is determined to be negative for all screening tests, it can be released from quarantine for clinical use.

- Perform cross-checks to identify the unit against the test results
- Inspect the blood component before release for signs of contamination and infection
- Inspect for hemolysis
- Check for change of color (e.g., darker or purple/black)

- Check for clots
- Inspect for any leak/air inside the bag
- Label released blood component as "ready for clinical use" according to the facility procedures.

Once the blood is released from quarantine, the label should contain relevant details, such as:

- Temperature of storage
- Date blood was collected
- Expiry date of the component prepared
- Blood group (ABO + Rh(D)) of the blood component
- Donation or pack number
- Name and volume of the anticoagulant solution

### Blood Storage and Short Distance Transport

- Blood units must be stored in a refrigerator at a temperature ranging from 1 to 6$^{o}$C.
- There must be a system to monitor temperatures continuously and record them at least every 4 hours.

### Steps of Discarding Blood Exposed to Higher Temperature:

- Wear examination or utility gloves and protective eyewear.
- Pour content down a utility sink or drain into a flushable toilet or latrine.
- Place empty blood bags and tubing in a leak-proof container.
- Burn or bury them for disposal.

### Testing and Cross-Matching Recipients' Blood Before Transfusion

The purpose of pre-transfusion testing is to select blood/blood components that will not cause harm to the recipient and to ensure that the red cells will survive (not be destroyed too rapidly) when transfused. When performed properly, pre-transfusion tests will confirm the ABO group of the red cells, Rh blood type, the presence of clinically significant red cell antibodies in the recipient's blood, and compatibility between selected samples of donor blood with the recipient's blood (cross-matching).

## Transfusion of Blood or Blood Components

Indications for blood transfusion are:

- Actively bleeding patients

- Patients with chronic or symptomatic anemia

The generally accepted hemoglobin level for transfusing patients with acute blood loss is 7 gm%; those patients having a level of 6 gm% almost always require transfusion, but those with a level of ≥10 gm% rarely need it.

Before starting the transfusion:

- Explain the procedure to the patient if he/she is conscious.
- Correctly identify the blood product and the patient: confirm patient's name, check compatibility information attached to the blood bag and expiry date, check the ABO and Rhesus factor status of the patient on the patient chart, double check blood or type of blood product with the physician's order and check blood for clots.
- Record baseline pulse and blood pressure.

## SUMMARY

When blood transfusions occur safely, they can save lives and are an important medical treatment. The responsibility for safety at blood donor sessions and in the laboratory rests with everyone who works there even if a specific person is assigned overall responsibility for ensuring safety. Any staff working in blood banks and transfusion services are at risk of exposure to pathogens in blood. Laboratory staff and HCWs can reduce their risk of accidental exposure to bloodborne pathogens by practicing standard precaution and transmission precaution measures while collecting donor blood and during testing, processing, transporting, and transfusing blood/blood components.

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# CHAPTER 5: PREVENTING MATERNAL AND NEWBORN INFECTIONS IN HEALTHCARE SETTINGS

**Key Topics**

- Epidemiology of maternal, fetal, and newborn infections
- Prevention of maternal and newborn infections during labor, delivery, and the postpartum period
- Prevention of infections in newborns requiring specialized care
- Management of outbreaks in the nursery or NICU

## BACKGROUND

Maternal and newborn care is unique and complex. It requires the simultaneous care of two interdependent patients over time, in the same or separate settings, often by different groups of HCWs. Management ranges from supporting a healthy woman and newborn during birth in a healthcare facility, to caring for of a high-risk woman in an operative setting and a newborn in a NICU. The outcomes for the mother and her newborn are dependent on one another and are determined by a group of factors, such as the mother's state of health, infection risk factors, and the care of the mother and the newborn from preconception to and after the birth. For these reasons, the woman and newborn should be considered as one in the management of their care.

Unfortunately, evidence-based preventive care is not always available to women and infants in resource-limited settings where poor nourishment, limited antenatal care, anemia, and the resurgence of TB, especially drug-resistant strains, further complicate pregnancy outcomes, leaving mother and infant vulnerable to infection. Preventative care, such as maternal screening and vaccination during pregnancy, treatment of infection, clean birth practices, and appropriate postnatal care for infants, are some of many interventions that prevent infections.

In many countries in sub-Saharan Africa, South Asia, and Southeast Asia, more than three-quarters (74.7%–89.9%) of women in the lowest two wealth quintiles give birth at home (Montagu, Yamey, Visconti, et al. 2011). However, in some areas, this is beginning to change as more mothers are choosing to give birth in healthcare facilities. This trend increases the importance of IPC in healthcare facilities, where there are many potential sources of infection transmission, including contaminated equipment and surfaces, other mothers and newborns, HCWs, and visitors. Consequently, pregnant women and their newborn babies in low-resource settings are at a much higher risk for infections following childbirth than their counterparts in high-income countries. Use of recommended IPC practices during the perinatal period can significantly reduce maternal and newborn infections (Garces, McClure, Chomba, et al. 2012).

## Epidemiology

### Maternal Infections

Maternal infections can be symptomatic (postpartum endometriosis) or asymptomatic (e.g., group B streptococcus [GBS]); primary (e.g., bacterial) or secondary (e.g., yeast); chronic (e.g., syphilis) or

recurrent (e.g., herpes simplex virus [HSV]); from intrinsic or extrinsic sources (e.g., MRSA); or acquired before or during pregnancy or after the birth. In addition, the mother's genitourinary tract is normally colonized with various nonpathogenic, opportunistic and/or infectious organisms, some of which may be MDROs.

As many as 5.2 million cases of maternal sepsis, resulting in 62,000 maternal deaths, are thought to occur annually (Hussein, Mavalankar, Sharma, et al. 2011). Infection of the surgical site and uterus following a C-section, UTIs, puerperal sepsis, amniotic fluid infections during pregnancy, and septic pelvic thrombophlebitis, are responsible for the highest rates of infectious morbidity during pregnancy and following childbirth. Puerperal sepsis is now rare in high-income countries but causes about 11% of maternal deaths in resource-limited settings (Tietjen, Bossemeyer, McIntosh 2003).

Intra-amniotic infection (IAI) occurs in fewer than 5% of term pregnancies but up to 25% in preterm births. Common pathogens associated with IAI are normal vaginal flora, such as Gardnerella vaginalis; group A, B, and D streptococci; and Escherichia coli. Risk factors for IAI are prolonged rupture of membranes (the most common), prolonged labor, number of vaginal examinations (more than three) during labor, and internal monitoring (Fahey 2008; Mayhall 2011).

Endometritis risks increase with childbirth, including vaginal deliveries and C-sections, especially C-sections after prolonged rupture of membranes. Endometritis can progress into abscess formation, sepsis, and in some cases septic pelvic thrombophlebitis (Chen, Sexton, Bloom 2013).

In resource-limited settings, postpartum infection remains second only to postpartum hemorrhage as the leading cause of maternal mortality and is the leading cause of serious maternal complications of childbirth. The lifetime risk of maternal death in high-income countries is 1 death per 3,300 pregnancies; however, in low-income countries, that risk can be as great as 1 death per 41 pregnancies, with infection being one of the leading causes of these deaths (WHO 2015b). Colonization and infection of the mother affect the well-being of the fetus or newborn.

## Fetal and Newborn Infections

Maternal infections before or during childbirth are associated with an estimated one million newborn deaths annually (WHO 2015b). Infection accounts for 36% of newborn deaths, ranking it as one of the three major causes of newborn deaths worldwide (along with preterm birth and birth asphyxia). This number includes sepsis (6%), pneumonia (4%), tetanus (1%), and diarrhea (1%) (UNICEF, WHO 2015). Infections in newborns also include congenital syphilis and mother-to-child transmission of HIV.

Infection in the newborn can be acquired in utero before birth from the mother (e.g., rubella, HIV, syphilis); during the period shortly before to shortly after birth (e.g., HSV, HIV, HBV, various bacterial infections); or from maternal, hospital, visitor, or other sources after delivery (e.g., influenza, bacterial infections of the skin, eyes, blood). In utero infections are referred to as congenital, intrauterine, or transplacental. Intrapartum infections occur during passage through the birth canal (table 4.5-1). It is important to differentiate the source of the infection to target appropriate IPC interventions. For the same purpose, the causes of sepsis in newborns are often divided into early- and late-onset sepsis.

Table 4.5-1. Sources and microorganisms causing infections in newborns

| Source | Microorganisms |
|---|---|
| Across the placenta | Treponema pallidum, cytomegalovirus, rubella, varicella (chicken pox), Toxoplasmosis gondii, HIV |
| Mother's birth canal | GBS, E. coli, Coagulase-negative staphylococcus, Listeria monocytogenes, HBV, HIV, HSV |
| Environment in the healthcare facility | Gram-negative organisms (e.g., Klebsiella pneumoniae) often multidrug resistant, opportunistic infections (e.g., coagulase-negative Staphylococcus spp.), Gram-positive organisms (e.g., MRSA), respiratory viruses, and GI infections (e.g., Staphylococcus spp). |

*Source:* Tietjen, Bossemeyer, McIntosh 2003

Most infants are delivered from a sterile environment inside the uterus. Colonization with normal flora and pathogens from the mother begins during labor and childbirth and continues into the newborn period, when infants are exposed to microorganisms from family members, HCWs, other infants in the nursery, and the surrounding environment.

The use of invasive devices, such as central venous catheters (such as umbilical catheters) and mechanical ventilation, which are used in special care settings, put infants at higher risk for infection, especially with gram-negative bacteria. Inappropriate management of the umbilical cord and newborn circumcision procedures can also expose newborns to infectious microbes.

Ensuring excellent compliance with hand hygiene (see Volume 1, Chapter 4: Hand Hygiene), appropriately following standard precautions and transmission-based precautions (see Volume 1, Chapter 3: Standard and Transmission-Based Precautions), meticulous environmental cleaning (see Volume 1, Chapter 9: Environmental Cleaning), careful disinfection and sterilization practices (see Volume 1, Chapter 7: Decontamination and Reprocessing of Medical Devices), and appropriate care of infants with invasive medical devices are key to preventing maternal and newborn infections during labor and childbirth.

## Risk Factors for Mothers and Newborns

Table 4.5-2 describes the complex factors that increase the risk of infection in mothers and newborns.

Table 4.5-2. Infection risk factors for mothers and newborns

| | Risk factors |
|---|---|
| MATERNAL FACTORS that increase the risk of infection in both the mother and newborn | • Immunosuppression (e.g., steroids, HIV)<br>• Uncontrolled diabetes<br>• Nutritional status, either a low or high (< 19 or > 30) body mass index<br>• American Society of Anesthesiologists score of > 3<br>• Low socioeconomic status<br>• Smoking (delays wound healing)<br>• Vaginal colonization/infections, which cause problems and infections in the mother (e.g., UTI, GBS, and bacterial vaginosis)<br>• Colonization and infections, which may cause infection in the newborn (e.g., GBS, HIV, HSV, syphilis, gonorrhea, chlamydia) |

| | Risk factors |
|---|---|
| LABOR-RELATED RISK FACTORS<br>that increase the risk of infection in both the mother and newborn | • Ruptured membranes (ROM) (may be the cause or consequence of infection)<br>• Preterm labor, which may be caused by IAI<br>• Premature ROM<br>• Prolonged ROM (usually considered longer than 24 hours)<br>• Prolonged labor<br>• Prolonged prenatal hospital stay<br>• Multiple vaginal examinations<br>• Use of internal monitoring<br>• Trauma to the birth canal (vaginal or perineal lacerations and urethral tears)<br>• Use of forceps or vacuum extractor for delivery<br>• C-section<br>• Manual placental removal |
| NEWBORN RISK FACTORS<br>that increase the risk of infection in the newborn | • Lower birth weight<br>• Younger gestational age<br>• Co-morbidities (e.g., congenital conditions) |
| CARE-RELATED RISK FACTORS<br>that increase the risk infection in the newborn | • Intensive care stay<br>• Presence of invasive medical devices<br>• Longer hospital stay<br>• Parenteral nutrition<br>• Antimicrobial therapy, which may lead to MDRO infection<br>• Overcrowding and understaffing<br>• Ward layout (sinks, bed spacing)<br>• Use of fetal scalp electrodes<br>• Contact with colonized/infected family, visitors, or HCWs<br>• Proximity of colonized neonates |

*Source:* Tietjen, Bossemeyer, McIntosh 2003

## Prevention of Maternal and Newborn Infections

Prevention of infections in mothers and neonates begins in the preconception period and continues throughout the perinatal period and includes:

- Health education of the mother and family
- Preconception and prenatal care (e.g., providing education; screening; infection prevention [IP], including vaccination; managing infections; addressing risk factors and behaviors)
- Appropriate interventions during labor and delivery, both at home and in the healthcare facility (e.g., perineal cleaning, aseptic technique during delivery or in the OT, safe medication practices, rational antibiotic use and prophylaxis only as indicated, limiting of invasive procedures and vaginal examinations, proper insertion and care of invasive medical devices)
- Postpartum care for the mother (e.g., regular perineal care, breast care, care of breast pumping equipment)

- Care of the newborn (e.g., hand hygiene; bathing; cord, skin, and eye care; appropriate handling of infant nutrition; restrict use of antibiotics to recommended indications; immunoprophylaxis antibodies and vaccination as per national guidelines)
- Prevention of postnatal transmission of infection from mother to newborn (e.g., education on hand hygiene, general hygiene, transmission-based precautions when appropriate)
- Screening of birthing support persons and visitors for signs and symptoms of infections (e.g., fever, respiratory viruses, draining skin lesions, diarrhea)

### Infection Prevention and Control Interventions During Pregnancy: Prenatal Care

Prenatal care is essentially caring for two inseparable, interdependent patients: the mother and the fetus. Undetected or poorly managed maternal infections can lead to sepsis, death, or disability for the mother and increased likelihood of early infection for the infant, with possible serious outcomes. Aspects of care relevant to IPC include:

- Identify and stabilize pre-existing diseases (such as malaria, diabetes, heart disease, parasitic infestations, HIV)
- Provide vaccinations:
    - Tetanus, if not previously vaccinated according to national recommendations
    - Influenza during any trimester, if available (not included in WHO 2015b recommendations)
- Assess and maximize nutrition including:
    - Daily iron, folic acid supplementation with 30 mg–60 mg of elemental iron and 400µg (0.4 mg) of folic acid for all pregnant women
    - Counseling on healthy diet and exercise, and weight loss or weight gain, as appropriate
    - Calcium and vitamin A and protein supplements, as indicated by national guidelines
- Assess for anemia, asymptomatic bacteriuria (treat with 7-day antibiotic regime), and gestational diabetes
- Assess for smoking and substance abuse; encourage and support cessation efforts
- Screen for GBS, HIV, syphilis, and TB in high-prevalence settings
- In endemic areas provide:
    - Preventive anti-helminthic treatment (in areas with greater than 20% prevalence of infection with any soil-transmitted helminths)
    - Intermittent preventive treatment with sulfadoxine-pyrimethamine for malaria in all pregnant women. Dosing should start in the second trimester, and doses should be given at least one month apart to ensure that at least three doses are received (relevant to malaria-endemic areas only).

**Not recommended:** Routine antibiotic prophylaxis during the second or third trimester with the aim of reducing infectious morbidity is NOT recommended.

- Education and counseling around pregnancy- and health-related risk factors and behaviors (WHO 2015b).

## IPC Interventions During Birth: Intrapartum Care

### Preventing Infection During Labor and Vaginal Delivery in a Healthcare Setting

Although vaginal delivery does not require the aseptic conditions of an OT, it does require the vigilant use of basic IPC practices during labor and delivery to prevent infections of the mother, infant, and HCWs.

The importance of healthcare environment cleanliness and effectiveness of basic IPC practices in preventing infection during childbirth is well-established. The nature and complexity of the birth process provide many opportunities for infection to be introduced to the mother, newborn, and HCWs: a large amount of blood and body fluids; frequent contact with mucous membranes by HCWs; many pieces of equipment that must be cleaned, disinfected, and sterilized; potentially invasive devices and procedures; and the care of two interdependent patients at the same time. The following are recommendations for the prevention and treatment of intrapartum infections (WHO 2015b).

### Minimizing HCWs' Risk of Infection

HCWs should protect themselves against the risk of exposure to HIV and other bloodborne diseases during labor, delivery, and care of the infant by consistently and correctly complying with recommended IPC practices, including standard precautions and transmission-based precautions.

### Selecting Gloves for Intrapartum Procedures

In many resource-limited settings, gloves are in short supply; however, sterile or non-sterile gloves should never be reprocessed. Therefore, the appropriate choice of gloves is crucial to avoid waste from unnecessary use and prevent infection. Table 4.5-3 describes the selection of gloves for use by HCWs during the intrapartum period. (See also Volume 1, Chapter 4: Hand Hygiene.)

Table 4.5-3. Selection of gloves for intrapartum procedures

| Gloves may not be required: | Clean, non-sterile gloves required: | Sterile gloves and aseptic technique required |
|---|---|---|
| Gloves not required: for routine patient care activities in which contact is limited to a patient's intact skin.<br><br>For example, but not limited to:<br>• Assisting mother to breast feed<br>• Taking blood pressure, temperature, and pulse<br>• Performing injections<br>• Transporting patients<br>• Manipulating vascular line in absence of blood leakage<br>• Giving oral medications<br>• Distributing or collecting patient dietary trays | Clean, non-sterile gloves required: for contact with mucous membranes, non-intact skin and when there is a risk of exposure to blood and body fluids.<br><br>For example, but not limited to:<br>Contact with:<br>• Vaginal secretions<br>• Amniotic fluid<br>• Placenta<br>• Meconium<br>• Breast milk<br>For procedures such as:<br>• Changing diapers<br>• Handling the newborn before the first bath<br>• IV insertion and removal<br>• Drawing blood<br>• Discontinuation of IV line | Sterile gloves and aseptic technique required: for invasive procedures and contact with sterile sites.<br><br>For example, but not limited to:<br>• Surgical procedures<br>• Vaginal delivery<br>• Invasive radiologic procedure<br>• Vascular access (central lines)<br>• Vaginal exams during labor<br>• Rupture of membranes<br>• Trans-vaginal ultrasound internal monitoring<br>• Chorionic villus sampling<br>• Use of forceps during delivery<br>• Spinal or epidural anesthetic (caps, masks, sterile gloves)<br>• Urinary catheter insertion<br>• Assistance with or obtaining fetal scalp blood sample<br>• Examination of the perineum and perineal repair |

*Adapted from*: Alberta Health Services 2015

## Cleaning the Perineum

Before each vaginal examination, the HCW should perform the following steps:

- Perform hand hygiene.
- Assist the woman onto the examination table.
- Put on PPE: plastic or impermeable gown, face shield (or a mask and goggles), and non-sterile gloves on both hands (splashing of blood and/or amniotic fluid may be expected).
- With soap and clean water, wash the perineal area (vulva, perineum, and anal region). Use a front-to-back technique so that fecal material will not be introduced into the vagina.
- Clean the anal area last using a front-to-back technique and dispose of the washcloth or towel.
- Remove gloves. Perform hand hygiene.
- Assist the woman into a modest and comfortable position.

**Not recommended:** Routine perineal shaving for women giving birth vaginally is NOT recommended. Hair removal before birth is a social norm in some cultures. Educate the woman on the risk of infection from shaving and possible alternatives (such as clipping).

WHO 2015b

## Performing a Digital Vaginal Exam

- Limiting the number of vaginal examinations and performing exams using clean technique prevents the introduction of vaginal or intestinal organisms into the uterus.
- Avoid digital vaginal exam until active labor occurs or to induce labor.
- Perform hand hygiene and put on sterile gloves.
- Perform a digital vaginal exam only every four hours for routine assessment of labor progress in low-risk women during active first stage labor.
- Monitor and record the frequency of exams.
- Only perform if necessary for care decisions.

**Not recommended:** Routine vaginal cleaning with chlorhexidine during labor to prevent infection in general and to prevent neonatal GBS infection in women colonized with GBS is not recommended.

WHO 2015b

## Antibiotic Use

In many settings, it is common clinical practice to give antibiotics for obstetric conditions and procedures that are thought to carry risks of maternal infection. In many cases, this represents over-prescribing and is not a rational use of antibiotics and, therefore, may contribute to the development of resistant bacteria strains, facilitating MDRO infections. The following are recommendations for antibiotic use in the intrapartum period. Administer recommended antibiotics for:

- Women with preterm pre-labor rupture of membrane
- Women with GBS colonization to prevent newborn infection
- IAI (chorioamnionitis) during labor and childbirth
- Women undergoing manual removal of the placenta
- Women with a third- or fourth-degree perineal tear
- Stop antibiotics as soon as recommended after birth
- Educate mothers to complete the full course of prescribed antibiotics

**Not recommended:** Routine antibiotic prophylaxis is NOT recommended for women with the following conditions:

- Uncomplicated vaginal birth

- Operative vaginal delivery
- Episiotomy
- Threatened or actual preterm labor with intact membranes
- Preterm pre-labor ruptured membranes (ROM) (included on condition need antibiotics)
- Pre-labor ROM at or near term
- Meconium-stained amniotic fluid
- Women undergoing operative vaginal birth

WHO 2015b

## PPE for Delivery

HCWs should use appropriate PPE to protect against the risk of exposure to blood and body fluids during labor, delivery, and resuscitation of the infant.

Wear appropriate PPE for delivery:

- For the delivery team: sterile, fluid-resistant, long-sleeved gown (and apron on non-fluid resistant gown); face shield or goggles and mask; boots or fluid-resistant shoe and leg covers; sterile gloves
- For anesthesia: non-sterile gloves
- For the newborn resuscitation team: see the Preventing Infection in the Newborn section below.
- Wear gloves when handling the placenta
- Wear non-sterile gloves for handling the newborn until blood and amniotic fluid have been removed
- Wear elbow-length, sterile gloves and PPE as above, for the delivery team, if manual removal of the placenta is required

## Equipment for Vaginal Delivery

Make sure that the following items are available for a vaginal delivery:

- Clean water, soap, a nail brush, clean towels
- ABHR
- A basin of clean warm water, soap, a washcloth, and a clean, dry towel
- Gloves: sterile gloves (four pairs), clean examination gloves, utility gloves
- PPE as detailed in the section above
- A blood pressure cuff and stethoscope

- A new razor blade
- Sterile blunt scissors
- Sterile cord clamp forceps, for clamping the umbilical cord before it is cut
- Sterile thread or cord clamp to tie/clamp the umbilical cord
- Injectable oxytocin or oral misoprostol, new sterile needle, and syringe
- A sterile urinary catheter (straight, rubber, or metal) and clean basin to collect urine (optional)
- A package of gauze squares
- Antiseptic solution for cleaning the mother's perineum and genital area
- Tetracycline eye ointment (used to protect the newborn's eyes from infection)
- Mucus trap or suction bulb to suck mucus from the baby's airways
- A clean basin for the placenta
- A clean drape or cloth for wrapping the baby
- Clean perineal pads
- A light source (a flashlight or lamp) (if needed)
- A puncture-resistant sharps container (within arm's reach if possible)
- Three buckets or small bowls each of soap solution and clean water
- A plastic bag or a leak-proof, covered waste container for disposal of contaminated-waste items

If an episiotomy is required, the following will be needed as well:

- A sterile needle holder
- A sterile tissue forceps
- A #0 chromic suture on or with a curved, minimally blunt (preferred) or cutting suture needle
- A 5-mL, disposable needle and syringe
- Local anesthetic (without epinephrine)
- If sterile scissors, cord clamp, needle holder, or tissue forceps are not available, high-level disinfected items are acceptable (WHO 2016)

## Waste Disposal After Childbirth

- Before removing gloves, put the placenta in a clean basin for examination.

- Wearing non-sterile gloves, put the placenta into a bag and place it into a leak-proof infectious waste container designated for placenta.
- Dispose of the placenta in the correct, safe, and culturally appropriate manner. (Volume 1, Chapter 10: Healthcare Waste Management).
- Place all waste items (e.g., blood-stained gauze) in a leak-proof, covered, contaminated-waste container.
- If an episiotomy was done or surgical repair of tears was performed, dispose of sharps, including suture needles and syringes, in the puncture-resistant sharps container.
- Remove PPE and gloves and dispose of them in a leak-proof, covered, contaminated waste container.

## Preventing Infection During C-Sections

C-sections should be performed using the same standards as for any general surgical procedure, as described in Volume 2, Section 2, Chapter 1: Preventing Surgical Site Infections. Sterile techniques should be strictly followed.

The following recommendations apply specifically for C-section:

**Perform surgical scrub:** Wear appropriate PPE (for all surgical team members—scrubbed and non-scrubbed): scrub suit, hair cover, surgical mask, boots or fluid-resistant shoes, and leg covers. Non-sterile gloves worn as needed according to standard precautions. The scrubbed team members should also wear eye protection (goggles or face shield), fluid-resistant sterile surgical gown, and sterile gloves (double gloves if indicated [e.g., if the client is infected with HIV, hepatitis). (See Volume 1, Chapter 5: Personal Protective Equipment.)

Research on the protective effects of double gloving provides compelling evidence that surgical personnel should double-glove during all surgical procedures (Thomas-Copeland 2009).

### Antibiotic Prophylaxis

See Volume 2, Section 2, Chapter 1: Preventing Surgical Site Infections for general guidelines on surgical antibiotic prophylaxis, Appendix 2.1.B. Recommendations for Antimicrobial Prophylaxis for Selected Surgical Procedures, and Appendix 2.1.A. Recommended Doses and Re-Dosing Intervals for Commonly Used Antimicrobials for Surgical Prophylaxis for specific recommendations for C-section. Reminders:

- Prophylactic IV antibiotic within 60 minutes before surgical incision
- Prophylactic antibiotics should be given before skin incision, rather than intraoperatively after umbilical cord clamping.
- Adjust the dose of antibiotic for obese patients.

Do not continue antibiotics after the procedure, unless indicated for specific infections. (See the Antibiotic Use section above for details.) (WHO 2015b)

## Preparation of the Surgical Site

See Volume 2, Section 2, Chapter 1, Preventing Surgical Site Infections for general principles governing the standards for surgical site preparation for all surgical procedures, including C-sections. Reminders:

- Hair removal: Patients should not be shaved before surgery. If it is necessary to remove pubic or abdominal hair, clip the hair with an electric clipper or scissors just before surgery, taking care not to nick (scratch or cut) the skin. Hair removal before childbirth is the norm in some cultures and women may present having shaved. For elective C-section, educate the women about the increased risk of infection and her options.

## Cervical or Vaginal Preparation Before a C-Section

- Gently wash the external genital area with soap and clean water and dry the area before applying the antiseptic.
- Ask the patient about allergic reactions (e.g., to iodine preparations) before selecting an antiseptic solution.
- Use an iodophor (povidone-iodine) or 2%–4% aqueous CHG (e.g., Hibiclens) for preparing the vagina and cervix. Do not use alcohols or alcohol-containing preparations.
- After inserting the speculum, apply antiseptic solution liberally to the cervix and vagina (twice). It is not necessary to prepare the external genital area with antiseptic solution if it appears clean. Allow two minutes before proceeding (for drying and antimicrobial action).

## IP Measures Related to Surgical Technique

Good surgical techniques minimize tissue trauma, control bleeding, eliminate dead space, remove dead tissue and foreign bodies, use minimal sutures, and maintain adequate blood supply and oxygenation. The following recommendations apply specifically for C-section or require special emphasis:

- Make the skin incision with a scalpel rather than with electrocautery.
- Avoid compromising sterile technique by touching a non-sterile area, such as when the gloved hand reaches down into the pelvis to extract the baby's head or buttocks.
- Change a sterile surgical glove (or gloves) immediately when contamination occurs, before touching a sterile area. (See Volume 1, Chapter 5: Personal Protective Equipment for how to change gloves.)

For prolonged ruptured membranes or with documented IAI (chorioamnionitis), ensure the following:

- Avoid spillage of amniotic fluid into the abdominal cavity.
- Place folded, moistened sterile laparotomy pads or towels on either side of the uterus (paracolic gutters) to absorb as much contaminated amniotic fluid from the abdominal cavity as possible.

- If large amounts of meconium (early feces of the newborn) or amniotic fluid spill into the abdominal cavity, remove the laparotomy pads or towels in the gutters and lavage (irrigate) the cavity with warmed sterile isotonic (0.9%) saline solution.
- Do not explore the peritoneal cavity unless absolutely necessary. If necessary, then perform only after closure of the uterine incision and changing to a pair of new surgical gloves.
- Prepare equipment for newborn delivery, including cleaned and disinfected resuscitation equipment, (Volume 2, Section 2, Chapter 4: Preventing Healthcare-Associated Pneumonia for details on care of respiratory equipment), and a clean area to place the baby if resuscitation is required.
- Ensure an assistant, having performed hand hygiene and wearing new non-sterile examination gloves, is ready to receive and handle the newborn. Once the newborn has been delivered, place the infant on a clean towel. See the Infection Prevention and Control Interventions after Delivery: Care of the Newborn section below.

Following delivery of the newborn, if the mother's cervix is closed and membranes were not ruptured before the C-section, complete the following procedures:

- Dilate the cervix from below (i.e., through the vagina) sufficiently to permit the outflow of blood and fluid after delivering the newborn and placenta.
- Insert the gloved finger into the cervix only once to dilate it. This hand is now no longer sterile.
- When dilation is completed, remove the gloves and put on a new pair of sterile gloves.
- Do not go back and forth or remove the finger from the cervix and then put the hand back into the pelvis though the abdominal incision.
- Irrigate the incisional wound, before closure, using a sterile aqueous solution of povidone-iodine followed by sterile normal saline solution.
- Whenever possible, do not place drains in the subcutaneous layer.
- Close the skin edges using a subcuticular technique.
- Apply a sterile dressing and care for the wound. (See Volume 2, Section 2, Chapter 1: Preventing Surgical Site Infections.) (WHO 2016)

## Preventing Infection During Home Births

In addition to preventing and treating maternal infections during pregnancy, prevention of infections in mothers and neonates includes ensuring a clean birth (either at home or in a facility) (table 4.5-4). To promote clean home birth practices, clean birth kits (now adopted by at least 51 countries) along with the "Six Cleans" method are used as a way to decrease the incidence of infection in mothers and newborns. Clean birth kits include disposable items for clean birth practices (e.g., soap, blade, plastic sheet) (Blencowe, Lawn, Graham 2010).

Table 4.5-4. Recommended practices for preventing maternal and newborn infections

| Procedure | Recommended practices |
|---|---|
| Intrapartum practices that reduce infection | Use of partograph for prompt diagnosis of prolonged labor |
| | Timely management of prolonged labor |
| | Minimization of vaginal examinations |
| | Prevention and prompt diagnosis and treatment of IAI |
| The Six Cleans: A memory aid for birth attendants | Clean hands—vigilant hand hygiene and new gloves for vaginal exams or when handling the baby. |
| | Clean perineum—feces should be wiped away and the perineum washed before the birth (mother can shower or bathe). |
| | Nothing unclean introduced into vagina—hands, herbs, or other substances. |
| | Clean childbirth surface—a plastic cover is appropriate for home births; at facilities, the childbirth surface should be cleaned of blood and body fluids and then wiped with disinfectant cleaning solution after each use (e.g., hypochlorite solution). |
| | Sterile cord cutting instrument—at home, use a new razor blade.<br>Note: if sterile instruments are not available, high-level disinfected items are acceptable (WHO 2016). |
| | Clean cord care—clean, dry cord care is recommended for newborns born in healthcare facilities and at home in low newborn mortality settings.<br>Daily application of chlorhexidine (4%) on umbilical cord stump for first week of life is recommended for newborns who are born at home in settings with high newborn mortality (> 30 newborn deaths/100 live births). |

*Sources*: Partnership for Maternal, Newborn & Child Health 2006; WHO 2017a

## Infection Prevention and Control Interventions After Delivery: Postpartum Care of the Mother

### Preventing Infection in the Mother During the Postpartum Period

Minimizing the risk of HAIs in mothers during the postpartum period includes the following:

- IP education:
- Teach the mother and family about the following IP strategies:
    - Hand hygiene before touching wounds
    - How to wash the perineal area with clean water after changing a pad or having a bowel movement
    - Signs and symptoms of infection: fever, chills, abdominal pain, and/or offensive vaginal lochia
    - How to care for her breasts and nipples to avoid infection (mastitis)
    - Nutrition and birth spacing
    - Hand hygiene and respiratory hygiene around the newborn
    - In malaria-endemic areas, protection from mosquito bites: mother and baby to sleep under insecticide-treated nets

Limit the use of antibiotics after birth to recommended indications.

- Administer antibiotics for women with the following conditions:
    - Manual removal of placenta
    - Third- or fourth-degree vaginal tear (WHO 2015b)

### Preventing Infection in the Mother After Vaginal Delivery

Preventing infection during the postpartum period for mothers who have given birth vaginally includes the following:

- In the immediate postpartum period, check to be sure the patient is voiding within six hours and without difficulty.
- Wear new, sterile gloves when performing perineal care or touching the episiotomy. (See table 4.5-3 for choice of gloves for various procedures.)
- Wear new, non-sterile gloves when handling perineal pads, touching lochia (vaginal discharge), assisting with breastfeeding, etc.

### Preventing Infection in the Mother After C-Section

Preventing infection during the postpartum period for mothers who have had a C-section includes the following:

- Surgical wound care
- Post-operative pneumonia prevention
- Care of urinary catheter: Remove the catheter as soon as possible (within 24–48 hours)
- Maintain a closed drainage system and perform regular perineal care
- Care of intravascular device
- Remove the intravascular device as soon as possible
- Care for the intravascular device meticulously (WHO 2015b)

(See Volume 2, Section 2 ,Chapter 1: Preventing Surgical Site Infections; Chapter 2: Preventing Catheter-Associated Urinary Tract Infections; Chapter 3: Preventing Intravascular Catheter-Associated Bloodstream Infections; and Chapter 4: Preventing Healthcare-Associated Pneumonia.)

## Infection Prevention and Control Interventions after Delivery: Care of the Newborn

### Preventing Infection in the Newborn

**At Birth**

Preventing infection in newborns at birth includes the following:

- Keep the baby in a clean area and follow standard precautions for newborn resuscitation.
- Ensure that the newborn resuscitation team wears appropriate PPE; non-sterile, fluid-proof, long-sleeved gowns, face shields or goggles and masks, boots or shoe covers, and non-sterile gloves.
- Wear non-sterile gloves for contact with the newborn until after the first bath.
- Do not perform routine suction or aspiration at the delivery of the head. It should be done only in the presence of dense substances blocking the nose and mouth.
- Wipe both of the newborn's eyes with a sterile gauze square and discard the wet cloth. Use a separate square for each eye and wipe from the inner corner to the outer corner.
- Keep the newborn warm.
- After delivery, do not perform routine suction or aspiration.
- In the presence of meconium-stained amniotic fluid:
    - Do not perform tracheal suctioning and avoid suctioning of the mouth and nose before initiating positive pressure ventilation for infants who do not start breathing on their own.
- For newborns who do not start breathing on their own by one minute after birth, start positive pressure ventilation with room air with a self-inflating bag and mask (WHO, UNICEF, UNFPA 2015)

**Within the First Hour of Life**

- Initiate breastfeeding within one hour of birth. Encourage exclusive breastfeeding.
- Apply antiseptic eye drops or ointment (e.g., tetracycline ointment) to both eyes once, according to national guidelines. DO NOT wash away the eye antimicrobial.
- Administer vitamin K and recommended immunizations (birth dose of oral polio vaccine and HBV vaccine), using safe injection practices and sharps safety. (See Volume 1, Chapter 6, Injection Safety.)
- Apply relevant IPC precautions (transmission-based precautions and prophylaxis) to those who are exposed or infected during or before birth (e.g., congenital syphilis, rubella, HIV, HBV, and other infectious diseases). (See Appendix 5-A, Prevention of Fetal and Newborn Infectious Diseases.)

**General IPC Guidelines**

Preventing infection in newborns includes the following general practices relevant to all newborns:

- Comply with standard precautions at all times and use transmission-based precautions when indicated. (See Volume 1, Chapter 3: Standard and Transmission-Based Precautions.)

- Keep the mother separated from the baby for IPC purposes only when the mother has multidrug-resistant TB. Consult IPC staff regarding precautions for other infections in the mother. (See Volume 1, Chapter 3, Standard and Transmission-Based Precautions.)
- Follow patient spacing guidelines in the newborn nursery. See the section on the Management of the NICU in this chapter.
- Encourage exclusive breastfeeding. Manage expressing and storage of breast milk carefully to prevent infection. (See the breast milk handling and storage section in this chapter.)
- Manage the preparation of formula. (See Volume 1, Chapter 11: Food and Water Safety.)
- Screen visitors and exclude for signs of infection, such as fever, respiratory infection, diarrhea, and draining skin infection. (Case by case exceptions can be made for parents with guidance from IPC staff.)

Perform recommended cord care using standard precautions:

- For newborns born in healthcare facilities and at home in settings with low neonatal mortality, use clean, dry cord care. Use of chlorhexidine in these situations may help prevent application of harmful traditional substances, such as cow dung, to the cord stump.
- Keep the umbilical cord stump clean and dry.
- If visibly soiled, wipe the cord with clean water and leave the cord open to the air.
- Fold the diaper below the umbilical cord stump.
- Perform hand hygiene before and after touching the cord.
- Apply 7.1% chlorhexidine digluconate (i.e., 4% chlorhexidine) aqueous solution or gel for seven days on umbilical cord stumps of infants born at home if your area has neonatal mortality of 30 or more per 1,000 live births.

**Immunizations and Post-Exposure Prophylaxis**

- Provide non-live vaccines to medically stable infants (including premature infants) according to the national immunization schedule for age. Infants may be hospitalized for long periods.
- Do not provide live vaccines, such as polio and rotavirus, during admission due to the risk of transmission of the vaccine virus to immune-compromised patients.
- Follow adjusted guidelines for HBV vaccine in premature infants.
- Provide post-exposure vaccination prophylaxis and/or immunoglobulin, if available, for infants exposed from the mother or from other infants (e.g., HBV, HAV, varicella, and measles).
- Provide post-exposure antibiotic or antiviral prophylaxis, if available, for infants exposed to pertussis, H. influenzae type b, meningococcal infection, gonorrhea, syphilis, and infectious TB, and for certain high-risk newborns with intrapartum exposure to GBS, HSV, or HIV (WHO 2017a).

## Preventing Infection in Newborns Requiring Specialized Care

### Introduction to Specialized Care of Newborns

Newborns who require a higher level of care than can be provided in the newborn nursery may be transferred to a special care nursery or NICU. As the level of care increases, so does the risk of infection. Preventing infection in newborns in specialized care settings requires stricter and more vigilant application of the IPC practices that are recommended for all newborn care. As an overview, preventing infection in the newborn is based on strategies aimed at reducing transmission of microorganisms among infants and minimizing the risk of infection from the newborn's own flora by:

- Emphasizing hand hygiene before and after contact with each infant
- Not sharing equipment and supplies between infants
- Preventing the acquisition of infection from contaminated feedings, water, or air
- Protecting the infant from infected HCWs and visitors
- Using invasive medical devices judiciously
- Strictly adhering to aseptic technique
- All basic IPC precautions should be in place

Newborns who room in with mothers 24 hours/day are somewhat protected from acquiring infections from other infants. However, those receiving care in the nursery, special care nursery, or NICU are potentially exposed to other infants and more potential pathogens. HCWs practicing in these settings need to have expertise in incorporating these IPC practices into all aspects of workflow at all times.

All newborns have an immature immune system. Sick and premature newborns lack the immune capacity to fight off even small numbers of organisms acquired from hands-on contact, invasive medical device access, and procedures, which are features of the specialized care environment, especially the NICU. Even small breaches in IPC in the course of care puts the immunocompromised newborn at risk of infection. This section describes IPC considerations for the NICU. They should be implemented in addition to IPC recommendations for other ICUs.

**Hand hygiene**: Hand hygiene compliance has been shown to decrease all types of HAIs among NICU patients:

- Before handling neonates for the first time on a work shift in the NICU, HCWs should perform a wash of their hands and arms to above the elbows, with care to cleaning all parts of the hands and beneath the nails.
- Sufficient time should be taken to thoroughly wash and rinse all parts of the hands. Careful hand hygiene between patients is most likely of more benefit than the length of hand scrub on entry to the nursery.
- HCWs should perform meticulous hand hygiene before and after each patient contact and after contact with potentially contaminated patient care equipment.

**Use of multi-dose vials**: As for all settings, use a single dose from one vial for one patient, rather than multi-doses from larger vials, especially when the medication will be administered to multiple patients. However, because newborns require such small doses, cost-effectiveness may be an inhibiting factor in limited-resource settings. (See Volume 1, Chapter 6: Sharps and Injection Safety.)

## NICU Attire and Linen

- Special attire for entrance to the NICU is not required.
- Staff and parents should wear long-sleeved gowns if they are handling the infant outside the bassinet/crib/warmer/incubator.
- Staff gowns should be discarded after care of one infant and a new gown should be worn for handling the next infant.
- Parent gowns should be discarded at the end of the visit.

Gowns should be worn when entering the infant's area (even if not handling the infant) in the following situations:

- Soiling with blood or body fluids is expected (standard precautions always apply).
- The infant is on contact or droplet precautions.
- The parents are concerned about their own soiled clothing.
- Shoe covers or special shoes are not required. There is no known benefit, it takes resources, and hands may become contaminated when putting on and removing them.
- Sterilized or autoclaved linens for the NICU are not required.
- Use recommended temperatures and detergents to launder NICU linens. (See Volume 1, Chapter 8: Processing Reusable Healthcare Textiles.)
- Wrap or cover NICU linens during transport from the laundry and store them in closed cabinets to prevent contamination with dust (and associated bacterial and fungi).

## Family-Centered Care

Family-centered care is often a feature of NICU care, including extended or relaxed visiting hours and family members participating in care. This creates some unique challenges for IPC:

- Educate family members on IPC measures required for the care they are providing (e.g., hand hygiene, safe care of infant feeds, handling of invasive medical devices, cord care, wound care).
- Have a strict hand hygiene policy for family members entering the infant's bed space.
- Enforce strict hand hygiene for family members before they enter common kitchens, breast milk expressing areas, and other areas family members of the admitted infants co-inhabit.
- Do not allow family members to visit or assist with other infants.

- Do not allow ill visitors to enter the NICU with the exception of the mother, who may be allowed to care for the infant (with barriers in place) after consultation with IPC staff.

## Managing Newborns in the NICU

### Preventing Device-Associated Infections in the NICU

See recommendations for ventilator-associated pneumonia prevention—use a neonatal bundle as recommendations differ by age groups (Volume 2, Section 2, Chapter 4: Preventing Healthcare-Associated Pneumonia).

See recommendations for central line-associated blood stream infection prevention (Volume 2, Section 2, Chapter 3: Preventing Intravascular Catheter-Associated Bloodstream Infections).

See recommendations for catheter-associated urinary tract infection prevention (Volume 2, Section 2, Chapter 2: Preventing Catheter-Associated Urinary Tract Infections).

See recommendations for SSI prevention (Volume 2, Section 2, Chapter 1: Preventing Surgical Site Infections).

**Note that for some IPC recommendations, there is not enough data in neonates to make specific recommendations (e.g., there are no specific recommendations for optimal central line placement site, or optimal antiseptic for skin asepsis in newborns).**

**Choose the best equipment recommended for a given procedure**

Many NICUs use infant feeding tubes as umbilical or urinary catheters in newborns but this should be avoided when possible. Infant feeding tubes will not usually connect with a urine collection container or IV tubing systems to result in a closed system.

(WHO 2015c)

**Skin Asepsis Products in the NICU Population**

The NICU population presents challenges in the choosing of antiseptic products for skin asepsis and for daily bathing related to the risks of absorption of products through immature skin and skin irritation. Concerns about absorption with the use of CHG is an ongoing subject of study. Although some absorption has been documented, no systemic effects have so far been identified (Chapman, Aucott, Milstone 2012). Severe burns have occurred in infants weighing less than 1,000 grams and under 28 weeks' gestation when CHG with 70% alcohol and in aqueous solution was used during the first 48 hours of life. Although these issues are not yet fully resolved, CHG is currently used with selected infants in many NICUs in the United States. Other options include povidone-iodine (also concerns about absorption effecting thyroid function), 70% alcohol alone (can cause skin burns in premature infants), and octenidine (may cause skin irritation and absorption has not been studied). Hexachlorophene has been associated with neurotoxicity and should never be used.

When choosing products for skin asepsis in NICU patients, carefully weigh the potential benefit of preventing infection against the risks.

Low birth weight infants, premature infants (under 32 weeks' gestation and in the first two weeks of life), and those undergoing phototherapy have greater risks of adverse effects and may require different approach than other infants in NICU.

**Routine Active Surveillance Cultures**

The use of surveillance cultures to identify colonization with specific MDROs (e.g., MRSA, VRE, and other antibiotic-resistant gram-negative bacteria) requires specific laboratory capacity and is expensive and time-consuming for the laboratory, NICU, and the IPC department. Each facility should make a decision depending on the resources available, specific needs/problems, requirements, and patient populations.

In outbreak situations, active surveillance cultures may be used to:

- Identify colonized infants (with no signs, symptoms, or positive clinical cultures) as unappreciated sources of possible transmission.
- Use transmission-based precautions for colonized infants, or cohort infants, to prevent transmission from colonized infants.
- Identify transmissions (infants with previous negative surveillance culture converting to positive).

In non-outbreak situations, active surveillance cultures can be used for the above purposes in specific, high-risk groups (such as NICU patients) by conducting active surveillance cultures for a target organism on admission and periodically (such as weekly).

Consider costs and consequences carefully (e.g., cost of PPE for contact precautions or cohorting for those with positive results, explanation of colonization to families, PPE requirements for visitors, duration of contact precautions once applied, criteria for removal from contact precautions).

**Cohorting Patients and HCWs in the NICU**

The following information is specific to the NICU. (See Volume 1, Chapter 3: Standard and Transmission-Based Precautions, for details on cohorting.)

- Group patients into infected/colonized, exposed, and not exposed.
- In outbreak situations, dedicate HCWs to each patient cohort with no movement among patient cohorts.
- In non-outbreak situations, dedicate HCWs to each patient cohort, but with some flexibility according to the risks and benefits.

**Outbreaks in the Nursery or NICU**

An outbreak should be suspected if two or more newborns with the same condition (e.g., skin infection or sepsis with the same organism) or one incidence of a new or unusual organism occurs at the same time in a nursery or NICU. Once an outbreak is suspected, investigation and measures to halt any further spread should be implemented promptly. During an outbreak, control measures should be monitored along with any new infections to make sure that they have been effective and the problem is resolving.

(See Appendix 5-A, Prevention of Fetal and Newborn Infectious Diseases, for infections commonly occurring in newborns and recommended IPC precautions to prevent their transmission.)

For information on investigation and management of outbreaks, see Volume 2, Section 5, Chapter 1, Principles of Public Health Emergency Preparedness and Outbreak Management for Health care facilities. For information on IPC practices that can be implemented to halt an outbreak, use this chapter and see Volume 1, Chapter 3: Standard and Transmission-Based Precautions; Volume 1, Chapter 4: Hand Hygiene; Volume 1: Chapter 6, Sharps and Injection Safety; Volume 1, Chapter 12: Facility Design and Patient Flow; and Volume 2, Section 2, Chapter 5: Preventing Healthcare-Associated Infectious Diarrhea.

## Management of the NICU

### Patient Spacing

Healthcare facility spaces should be designed to accommodate the bed and necessary patient care equipment, ensure adequate room for staffing levels required for the number of patients under care, and avoid crowding. Consult national guidelines for specifics, but as a guide for ideal NICU design, see table 4.5-5.

Table 4.5-5. Spacing for facilities with newborns

| Type of Design | Newborn Nursery | Special Care Unit | NICU |
|---|---|---|---|
| Multi-patient rooms | 2.2 square meters (24 net square feet) per infant | > 11.2 square meters (120 net square feet) per infant | |
| | > 1 meter (3 feet) between bassinets | 2.4 meters (8 feet) between incubator/warmer/bassinet/crib | |
| | | Aisles > 1.2 meters (4 feet) wide | |
| Single patient rooms | 2.2 square meters (24 net square feet), at least 1 meter (3 feet) in all directions between cribs | > 14 square meters (150 net square feet) | > 14 square meters (150 net square feet) |
| | | | 2.4 meter (8 feet) wide aisles |
| | | | Space should be added for sinks, desks, |
| | | | cabinets, computers, and corridors |
| Handwashing sinks | 1 sink for every 6–8 patients | 1 sink for every 3–4 patients | |
| | A sink in the resuscitation area | | |
| | 1 sink per 3–4 patients in admission, observation, and continuing care areas | | |
| Air supply | | Positive pressure to adjacent areas | |
| | | 90% efficiency filtration | |
| | | 6 air exchanges/hour | |

| Type of Design | Newborn Nursery | Special Care Unit | NICU |
|---|---|---|---|
| Airborne infection isolation room (AIIR) | Access to at least one AIIR, which may be located on another ward | | |

*Adapted from*: American Academy of Pediatrics (AAP) 2012; American College of Obstetricians and Gynecologists (ACOG) 2012

## Water Supply and Use

Water supply and water reservoirs can become a source of infection in NICUs:

- Ensure that the water supply for the NICU is treated adequately (either at the municipal level or on arrival to the hospital). (See Volume 1, Chapter 11: Food and Water Safety).
- Be aware that water storage tanks can become sources of contamination, even if treated.
- Drain the water reservoir of evaporative humidifiers in incubators, clean, and refill with sterile water every 24 hours.
- Replace nebulizers, attached tubing, and water traps regularly; use new, sterilized, or high-level disinfected equipment.
- Use only sterile water in nebulizers and humidifiers.
- Drain and discard condensate in ventilator tubing periodically.
- Clean bassinets/cribs/warmers/incubators regularly inside and out to remove visible soil (blood, milk, body fluids) and reduce microbial burden.
- Change bassinets/cribs/warmers/incubators periodically.
- Use disinfectants, such as quaternary ammonium and chlorine compounds for cleaning bassinets/cribs/warmers/incubators (low-level disinfection).
- Avoid the use of phenolic compounds (e.g., phenol, o-phenylphenol, chloroxylenol, hexachlorophene, hycolin, thymol, amylmetacresol, Dettol, and triclosan) on bassinets/cribs/warmers/incubators or other surfaces in direct contact with infants' skin. Phenol has been known to cause neonatal hyperbilirubinemia and hexachlorophene has been associated with neurotoxicity.
- Use caution when using evaporative humidifies in incubators.
- Do not use if central humidification provides enough humidity.
- Drain, clean, and refill with sterile water every 24 hours when in use.
- Avoid placing toys that are not able to be adequately cleaned, such as stuffed toys, in incubators.

## Handling Infant Feeds

### Breast Milk Handling and Storage

Breast milk can transmit viruses, such as HIV, cytomegalovirus, and HTLV-1 (human T-cell lymphotropic virus type 1), or become contaminated during collection, handling, or storage. Infections have been associated with contaminated breast milk pumps and refrigerated storage practices.

For mothers expressing, ensure hand hygiene and expression of milk into sterile containers. Clean the containers with hot, soapy water after each use, before they are sterilized.

For mothers using a breast pump dedicated to one mother:

- Wash all pump components that are in contact with milk with hot, soapy water after each use, dry thoroughly, and store in a clean place.
- Sterilize or high-level disinfect pump components daily.

For a breast pump shared between mothers:

- Wash all pump components that are in contact with milk with hot, soapy water after each use, then sterilize or high-level disinfect before use by a different mother.
- Store milk in sterile, labeled containers that are closed (tied or covered securely):
- Label milk at the time of expressing/pumping with the infant's name, medical record number, date of birth, and date of pumping.

When stored in a refrigerator or freezer with milk for other infants, place all the feeds for each infant into a larger, labeled, cleanable bin or zip-lock bag, one for each infant.

- Clean and disinfect the container after the infant is discharged.
- Use oldest milk first.
- Confirm the right milk for the right infant with two separate patient identifiers (e.g., name and medical record number or name and date of birth).

If breast milk is given to the wrong infant, treat as a blood/body fluid exposure. Follow the facility's written policy to identify and follow up (create a policy if none exists).

Store breast milk as outlined in table 4.5-6.

Table 4.5-6. Breast milk storage

| Location | Temperature | Length of time | Details |
|---|---|---|---|
| Fresh breast milk | | | |
| Room temperature (fresh) | 16–29°C [61–84°F] | Storage time: 3–4 hours (less in hotter environments)<br>Hang time for feeds: < 4 hours. Replace entire feeding set every 4 hours. | Potential for contamination if stored at bedside awaiting use<br>Use containers covered with a lid or tied at the top<br>Label with infant's name, medical record number, and date of birth |
| Refrigerator | 4°C [39°F] or below | 72 hours | Use containers covered with a lid or tied at the top<br>Label with infant's name, medical record number, and date of birth<br>Place all the feeds for each infant into a larger, labeled, cleanable container, one for each infant |
| Frozen breast milk | | | |
| Freezer | below -17°C [0°F] | 6 months (optimal) up to 12 months (acceptable) | Use containers covered with a lid<br>Label with infant's name, medical record number, and date of birth<br>Place all the feeds for each infant into a larger, labeled, cleanable container, one for each infant |
| Thawing frozen milk | In the refrigerator or quickly under running water | Until thawed | Avoid contamination from the water<br>Do not use hot water<br>Do not thaw in microwave |
| Thawed breast milk | | | |
| Thawed milk in refrigerator | 4°C [39°F] or below | No longer than 24 hours | Do not refreeze<br>Do not refrigerate once milk has been warmed (use within 4 hours or discard) |
| Thawed milk at room temperature | 6–29°C [61–84°F] | Maximum of 4 hours (less in hotter environments) | Do not refreeze<br>Discard unused milk once warmed |

*Source*: APIC 2016

## Formula Preparation and Care

Powdered infant formula is not sterile and can be contaminated by the manufacturer, after the formula container is opened, during the preparation, or during storage. (See detailed instructions for preparation in Volume 1, Chapter 11: Food and Water Safety.)

When formula feeds are used, take meticulous care with hand hygiene, disinfection, and sterilization of the area and equipment used, storage, and length of time at room temperature.

It is safer to make only the amount of formula needed just before for each feed.

Do not prepare feeds in areas where patient care is taking place.

## SUMMARY

Maternal and newborn care is unique and complex, requiring the simultaneous care of two interdependent patients. Their outcomes are dependent on one another and are determined by a set of factors, such as the mother's state of health, risk factors for infection, and the care of the mother and the newborn from preconception to after the birth.

The nature and complexity of the birth process provide many opportunities for infection to be introduced to the mother, newborn, and HCWs. The importance of effective IPC practices in preventing infection during childbirth is well-established. HCWs should correctly and consistently practice all basic IPC practices when caring for mothers and infants, and recommendations specific to maternal and newborn health. Infants in specialized care settings, such as the special care nursery and NICU, are especially vulnerable to infection. Outbreaks of HAIs are common, need to be investigated, and measures to halt any further spread implemented promptly.

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# CHAPTER 6: MORTUARY–INFECTION PREVENTION AND CONTROL FOR HANDLING HUMAN REMAINS

**Key Topics**

- IPC Practices for Handling Human Remains
- IPC Practices for Postmortem Examinations
- IPC Practices for Handling Remains of Patients with Highly Infectious Diseases
- IPC Practices for Handling Human Remains during Natural Disasters

## BACKGROUND

Clinical and mortuary staff are at risk of occupational injury from sharp objects and infection from exposure to blood, body fluids, and biological agents while handling human remains and conducting autopsies. The preparation of human remains for the mortuary, procedures in the mortuary, and autopsies always involve handling potentially infected material, and all human remains should be treated as potentially infectious. Although the risk of infection in most cases is low, bodies can remain infectious after death. Performing the autopsy poses the highest risk. However, by following strict IPC practices, HCWs *can* prevent the risk of injury and infection from occurring while handling bodies.

Managing human remains begins immediately after the pronouncement of death *(*figure 4.6-1*)*. It includes hygienically preparing the body for transport to the mortuary, storing in the mortuary, conducting the postmortem examination *(if needed)*, and handing the body over to the family, or transporting the body for cremation or burial. All human remains should be treated as potentially infectious. Therefore, HCWs and others who handle dead bodies must follow recommended IPC practices to protect themselves from the risk of exposure to infectious microorganisms. (See Appendix 4.6.A. Mortuary—Infection Prevention and Control for Handling Human Remains Mortuary Starter Kit for a list of microorganisms that can be transmitted after death.)

Human remains may contain infectious organisms present at the time of death. Infections can be known or undiagnosed, so all human remains should be treated as potentially infectious. Performing the autopsy poses the highest risk, with exposure to sharp instruments, bone shards, fragmented projectiles, and large amounts of blood and body tissue. Occupational transmission of infections from human remains does occur, especially during autopsies when exposure to aerosols, spills/spatters, and punctures with sharp objects result in bloodborne diseases and TB. Moreover, sampling of environmental surfaces in morgues has revealed surfaces contaminated with fecal matter and DNA, even after routine cleaning. Although the risk of infection in most cases is low, HCWs who handle human remains are at risk from infection from the following:

- Bloodborne pathogens (e.g., hepatitis viruses, HIV, EVD) from:
    - Sharps injuries from potentially contaminated sharp objects, such as sharp fragments of bone, metal fragments embedded in the tissue (e.g., gunshot wounds), and sharp instruments that have been used on the body (e.g., needles or scalpels).
    - Splashes into the eyes or mucous membranes from movement of the body during cleaning, removal of medical devices, or other autopsy procedures.

- Intestinal microorganism from internal organs or anal and oral orifices (e.g., shigella and salmonella)
- Discharge from abrasions, wounds, and sores on the deceased person's skin
- Aerosols from body openings, body cavities, or particles aerosolized during the use of autopsy equipment (e.g., *M. tuberculosis*, pandemic influenza)
- HCWs may also ingest infectious agents through:
    - Unconsciously putting their fingers in their mouths or eyes
    - Placing contaminated articles (pencils/pens) or fingers (e.g., when biting fingernails) in the mouth
    - Eating, drinking, applying lip gloss/lipstick, or smoking in the mortuary
    - Failing to use proper hand hygiene

Using recommended IPC practices protects staff from occupational injury and infection acquired while performing postmortem care.

## Infection Prevention and Control Practices for Handling Human Remains

To minimize the risks of transmission of known and unsuspected infectious diseases, HCWs should handle human remains in such a way that their exposure to blood, body fluids, and tissues is reduced. All human remains should be treated as potentially infectious. In the case of infection with highly infectious diseases (such as cholera or EVD) additional precautions are required. (See the section on IPC Practices for Handling Remains of Patients with Highly Infectious Diseases below.) The following are general recommendations for all HCWs who handle human remains:

- Be vaccinated against hepatitis B.
- Observe strict personal hygiene.
- Cover wounds, cuts, and abrasions with waterproof bandages.
- Treat all human remains as infectious: Use standard precautions at all times, including:
    - Perform hand hygiene.
    - Wear appropriate PPE for the task (preparing and transporting the body vs. autopsy) and for the risk of exposure.
    - Follow recommendations for preventing exposure to blood and body fluids.
    - Practice sharps safety: To prevent sharps injuries, use engineering controls and safe work practices to reduce risk from cutting tools and sharp objects.
    - Clean and disinfect equipment and environmental surfaces.
    - Clean and reprocess instruments as recommended.
    - Practice safe waste management.
- Handle human remains in such a way that exposure to blood, body fluids, and tissues is reduced. Take measures to prevent spillage or leaking of blood or body fluids.
- Treat and report accidental exposures to blood or body fluids. (See Volume 1, Chapter 13 on occupational health.)

- Treat all specimens and tissue samples as infectious, taking measures to reduce potential exposure.
- Clean spills of blood and body fluids immediately, using recommended protocols.

## Implementation

**Preparing the Dead Body and Transporting Human Remains to the Morgue**

Preparing the body for the morgue always involves the handling of blood, body fluids, and biological agents, and may also involve exposure to life-threatening microorganisms.

- Perform hand hygiene using soap and water or ABHR and put on gloves.
- Apply standard precautions every time when handling and transporting human remains. Use appropriate PPE, based on the risk, while performing tasks.
- Treat all human blood and other body fluids as infectious.
- Be gentle in handling and lifting dead bodies to avoid splashing, splattering, or generating aerosols.
- Do not shave patients who died of an infectious disease.
- Pack all orifices and pad and seal any leaking wounds with waterproof tape.
- If an autopsy is required, leave all catheters, tubes, and IV lines in place; block and seal them.
- Appropriately identify and tag the body following local guidelines/requirements.
- Place the body in a leak-proof body bag, seal, and label as biohazard, if indicated (table 4.6-1).
- Transfer the body to the mortuary for holding until the autopsy is done.
- Strictly follow safe sharps handling and disposal practices (e.g., safely dispose of single-use sharp devices).
- Clean and disinfect all surfaces, devices, and reusable items, including reusable PPE, after preparing each body or at the end of the day. (See Volume 1, Chapter 9 on Environmental Cleaning.)
- Dispose of waste following the guidance in the waste management chapter (Volume 1, Chapter 10).
- Perform hand hygiene after removing gloves.

### IPC Practices for Postmortem Examinations

Postmortem examinations are routinely performed in health facilities for forensic purposes and to ascertain cause of death for public health reasons. Postmortems involve the collection of anatomical samples, such as viscera and other organs, to determine the cause of death. Performing the postmortem

examination is a high-risk procedure because it involves handling of human remains, placing the HCW at risk of acquiring infections if proper IPC and other safety measures are not in place.

Staff who perform postmortems should take the following precautions:

- Work in a room ventilated according to recommendations: at negative pressure with respect to adjacent areas, with room air exhausted directly outside and 12 air changes per hour.
- Gather all the necessary supplies before starting.
- Perform all procedures with minimal distractions and adequate assistance to prevent accidents and injuries.
- Operate as though the entire autopsy suite and its contents are an infectious area.
- Ensure that all staff performing or assisting in the procedures wear recommended PPE:
    - Fluid-resistant gown or jumpsuit—long sleeved, cuffed
    - Waterproof apron
    - Non-sterile, elbow-length utility gloves and double gloves
    - Rubber boots or protective shoe covers
    - Eye and face protection (e.g., mask and goggles or mask and face shield)
    - Cap/head cover
    - Respiratory protection with an N95 respirator
- Follow the standard operating procedures for performing postmortem examinations.
- Treat all specimens as infectious:
    - Retain all tissues on the autopsy table until fixed unless transported on a tray or in a leak-proof container.
    - Cut frozen sections only on fixed tissue.
- Where possible, use safe engineering designs and work practice controls to avoid sharps hazards by:
    - If available, using gloves made with "cut-resistant fabric" under the outer glove
    - Limiting scalpel use by blunt dissection with blunt tipped scissors
    - Having careful tabletop instrument control
    - Limiting the number of sharp instruments on the autopsy field to one scalpel
    - Taping or covering bone and jagged rib edges with cut towels
    - Limiting blind evisceration
    - Sawing the skull with the head and saw enclosed in a plastic bag or box taped at the portals to avoid aerosolization of dust
    - Announcing in advance any repositioning of sharp devices
    - Avoiding hand-holding of bottles when injecting body fluids or passing devices during the procedure

- Where possible, employ safe engineering designs to avoid cutting, splashing, and aerosol-generating actions during postmortem procedures:
    - Use biosafety cabinets for handling and examining smaller specimens.
    - Work in a room ventilated according to recommendations.
    - Use protective guards on tools.
    - Use vacuum shrouds for oscillating saws.
    - Avoid the use of high-pressure water sprays.
    - Employ drains or disposal units to facilitate evacuation and disposal of solid wastes.
    - Open intestine under water as it may release gases and generate aerosols.
- At the completion of the autopsy, suture incisions with needle and forceps, wash the body with detergent followed by 1:10 solution of 5.25 % sodium hypochlorite, and enclose in a leak-proof body bag.
- Remove PPE and perform hand hygiene after removing PPE and before leaving the postmortem room.
- Reprocess instruments and surfaces contaminated during postmortem procedures using standard cleaning procedures to remove all vegetative organisms:
    - Use enzymatic cleaners, intermediate-level disinfectants, and instrument washer sterilizers for cleaning and re-processing.
    - Flush autopsy tables of gross material with water followed by disinfectant and detergent, scrub all surfaces, and rinse.
- Appropriately segregate, collect, transport, and dispose of waste.
- Consider screening autopsy reports to identify exposures from unidentified infectious diseases or information on previously undiagnosed infections.

## IPC Practices for Handling Remains of Patients with Highly Infectious Diseases

Handling human remains is a widespread cultural practice in Africa. It was considered one of the most important factors in the spread of EVD in the West African countries of Liberia, Guinea, and Sierra Leone during the outbreak from 2014–2016. Practices for reducing the risk from known or undiagnosed highly infectious diseases will vary according to the disease (table 4.6-1), but the following are general guidelines:

- Wear recommended PPE and follow IPC guidelines strictly.
- Handle the body as little as possible.
- Take recommended measures for:
    - Preventing the escape of potentially infected body fluids
    - Performing decontamination procedures
- Plan the transport of the body and the workflow of staff carefully to minimize the potential for transmission of infection.

- Seal bodies in water-tight body bags, if appropriate (table 4.6-1):
    - Ritual cleaning and preparation of the body should be prevented.
    - Relatives should be prevented from touching the body.
- Communicate with community leaders and clergy to assist with educating the public if bodies cannot be released to the family or IPC recommendations are at odds with the religious/cultural practices of the family.
- Have the burial take place close to the point of death, and restrict the number of people present at the burial.

Table 4.6-1. Summary table on precautionary measures for handling and disposal of dead bodies

| Risk category | Bagging | Viewing in funeral parlor | Embalming | Hygienic preparation in funeral parlor | Disposal ofdead body |
|---|---|---|---|---|---|
| **Cat. 1**<br>Other than those specified in Cat 2 & Cat 3 below | NOT necessary | Allowed | Allowed with PPE***** | Allowed with PPE***** | Coffin burial or cremation is optional |
| **Cat. 2**<br>1) HIV infection<br>2) Hepatitis C<br>3) Creutzfeldt-Jacob disease without necropsy<br>4) Severe Acute Respiratory Syndrome (SARS)<br>5) Avian influenza<br>6) Middle East Respiratory Syndrome (MERS)<br>7) Coronavirus disease (COVID-19)<br>8) Others******: | Must | Allowed | NOT Allowed | Allowed with PPE***** | Cremation is advisable |
| **Cat. 3**<br>**1**) Anthrax<br>**2**) Plague<br>**3**) Rabies<br>**4**) Viral hemorrhagic fevers<br>**5**) Creutzfeldt-Jacob disease with necropsy<br>**6**) Others******: | Must | NOT Allowed | NOT Allowed | NOT Allowed | Cremation is strongly advisable |

*Source*: Department of Health Hospital Authority Food and Environmental Hygiene Department, Honk Kong 2022

## Ebola

Remains of patients with EVD continue to be infectious for up to a week after death. Only personnel trained in handling infected human remains and wearing recommended PPE should touch or move any

remains of a patient who died of EVD. (See Appendix 4.6.A, the Mortuary Starter Kit, for details on handling bodies of patients who died from EVD.)

### Cholera

The bodies of people who have died from cholera may leak fluids that contain high concentrations of cholera bacteria and therefore pose a risk of transmission. Key points for handling patients with cholera include:

- Disinfect bodies with 2% chlorine solution.
- Plug all orifices with cotton soaked in 2% chlorine solution.
- Place the body in a body bag after the steps above are completed.
- Spray the body and area where the body was, including the body bag, with a chlorine solution before and after moving the body.
- Ensure that staff handling the remains wear PPE to prevent transmission by contact and droplet (splashes) routes.
- Ensure that staff know how to use a sprayer and handle the body appropriately.

### Tuberculosis

TB can pose a hazard when HCWs handle the body of a patient who died with TB. Placing a cloth over the mouth of the body when it is being handled to prevent the escape of air and ensuring adequate ventilation in the area can reduce the risk of transmission. Performance of an autopsy on a known or suspected case of TB is considered a high-hazard procedure requiring personnel to use approved respiratory protection. When *M. tuberculosis* is known or suspected, tissue fixatives should be prepared with 10% formalin in 50% ethyl alcohol (one part 3.7% formaldehyde plus nine parts 10% ethanol in saline).

**Adaptations**

If body bags are not available:

- Conduct risk assessment to make sure that use of a body bag is absolutely necessary.
- Use plastic sheets to wrap the body.
- Conduct immediate cremation or funeral to avoid the need for placing body in the body bag.

**Additional Information**

HCWs who handle and transport dead bodies should be trained on the risks of exposure and safe handling of human remains. Appoint a designated employee/circulator who will facilitate adherence to IP precautions by preparing the postmortem/autopsy room, and assisting with photography.

**Postmortem**

IPC requirements for postmortem examinations may be regulated by national health and occupational safety organizations. The facility should have policies and training in place to ensure and provide:

- The standard use of PPE (see Volume 1, Chapter 5 on PPE)
- Engineering devices to minimize exposure
- Work practices that delineate which tasks or conditions of employment require protective equipment and engineering devices
- An area where the employee may safely consume food and beverages
- Guidance on how the employee would clean up a blood spill and report an exposure (see Volume 1, Chapter 9 on environmental cleaning)

## IPC Practices for Handling Human Remains during Natural Disasters

Managing dead bodies is challenging during natural disasters due to the large number of deaths and the spread of diseases. Health facilities should follow the IPC guidelines for appropriately handling, storing, and finally disposing of dead bodies during both routine and outbreak situations; however, existing facilities can easily become overwhelmed. The religious and cultural practices should always be respected, as appropriate. The key steps include:

- Recover all dead bodies as soon as possible and place them in body bags, plastic sheets, shrouds, or bed sheets.
- Follow standards precautions, including wearing appropriate PPE and practicing hand hygiene during transportation of bodies to the mortuary or burial site.
- Ensure that transport vehicles are cleaned and disinfected at the end of the day.
- Apply control measures, including disinfection of the body using 0.5% chlorine.
- Limit physical contact by family members with the remains.
- Store the body in a refrigerated storage facility at 2-4°C (35-40°F). Keep bodies in original body bags or plastic wraps.
- Ensure that the burial site is at least 200 meters (700 feet) away from a water source, such as lakes, streams, beaches, and the sea.

**Contents of Starter Kit**

See Appendix 4.6.A. Mortuary—Infection Prevention and Control for Handling Human Remains the Mortuary Starter Kit for the following content:

- List of microorganisms that can be transmitted after death
- How to conduct safe and dignified burial of a patient who has died from suspected or confirmed EVD virus disease
- Recommendations for the design and layout plan of a mortuary

## SUMMARY

Human remains may contain infectious organisms present at the time of death. Infections can be known or undiagnosed, so all human remains should be treated as potentially infectious. To minimize the risks of transmission of known and unsuspected infectious diseases, HCWs should handle human remains in such a way that their exposure to blood, body fluids, and tissues is reduced. Health facilities should follow the IPC guidelines for appropriately handling, storing, and finally disposing of dead bodies during both routine and outbreak situations

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# CHAPTER 1: PUBLIC HEALTH EMERGENCY PREPAREDNESS AND OUTBREAK MANAGEMENT FOR HEALTHCARE FACILTIES

## Key Topics

- Infection control in public health emergencies
- Principles of emergency management: mitigation, preparedness, response, and recovery
- The role of the healthcare facility in data collection and epidemiological investigation during an emergency or outbreak
- Information sharing and communication during a public health emergency

## Key Terms

**Case definition** is a set of uniform criteria used to define a disease for public health surveillance.

**Emergency management** is the process by which an individual, facility, and/or community uses mitigation strategies to better prepare for, respond to, and recover from a disaster or emergency.

**Endemic** refers to the baseline level of disease occurrence in a community; in technical terms, it refers to the usual prevalence of cases of a disease or infectious agent in a population (group of people) in a geographic area.

An **epidemic** is the occurrence of more cases of a disease than expected in a defined population, geographic area, or season.

**Isolation** is the separation of people who have a communicable disease from others.

**Mitigation** is the actions taken before and during an outbreak or epidemic to decrease the potential impact of the situation.

**Outbreak** is the occurrence of more cases of a disease or infectious agent than expected in a defined population (group of people), geographic area, or season. This is the same definition as "epidemic," but an outbreak usually refers to disease events occurring in a more limited geographic area than an epidemic.

A **pandemic** is an epidemic that has spread over several countries or continents, usually affecting a large number of people.

**Quarantine** is the separation and restriction of movement of people who may have been exposed to a communicable disease but are not yet ill. It is used to stop the spread of a disease.

**Surveillance** is the systematic collection, analysis, and interpretation of data on the frequency of disease. It is essential to the planning, implementation, and evaluation of public health practices and the timely dissemination of this information for public health action.

**Zoonotic disease** is a disease that can be passed between animals and humans.

## BACKGROUND

Public health emergencies can be classified in various ways. One way is to differentiate between infectious and non-infectious emergencies. Infectious disease emergencies include all events that involve a biological agent (e.g., bioterrorism event) or a disease (a pandemic or an outbreak of an emerging pathogen) and which impact a large number of people, such as in a pandemic (e.g., avian influenza) or an outbreak of an emerging infectious disease (e.g., Middle East Respiratory Syndrome-Corona Virus [MERS-CoV]). Non-infectious disease emergencies include all natural and manmade events that do not include an infectious agent as the source of the incident.

Infectious disease outbreaks can be triggered by other emergencies, such as natural disasters. These are usually the result of population displacement, poor sanitation, lack of clean water, breakdown of healthcare services and prevention efforts, endemic pathogens, zoonotic diseases, and foodborne illness. After a natural disaster, animals and humans may face displacement, which can lead to an increase in zoonotic diseases (APIC 2014).

As an example, there was an outbreak of cholera following the 2010 earthquake in Haiti. Before the outbreak, Haiti had been free from cholera for more than 100 years. Displacement of more than 1 million people, destruction of water and sanitation systems, poor sanitation, and improper hygiene resulted in contamination of drinking water with the *Vibrio cholerae* bacteria and an outbreak of cholera (CDC 2011a; WHO 2015b).

### Infection Prevention and Control and Public Health Emergencies

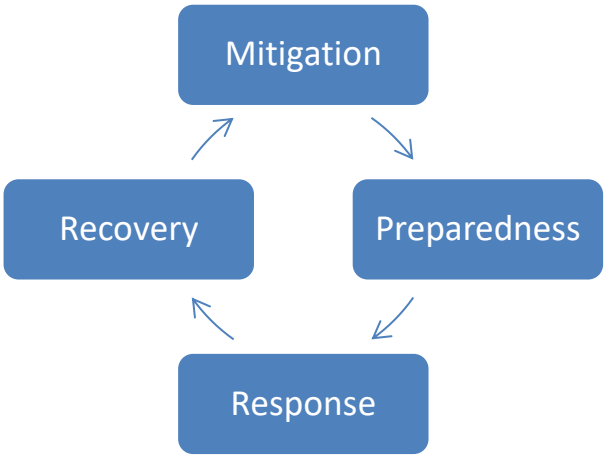
Outbreaks and public health emergencies tend to bring IPC infrastructure into the spotlight as routes of disease transmission are investigated. Many outbreaks in the past have revealed breakdowns in IPC practices, even in institutions and countries that were assumed to have strong practices.

With the increased attention comes an effort to strengthen the systems already in place. For example, during the 2014–2015 EVD outbreak, a CDC team found many lapses in basic IPC practices during a rapid needs assessment in Sierra Leone. The team identified a lack of dedicated IPC personnel and standard operating procedures related to many IPC practices, including screening, triage, and isolation. The investigation into the causes of EVD transmission in a healthcare facility in Texas in the United States revealed staff skills in the appropriate use of PPE were lacking in many instances. The findings of these reports triggered resources for developing basic IPC practices (Chevalier, Chung, Smith, et al. 2014; Pathmanathan, O'Connor, Adams, et al. 2014).

### Four Principles of Emergency Management

Public health emergencies should be planned for and responded to using the primary principles of emergency management (figure 5.1-1): mitigation, preparedness, response, and recovery.

Figure 5.1-1. The Four principles of emergency management




## Mitigation

Mitigation strategies can help a healthcare facility decrease the devastating impact of a potential public health emergency. The exact mitigation strategy used will depend on the type of event. The strategy should include activities that would prevent or reduce the chance of an emergency, or reduce vulnerability of high risk groups. For example, offering timely vaccination if an effective vaccine is available against the disease, such as influenza, polio, measles, or yellow fever, can prevent or mitigate an outbreak of these diseases (APIC 2014; FEMA 2015).

## Preparedness

Healthcare organizations, facilities, and communities that are most successful at handling public health emergencies begin preparations long before any cases of disease or other emergencies occur. Preparedness actions, which take place before an emergency, increase a facility's ability to respond when an emergency occurs. They include planning, organizing, training, equipping, practicing, evaluating, and taking corrective actions. IPC aspects of preparedness include stockpiling IPC supplies, training staff, and increasing compliance with recommended IPC practices during mitigation.

However, preparedness is more than writing a plan down on paper. It is essential to test the system and make sure that the facility is clear about who is expected to do what.

**Preparedness Assessment**

Facilities should perform a facility preparedness assessment during the early preparedness stages to determine whether the facility is prepared, and where actions and resources for handling a public health emergency are most needed. (See Appendix 5.1.A for an example of a facility emergency preparedness checklist.)

In addition to performing a facility assessment, other key steps in the pre-emergency preparedness phase are:

- Creating a strong disease surveillance system
- Reinforcing IPC practices

- Coordinating with health ministries or other public health authorities
- Partnering with the community for education, involvement, and communication
- Performing drills and tests of the system

These steps are described in detail in the following sections.

**Create a Strong Disease Surveillance System**

Facilities and communities should be able to identify when a disease rises above normal levels in a specific facility or area. Outbreaks, epidemics, and pandemics, by definition, occur when there is an increase in the endemic level of a disease in a certain area. A strong disease surveillance system should assist a facility in identifying cases of disease that are of concern. (See Volume 2, Section 3, Chapter 1: Introduction to Surveillance of Healthcare-Associated Infections, for more detailed information on how to create surveillance systems for HAIs.) Partnering with the public health authorities will assist a healthcare facility to increase its awareness concerning diseases in neighboring communities or countries.

**1. Case Definitions**

During an outbreak situation, it is important that a facility have clear procedures for identifying, investigating, and evaluating possible cases of disease. Successful case identification depends on clear and easy-to-use case definitions. Case definitions in community outbreak situations are generally developed or adapted by national or international public health authorities. Case definitions describe the characteristics and signs or symptoms of a disease so that those who might have the disease can be recognized early and followed up by healthcare facilities or public health authorities. It can be challenging to create a case definition during an outbreak of a new infectious disease, especially in the early stages of the outbreak when there is not a lot of information available (CDC 2021b).

Case definitions should be specific enough to identify true cases of disease that are part of an outbreak, and at the same time, they should be sensitive enough to capture all potential cases. During an outbreak, case definitions are used to classify the likelihood of a specific case being a part of the outbreak. Case definitions can be separated into three categories: confirmed, probable, and possible cases.

- **Confirmed cases** are typically laboratory-confirmed cases.
- **Probable cases** usually have characteristics and clinical features of the disease but do not have laboratory confirmation.
- **Possible cases or suspect cases** usually have some, but not all, of the characteristics and clinical features of the disease and do not have laboratory confirmation.

As an outbreak evolves and more information becomes available, it is common for case definitions to be adapted and change.

MERS-CoV is a viral respiratory illness that affects the lungs. The first known cases of MERS-CoV occurred in Jordan in April 2012.

**2. Screening and Triage Systems**

Preparation should include setting up a screening and triage system. The goal of screening patients is to quickly identify potential cases before they receive care in the healthcare facility, thus minimizing the risk of disease transmission in the facility.

After a patient arrives at a facility, screening should occur as soon as possible, ideally before any direct patient care begins. It is not necessary for the person conducting the screening to be a clinician, but everyone involved in screening and triage should be appropriately trained. It is helpful to have print copies of screening forms as job aids. The person conducting screening may be required to wear some PPE or maintain a distance of at least 2 meters (6 feet) from the patients, depending on the disease and its mode of transmission.

In addition to having case definitions for screening, HCWs should know what to do with any patients who meet the case definition criteria. There should be a designated workflow that moves patients from screening to isolation and triage, as indicated. Staff engaged in screening and triage should follow the recommendations for reporting a positive case and follow the specific instructions on reporting frequency.

Any patients identified by screening should be isolated immediately. Isolation refers to the physical separation of these patients from other patients. Potential cases should be moved to an area away from other patients and staff, and appropriate PPE should be worn by all staff. The designated area for these patients should be decided ahead of time. The type of isolation and PPE required will depend on the characteristics of the disease and the possible mode of disease transmission. (More information on the types of PPE can be found in Volume 1, Chapter 5: Personal Protective Equipment.)

**Reinforce IPC Practices**

IPC practices should be followed every day with every patient in a healthcare facility. However, during an outbreak or other public health emergency, complying with IPC principles becomes more critical. Basic IPC measures, such as standard precautions, including hand hygiene, cleaning and disinfection, and transmission-based precautions, are key practices that help prevent disease transmission in healthcare facilities at all times, including during an outbreak.

A facility must have strong IPC principles in place before the outbreak occurs to rapidly prevent any further spread. A component of preparedness is training HCWs and other facility staff on the basics of IPC. Box 5.1-1 lists IPC topics to be prioritized for education as part of a preparedness plan.

Box 5.1-1. IPC topics for staff education during the preparedness phase

- Self-screening for illness
- Screening and triage of patients
- Internal and external reporting of communicable diseases
- Surveillance
- Emergency management plan and procedures
- Modes of disease transmission
- Standard precautions
- Transmission-based precautions
- Respiratory etiquette
- Hand hygiene
- Handling contaminated linens
- Obtaining and handling specimens
- Environmental cleaning and disinfection
- Cleaning, disinfection, and sterilization of medical equipment and devices
- Waste management procedures
- Decontamination procedures
- Postmortem care
- Vaccination

- Use and reuse of PPE

*Adapted from*: Rebmann 2009

Most outbreaks involve organisms that require transmission-based precautions, in addition to standard precautions. The availability and proper use of PPE are critical in an outbreak situation. The types and combinations of PPE worn during an outbreak will depend on the mode of transmission of the organism. If worn correctly, PPE is an effective physical barrier between infectious agents and the HCW.

The greatest risk of contamination to HCWs is during the removal of PPE. Emergency preparedness activities for HCWs should include competency-based training and adequate practice on the use of PPE. PPE training and competency assessment should occur during the pre-emergency preparedness stages. Practice with immediate visual feedback of contamination can help staff to see where contamination is likely to occur. This can be accomplished using red paint, jam, tomato ketchup, fluorescent dye, or other brightly colored materials (Tomas, Kundrapu, Thota, et. al 2015). (See Volume 1, Chapter 5: Personal Protective Equipment, for more information.)

As part of the preparedness, a healthcare facility should make sure that there is enough PPE for an outbreak or emergency situation. It is challenging to determine how much PPE to stockpile, especially because the type of PPE varies depending on the pathogen. The amount to be stockpiled can be based on the number of HCWs, the number of PPE sets required for each HCW per day, and the estimated length of time of the outbreak using the following calculation:

*(Number of HCWs x number of PPE sets per HCW per day) x estimated number of days in outbreak = Estimated number of PPE sets needed for stockpile*

The estimated cost of the PPE stockpile can be calculated by multiplying this number by the average cost of one set of PPE (Hashikura, Kizu 2009). (See Appendix 5.1.B for an example of calculating a PPE stockpile.)

IPC practices must also be followed when collecting, transporting, and handling laboratory specimens to prevent disease transmission to HCWs and lab workers. (See Volume 1, Chapter 2: Basic Microbiology for IPC, for details on safe specimen collection and handling.) Safe work practices by laboratory workers, including biosafety precautions appropriate for the pathogen, must be in place. (See Volume 2, Section 4, Chapter 3: Clinical Laboratory Services, for more details on safe work practices in the laboratory and appropriate safety considerations for each biosafety level.)

### Coordinate with Health Ministries or Other Public Health Authorities

As recent outbreaks have demonstrated, disease cases can spread over large geographic areas in just a few days or weeks. With constant international travel and many portals of entry and exit across porous borders, the likelihood of an infectious disease spreading across multiple countries, and even continents, has increased. Ministries of health play a critical role in understanding the bigger picture of disease distribution, and these authorities can be very valuable in helping to identify disease threats that may be moving toward a facility or country. Open communication with public health authorities will help a facility remain vigilant for emerging pathogens.

### Partner with the Community for Education, Involvement, and Communication

The community presents a unique challenge during an outbreak or emergency situation. It may be easily alarmed and skeptical of the information coming from the authorities during an emergency (WHO 2005a). Mistrust in a community can escalate during emergency situations. Open communication with the community can reduce the potential for feelings of mistrust if an outbreak occurs. Community members can help disseminate information and follow recommendations from public health authorities, including recommendations on isolation and quarantine. By developing a good relationship with the community before an emergency occurs, the community and healthcare facility are better able to come together during times of public health emergency.

**Perform Drills and Tests of the System**

With effective disease surveillance systems, strong IPC practices, and good partnerships with the local public health authorities and the local community in place, a healthcare facility is much more likely to be able to respond well to a public health emergency. However, healthcare facilities should test their systems to ensure that plans unfold as intended and roles and responsibilities are clear. Each test of the system is a learning process and enables emergency preparedness plans to be further refined.

## Response

Response to public health emergencies includes activities in reaction to a known or suspected event. This is when emergency plans are operationalized. Depending on the nature of the emergency, response activities may be restricted to the healthcare facility itself or may include local, community, regional, and national actions, and may continue for a short, intermediate, or long time. Response functions and tasks are divided into three time frames: **immediate, intermediate, and extended** (table 5.1-1).

Response to any public health emergency is a dynamic process; activities may be repeated at various stages of the response. Immediate and intermediate interventions are implemented during the first 24 hours, and the extended response activities are implemented until the emergency is over (CDC 2011b)

Many facilities use the formal Incident Command System (ICS) when responding to an emergency. ICS is a management system aimed at using a common organizational structure to respond to an incident. ICS can be used across many different disciplines and in many types of incidents, including public health emergencies. ICS usually takes into account activities involving command, operations, planning, logistics, and finance and administration (FEMA n.d.).

Table 5.1-1. Public health emergency response, by time frame

| Immediate response (0–2 hours) | Intermediate response (2–6 hours) |
|---|---|
| • Assess the situation.<br>• Contact key government health personnel.<br>• Develop immediate response objectives and establish plan of action.<br>• Establish emergency operation center, if indicated, and engage public health professionals.<br>• Ensure that the site health and safety plans to protect response personnel are followed.<br>• Establish communication with key health and medical organizations.<br>• Assign and deploy resources and assets for initial health response objectives (including healthcare needs of those affected).<br>• Address requests for assistance and information.<br>• Initiate risk communication activities.<br>• Engage legal counsel, if available.<br>• Document all response activities. | • Continue activities already initiated.<br>• Verify that surveillance activities are operationalized.<br>• Ensure that laboratories are operational for confirmation of cases.<br>• Address the needs of special populations (e.g., children, pregnant women, elderly).<br>• Communicate with community about need for health-related volunteers and donations.<br>• Update risk communication messages as new information becomes available. |
| **Intermediate response 6–12 hours** | **Extended response 12–24 hours** |
| • Continue activities already initiated, as appropriate.<br>• Collect and analyze disease surveillance and laboratory data.<br>• Update information and make changes to objectives and plans, as needed.<br>• Prepare for onsite assistance from public health authorities.<br>• Assess and acquire supplies and other resources. | • Address mental and behavioral health support needs.<br>• Prepare for transition to extended operations. |

| Extended response: Ongoing public health emergency response functions and tasks from 24 hours onward | | |
|---|---|---|
| • Identify environmental hazards.<br>• Assess potential hazards.<br>• Assess epidemiological services.<br>• Assess health and medical needs.<br>• Identify and treat affected individuals.<br>• Control contamination.<br>• Conduct surveillance, include laboratory.<br>• Manage wastes.<br>• Quarantine and isolate affected individuals. | • Provide public health information.<br>• Communicate with facility staff and community.<br>• Assess responder safety and health.<br>• Assess overall health and medical personnel resources.<br>• Check health and medical equipment availability.<br>• Organize health-related volunteers and donations.<br>• Review in-hospital care.<br>• Plan evacuation and sheltering in place. | • Manage trauma and fatalities.<br>• Assess morgue services and disposal of human remains.<br>• Initiate mental health and social services.<br>• Ensure water and food safety.<br>• Control vectors.<br>• Review sanitation and hygiene practices.<br>• Maintain routine services.<br>• Coordinate with veterinary services.<br>• Plan long-term community recovery. |

Adapted from: CDC 2011b

## Recovery

Once an emergency is declared "over," the recovery efforts begin. Although specific recovery activities will vary depending on the type of event that has occurred, there are six general principles for recovery actions:

- Establish short- and long-term goals to return a facility or community to the pre-event baseline.
- Evaluate how the emergency management plan was carried out and identify gaps that occurred during the response.
- Determine potential solutions to the gaps identified in the emergency management plan.
- Update the emergency management plan to reflect lessons learned.
- Educate staff on changes in the emergency management plan.
- Practice the new emergency management plan.

(APIC 2014)

Restoring normal life in a community or facility is an important way to make staff feel safe and comfortable. There is no defined time period for how long recovery actions will take place.

Post-event evaluation is a critical piece of the emergency management framework. The goal of the post-event evaluation is to improve the system and to further increase the preparedness level of a facility. There are areas for improvement in every emergency response. It should be noted that identifying improvements is not a sign of weakness or failure. Questions to consider during the post-event evaluation include:

- Was the facility response appropriate for the emergency?

- Were the emergency preparedness plans implemented as they were intended to be implemented?
- Were the emergency preparedness plans timely and effective?
- Were the facility's patients, staff, and HCWs safe?
- Could risks have been further reduced for patients, staff, and the community?
- Were there any gaps in the system?
    - What was done well?
    - What could have been done better?

Recovery efforts should be multidisciplinary and include individuals with different backgrounds and expertise. Findings of the post-event evaluation can be compiled into an after-action report. Putting the findings into one document will easily allow the facility to identify strengths and opportunities for improvement.

Once an assessment of the response to the event has been performed, changes and adjustments to the emergency plans should be made to reflect the post-event discussions. Staff should be educated about these changes to make sure that they understand their roles and responsibilies in an emergency. Last, the whole cycle should begin again, with mitigation and preparedness. The new response system should be tested, especially the new portions of the system that were added after the emergency occurred.

## Role of the Healthcare Facility in Data Collection and Epidemiological Outbreak Investigation during an Emergency

Outbreak investigation requires cooperation and collaboration among many groups, including healthcare providers, epidemiologists, IPC staff, public health authorities, and the community. The healthcare facility has a role in assisting public health authorities with data collection and outbreak investigation during outbreak situations.

The ultimate goal of any outbreak investigation is to implement measures that stop or reduce the risk of continued spread and future occurrences of disease, and to methodically identify the factors that may have contributed to the outbreak. This is not always an easy task due to the many factors contributing to an outbreak. In addition, it is not always easy to collect data and information during an outbreak. However, data collection helps identify the scope of the outbreak, assists with refining and changing the case definition to be more accurate, identifies where to focus resources, and leads to a better understanding of risk factors. By tracking risk factors and exposures, outbreak investigators can better understand how to prevent exposures in healthy individuals. The WHO Ebola Situation Reports that were issued weekly during the 2014–2015 EVD outbreak in West Africa provide an example of excellent data collection during an outbreak (WHO 2015a).

### Outbreak Communication and Information Dissemination

Public health emergencies and outbreaks present many challenges for a healthcare facility, including how best to communicate with the public and the community. A public health emergency or outbreak brings its own unique set of communication difficulties that are defined by the pathogen, its mode of

transmission, and the political, economic, and cultural context in which the outbreak occurs. WHO has identified five best practices for outbreak communication (also called "risk communication"):

- Build trust
- Announce early
- Be transparent
- Respect public concerns
- Plan in advance

The goal of using these principles is to promote rapid containment of the outbreak with minimal social and economic disruption to the community (WHO 2005a).

### Build Trust

Building and maintaining trust with the community is the foundation for successful emergency communication. The public needs to trust that the health authorities are honest, competent, and in control throughout the outbreak. A foundation of trust in the investigators will reduce public anxiety during times of uncertainty, lead to greater compliance with recommendations from the authorities, and help prevent reactions that exacerbate an outbreak's social and economic impact.

### Announce Early

Announcing information early in the outbreak sets the tone for the entire outbreak. By sharing information early, expectations are set that information will be shared as it is learned and will not be concealed from the public. Early announcement is especially important for diseases that spread rapidly from one community to another and from one country to another. The very first communication about an outbreak can set the tone for all communications throughout the outbreak, adding to the importance of announcing early.

### Be Transparent

Transparent information is honest, easily understood, complete, and accurate. The more transparent communication is, the more trust the public will have in it. However, there are limits to transparency, especially when dealing with confidential and sensitive patient data.

### Respect Public Concern

It is important for health officials to listen to the concerns and fears of the public, even if they seem like overreactions or irrational. Being respectful of the concerns of the public will help to maintain trust.

### Plan in Advance

A communication plan is essential for good communication during an emergency or an outbreak. Emergencies can be chaotic, stressful, and emotional. It is best to develop a plan for communicating with the public before the outbreak even begins.

## SUMMARY

History has shown that basic IPC practices play an important role during outbreaks and public health emergencies. This role highlights the need for resources for strengthening basic IPC practices to prepare for the next public health emergency or outbreak. The four main principles of emergency management—mitigation, preparedness, response, and recovery—help determine how a healthcare facility will respond to an emergency or outbreak. Key steps in preparing facilities for an emergency are: creating a strong disease surveillance system; reinforcing basic and enhanced IPC principles; partnering with health ministries and the community for education, involvement, and communication; and testing the system. Although some public health emergencies cannot be prevented, the amount of time invested by a healthcare facility in preparing will help determine how successful the facility will be in responding to an emergency.

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# CHAPTER 2: MANAGING INFECTION PREVENTION AND CONTROL PROGRAMS

### Key Topics

- Structure and organization of IPC program management
- Roles and responsibilities of HCWs involved in IPC programs
- Attributes of effective IPC and PS programs
- Core components of IPC programs
- Major IPC program activities
- Continuous improvement IPC practices using a model for improvement

## BACKGROUND

Proper management of IPC and PS programs at various levels of implementation has paramount importance for the success and fulfillment of basic strategic objectives. Programs for preventing the spread of infectious diseases by any route and overall PS in healthcare facilities are based on understanding the scope of the problem, prioritizing activities, and effectively using available resources and scientific standards. Because available resources are invariably limited, careful planning, implementing, and monitoring activities on a regular basis are all essential from the primary to the tertiary level of the healthcare system. Proper supportive supervision for performance improvement and change management is also critical for IPC activities management. In many countries, including in Ethiopia, functioning infection surveillance systems are lacking and laboratory backup to identify the cause of HAIs is inadequate. Therefore, IPC and PS are not only the most cost-effective option of mitigating morbidity burden, but also the only realistic method to limit the spread of disease and insure PS in healthcare facilities. As with any clinical area, numerous situations arise calling for tough decisions to be made in IPC and PS, weighing the advantages of a certain procedures against the possible risks to the patient or HCW. These decisions must be practical and consistent inasmuch as possible, and most of all, should be based on scientific evidence. To make this happen, healthcare administrators, clinic managers, and staff at all levels of the healthcare system must be totally committed to supporting and applying recommended IP and PS practices.

### Structure and Organization of IPC Programs

Ideally, IPC at the facility level receives support from the highest-level public health authorities, with a planned and effective national IPC structure (WHO 2016). Having a robust structure and capacity in IPC at national and local levels strengthens the ability to plan and implement all core components of IPC, and also respond to communicable disease emergencies. This is reflected in WHO's *Core Components of IPC* (2016), in which the first six components have requirements at national and facility levels. The WHO Core Components of IPC are:

1. IPC programs at national and facility levels
2. IPC guidelines at national and facility levels

3. IPC education and training at national and facility levels
4. Surveillance of HAIs at national and facility levels
5. Multimodal strategies for implementing IPC activities at national and facility levels
6. Monitoring, evaluation, and feedback at national and facility levels
7. Workload, staffing, and bed occupancy at the facility level
8. Built environment, materials, and equipment for IPC at the facility level

(WHO 2016)

WHO calls for every country to have a national-level IPC program, with appointed staff, clear objectives, and a defined scope of responsibilities. However, a recent survey by WHO reports that only 41% (54/133), fewer than one-half of the countries surveyed, had a national IPC program in place (WHO 2016). Please note that, in Ethiopia, the IPC program includes the implementation of PS interventions.

Table 5.2-1. Composition, roles, and responsibilities for IPC programs at different levels

| **Level: Federal MOH and regional levels** | |
|---|---|
| Composition and required capacity | At a minimum, include a multidisciplinary group/committee to support an appointed technical team of trained IPC staff (including medical and nursing professionals) with protected and dedicated time and budget, decision-making authority, and links to related national-level programs and professional and academic organizations. |
| Role | Support facility-level programs in reducing healthcare risks and HAIs, and represent the IPC program at the national or regional level.<br><br>The main roles at the federal level are:<br>• Develop guidelines, polices, audit tools, and disseminate them<br>• Arrange periodic supportive supervision<br><br>Regional health bureaus should make:<br>• Periodic supportive supervision visits to facilities to assist materially and technically to fill gaps<br>• Advance efforts to achievement the national IPC performance standards |
| Responsibilities: | • Set objectives and functions of the national IPC program, appoint IPC program staff and define the scope of their responsibilities and, at a minimum, set goals to be achieved for endemic and epidemic infections and healthcare risks; develop recommendations for IPC processes and practices to prevent HAIs and AMR.<br>• Represent the IPC program with other national-level programs and stakeholders.<br>• Develop and update national, evidence-based IPC guidelines and implementation strategies to reduce HAIs and AMR.<br>• Ensure that infrastructure and supplies needed to enable the guidelines are in place.<br>• Develop a national surveillance program to monitor selected healthcare risks, HAIs and AMR patterns, including locally appropriate, standardized definitions, reporting channels, data management, laboratory support, and timely data feedback and benchmarking. Coordinate and facilitate the implementation of multimodal IPC strategies on a nationwide or subnational level.<br>• Develop a national monitoring and evaluation system to assess that IPC standards are being met. |

| | |
|---|---|
| | • Monitor hand hygiene compliance data and feedback as a key performance indicator.<br>• Support and mandate training programs for HCWs on IPC and guideline recommendations.<br>• Collaborate with local academic institutions to develop pre- and post-graduate IPC curricula.<br>• Facilitate access to materials and products essential for hygiene and safety.<br>• Encourage facilities to monitor HAIs with feedback to healthcare professionals.<br>• Be responsible for IPC aspects of national preparedness planning. |
| **Level: Facility-level** | |
| Composition and required capacity | Various possible structures, with at least one IPC focal staff member per maximum of 250 acute care beds (one IPC staff per 100 beds is recommended). |
| Role | Support facility-level programs in reducing the healthcare risks and HAIs, and represent the IPC program at the facility level. |
| Responsibilities of IPC focal person/s: | • Provide IPC expertise at the facility to ensure safe and efficient care to all patients by developing guidance, measuring compliance, conducting surveillance for infections, providing education, and intervening directly, when needed, to prevent infections.<br>• Conduct risk assessment to develop program objectives based on local epidemiology and facility priorities.<br>• Write, adapt, and adopt evidence-based guidelines based on international and national standards.<br>• Organize, implement, and monitor IPC practices using multimodal strategies, guided by a yearly work plan and linked to national quality improvement programs or accreditation.<br>• Conduct active surveillance of healthcare risks and HAIs to inform and guide IPC strategies, with timely feedback to HCWs and reports to national networks.<br>• Periodically assess surveillance data quality.<br>• Monitor (audit) healthcare practices against IPC standards with timely feedback to staff for the purpose of behavior change.<br>• Develop a plan to assess the effectiveness of interventions to improve PS at the facility (objectives met, goals accomplished, activities performed, aspects that may need improvement).<br>• Conduct training for HCWs in IPC (upon hire and periodically) using team- and task-based strategies that are participatory and include hands-on training.<br>• Evaluate effectiveness of training and staff knowledge periodically.<br>• Prioritize and ensure access to materials and products essential for hygiene and safety within the parameters of available resources.<br>• Advocate for bed occupancy not to exceed facility capacity and for staffing levels to be adequate for the workload to prevent HAIs.<br>• Advocate for the provision of a clean and hygienic patient care environment and the availability of appropriate IPC materials, including for hand hygiene at point of care.<br>• Represent IPC in relationships with other programs and stakeholders in the facility.<br>• Take responsibility for IPC aspects of facility preparedness planning. |
| **Level: Role of facility-level staff** | |
| Facility leadership | • Facility leadership should adapt the program structure based on the scope of the IPC program and the needs of the facility |

| | |
|---|---|
| IPC committee | • Provide a forum for multidisciplinary support, input, cooperation, and information sharing and oversight.<br>• Meet promptly in the event of an emergency situation.<br>• Report directly to administration or medical staff to promote program visibility and effectiveness. |

*Source*: Curless 2018

## The three primary goals for facility-level IPC programs are to:

- Protect patients
- Protect HCWs, visitors, and others in the healthcare environment
- Achieve this protection in the most cost-effective manner, within the constraints of available resources (Friedman, Barnette, Buck, et al. 1999; Scheckler, Brimhall, Buck, et al. 1998).

The structure and organization of the program tasked with achieving these goals can vary. It should take into account the unique situation, needs, and resources of each facility and the environment in which it operates. Such considerations as the type of care that is provided and the size of the facility are examples of factors that will influence the organization of the IPC program. There is no set organizational structure that is recommended over another as long as the key attributes and key staff/groups are in place (APIC 2014b; WHO 2002; WHO 2016).

## Some considerations and examples for possible IPC program structure include:

- All responsibilities of the program are carried out by IPC focal staff and are guided by a healthcare epidemiologist/infectious disease physician or other physicians with relevant expertise (e.g., a microbiologist or pathologist). A governing structure, like an IPC committee, is important to maintaining multidisciplinary input, support, and oversight (WHO 2002).
- The IPC team is composed of the IPC focal staff, chair of the committee, healthcare epidemiologist/infectious disease physician, or a physician with experience and expertise in infectious disease management. The team works closely with those responsible for occupational health. All responsibilities of the program are carried out by this group, with one person designated as the primary leader (APIC 2014b; Scheckler, Brimhall, Buck, et al. 1998).
- An IPC committee is the central decision-making body reporting to the medical staff administration. The IPC committee acts as the advocate for prevention and control of infections in the facility, formulates and monitors patient care policies, educates HCWs, and provides political support that empowers the IPC team as they implement IPC activities (Cook, Marchaim, Kaye 2011; Wiblin, Wenzel 1996).
- Multidisciplinary support is obtained via quality improvement teams that meet regularly, and are responsible for planning, policy development, interventions, and decision making rather than via an IPC team (APIC 2014b).

- IPC staff have designated hours each week (less than full time) to dedicate to IPC. The remainder of their time can be spent in clinical care or another area, such as occupational health or quality improvement (APIC 2014b; Smith, Bennett, Bradley, et al. 2008; WHO 2002).
- If one IPC staff member attends multiple clinics or facilities for an IPC activity, a structure, such as an IPC committee, is important for maintaining support and oversight (APIC 2014b; Smith, Bennett, Bradley, et al. 2008; WHO 2002; WHO 2016).
- The IPC focal staff report to and are overseen by a separate administrative area, such as microbiology, laboratory, medical or nursing hierarchy, public health services, quality improvement department, PS department, or another area (APIC 2014b; WHO 2002).

### Ratio of IPC Professionals to Workload

The WHO Core Components of IPC strongly recommend a minimum ratio of one full-time equivalent, adequately trained IPC staff member (nurse or physician) per 250 acute care beds. However, a higher ratio should be considered; for example, one IPC staff member per 100 beds because in many settings, patient acuity and complexity are increasing, as are expectations and responsibilities of IPC staff (WHO 2016).

## Roles and Responsibilities of HCWs Involved in IPC Programs

In addition to the designated program leader, key staff and groups involved in IPC and PS programs and who play a role in the oversight of a successful program include:

**Administrative leadership**: The reporting structure for the IPC program varies among healthcare facilities and can be adapted to fit the local context of the facility. One or more healthcare administrators will supervise the leader of the IPC program and will take an active role in helping shape and support the program's priorities and plans.

**IPC committee**: Partnerships between the IPC staff and others in the healthcare facility are necessary. In addition to the informal relationships and collaboration that occur with partners, it is important to identify and bring together key healthcare facility staff in a formal partnership to form and maintain an active IPC committee or similar administrative group. The purpose of the committee is to guide and support the use of recommended practices, and to review and resolve related problems that may arise. The committee also advocates for resources required for effective implementation of the IPC program. This committee should include representatives from different wards and units, including procurement, laboratory, sterilization, environmental cleaning, etc. In small facilities (e.g., health posts and clinics), where these functions often overlap, the group may consist of only two or three people. The IPC committee should meet on a regular basis, usually monthly, to review available IPC data and any problems or issues that are identified. Available IPC information can be used to plan and implement interventions to address the issues. The IPC committee should also participate in reviewing, developing, and approving the facility's IPC policies and in the yearly risk assessment, goals, and program evaluation that are described in the next section.

**Task forces/working groups**: Task forces or working groups, or similar structures that interact with the IPC team, may be needed at times. They can be permanent or temporary groups, and can be created, as needed, to provide input and oversight for a particular issue. Examples include groups

focused on disinfection and sterilization, waste management, or emergency preparedness. Task forces/working groups should consist of people with multidisciplinary expertise, and should be granted authority to make decisions and advise and oversee the IPC leadership and team in addressing the issue. IPC leadership or team members should also be included (WHO 2016).

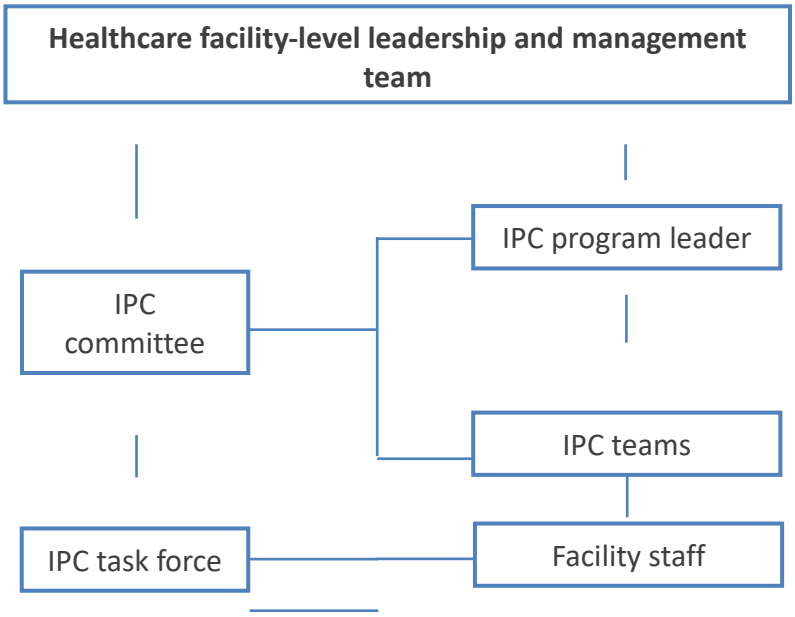
**Organizational oversight from top facility leadership**: IPC programs require input from the leadership of the facility. The actual organizational structure is not as important as the fact that IPC has been set as an organizational priority for the safety of patients. In addition to support for IPC (as described earlier in this chapter), the person or group with organizational authority should periodically review the status of HAIs at the facility and the effectiveness of measures designed to contain them (WHO 2002). This review can take the form of a quarterly report to the board of directors, the director, or the owner(s) of the facility. Although it can be difficult and sometimes distressing to review the performance of the program, the process can highlight important areas of risk and opportunities for improvement. Demonstration of these priorities and needs often prompts organizational leadership to provide the necessary support, authority, and resources to meet the facility's IPC needs. (See the Program Evaluation section later in this chapter.)

**National or regional public health authorities**: Public health authorities work closely with and support the facility-level IPC program, providing expertise, partnership, assistance, guidance documents, support for outbreak investigations, and authority to enforce IPC measures. The facility-level IPC team provides important frontline information to the public health authorities.

## Roles and Responsibilities of Facility-Level Staff

When considering the organization and structure of a facility's IPC program, it is important to have a clear concept of the composition, roles, and responsibilities of important program staff, including the IPC committee, program leader, IPC task forces, and facility staff (figure 5.2-1). The sections below on the IPC committee, program leader, task force/working group, team, and facility staff describe the recommended composition, roles, and responsibilities for each. Facility leadership should adapt the program structure based on the scope of the IPC program and the needs of the facility. Small healthcare facilities in rural areas may have one staff nurse or a medical officer and a few nurses, midwives, and other HCWs and limited scope of IPC, and may not need a staffing structure like that depicted in figure 5.2-1. Most functions related to the IPC program may be looked after and implemented by a small team. In a medium- to large-size facility, there should be a more organized staffing and program structure.

Figure 5.2-1. IPC program staff structure at the health facility level




*Source*: Curless 2018

## IPC Committee

**Composition**: Includes a wide representation of stakeholders at the facility, including administrators, leaders of the main clinical departments, physicians, nurses, and support services staff. Support services include central supply, maintenance, clinical microbiology laboratory, pharmacy, housekeeping, environmental services, orderlies, waste management, training, and others.

**Role**:

- Provide a forum for multidisciplinary support, input, cooperation, and information sharing and oversight.
- Meet promptly in the event of an emergency situation.
- Report directly to administrative or medical staff to promote program visibility and effectiveness.

**Responsibilities**:

- Meet regularly (monthly or quarterly) and keep a record of the topics discussed and decisions reached.
- Review and approve the yearly risk assessment and plan of program activities for surveillance and prevention.
- Review surveillance data and identify areas for intervention.

- Assess and promote improved practices at all levels of the facility.
- Ensure appropriate training in IPC.
- Review risks associated with new technologies, and monitor infection risks of new devices and products before their approval.
- Review and provide input on the investigation of epidemics.
- Communicate and cooperate with the other hospital committees with common interests (such as pharmacy antimicrobial use committee, biosafety, blood transfusion committee, etc.).

### IPC Program Leader

**Composition**: Ideally, a health professional (a physician or a nurse/midwife) with training, experience, and, if possible, certification in IPC.

**Role:** Assumes responsibility for the program activities, including guiding the implementation of the yearly plan, managing IPC staff, building the team, and providing expertise in and assuring the quality of day-to-day IPC activities.

**Responsibilities:**

- Represent the team and the program with the higher-level facility administration.
- Oversee and coordinate the IPC program activities, as described below.
- Build an effective and cohesive IPC team.
- Ensure that a quality improvement approach is applied to IPC activities.

### IPC Task Force/Working Group

**Composition**: Individuals with multidisciplinary expertise in the issue at hand. IPC leadership or team members should also be included. The group can be a permanent or pre-existing group, or it can be created to provide input and oversight of the IPC program for a specific issue.

**Role:** Provide input and advice and oversee the IPC program for a specific issue, with authority to make decisions about the issue. Examples can be groups focused on disinfection and sterilization, waste management, or emergency preparedness.

**Responsibilities:**

- Actively participate in the IPC task force/working group.
- Advise and oversee the IPC leadership and team in addressing the issue at hand.
- Meet and report regularly to the IPC committee on progress.

## IPC Team

**Composition:** Larger institutions may have full-time IPC teams or the team may have another composition, as described in this chapter. The composition and selection criteria for the IPC team should be decided by the IPC committee and department heads.

**Role:** Serve in a scientific and support role in attending to the day-to-day functions of IPC, acting as consultants, educators, role models, researchers, and change agents.

**Responsibilities**:

- Prepare and implement the yearly work plan, as per guidance from the IPC leader.
- Organize and conduct surveillance for HAIs and monitor events reporting on PS.
- Investigate and address outbreaks, and provide expert advice, analysis, and leadership in outbreak investigation and control.
- Oversee the implementation of and compliance with IPC practices.
- Assist the IPC committee in product and material evaluations.
- Control and audit methods of disinfection and sterilization, and the effectiveness of systems developed to improve hospital cleanliness.
- Implement departmental training programs.
- Support and participate in research and assessment programs at national and international levels.
- Participate in the development and operation of regional and national IPC initiatives.
- Participate in programs and initiatives to promote rational antimicrobial use.
- Ensure that patient care practices are appropriate to the level of patient risk.
- Participate in the development and provision of teaching programs for the medical, nursing, and allied health staff, and all other categories of HCWs.

## Facility Staff

**Composition:** All staff involved in direct and indirect patient care, including physicians, nurses, microbiologists, pharmacists, blood bank, and ancillary services workers.

**Role:** Implement recommended IPC practices, as per the recommended guidelines.

**Responsibilities:**

- Use practices that minimize infections when providing direct patient care.
- Understand and follow recommended IPC practices.
- Support the IPC team.

- Serve on or participate in IPC task forces and IPC committees, as requested.
- Notify the IPC staff about HAIs and infections with potential to spread in the hospital and initiate immediate containment measures.
- Participate in identifying HAIs in the facility.
- Process microbiological specimens and identify organisms when infection is suspected.
- Use recommended IPC practices; collect, process, and share results of appropriate samples; and make treatment decisions accordingly.
- Use antibiotics rationally.
- Follow clinical guidelines to treat infections.
- Advise and educate patients, visitors, and HCWs on techniques, such as hand hygiene, to prevent infections.
- Follow safe work practices; follow standard precautions.
- Ensure that medical equipment, instruments, and the environment are appropriately cleaned, disinfected, and sterilized.
- Obtain, store, and distribute supplies and equipment in a way that prevents infections.
- Participate in outbreak investigations.

(APIC 2014b; Friedman, Barnette, Buck, et al. 1999; Scheckler, Brimhall, Buck, et al. 1998; WHO 2002; WHO 2016)

## Attributes for Effective Infection Prevention and Control and PS Programs

A successful IPC program must be able to effectively guide, support, and assess IPC at the facility. Some of these attributes will be managed by senior facility leadership, and some by those designated as responsible and accountable for the facility's IPC program. In both cases, the program must acquire and retain the following attributes:

- Designated staff member/team who is responsible and accountable for IPC at the facility
- Competent IPC program leaders with appropriate training and education
- Formal authority granted to the IPC program
- Tangible support from facility leadership
- Adequate resources for IPC activities
- Partnerships with key stakeholders and frontline HCWs
- Effective communication about IPC

### Designated staff member/team responsible and accountable for IPC at the

## facility:

Preventing HAIs or any hazard is the responsibility of all HCWs who provide services at a facility. However, helping healthcare facilities become safer places for patients and HCWs is largely about effectively managing IPC programs. It also includes monitoring current practices, clinical results, and surveillance data, and intervening to provide education and change the culture and behavior when problems and risks are identified. The first step in organizing a successful IPC program is to ensure that one or more people are clearly designated as having responsibility and accountability for overseeing the facility's IPC activities and outcomes. The number of IPC staff and their level of prior experience and training in an IPC program will vary depending on the size and type of healthcare setting. Regardless of the size or composition of the program, it is important that facility leadership clearly designate staff who are responsible for these activities, rather than leaving IPC to chance or relying on all HCWs to implement evidence-based best practices without oversight and guidance (APIC 2014a; APIC 2014b; Friedman, Barnette, Buck, et al. 1999; Scheckler, Brimhall, Buck, et al. 1998; WHO 2002).

### Competent IPC program leaders with appropriate training and education

Once one or more people are designated as responsible and accountable for a facility's IPC program, it is important for these people to pursue and/or maintain some type of IPC training and education. Depending on the setting and resources, the training can be as simple as reading published literature, guidelines, policies, and manuals, and gaining on-the-job experience in IPC during times dedicated for these activities. In larger and more complex healthcare settings, IPC staff's training and experience should be more extensive and formalized. Ideally, the IPC program in complex and high-risk settings is led by a trained, certified, and experienced IPC specialist. There are a variety of training programs and educational materials available, both online and in person, for those who are new to IPC.

Networking with peers and experts in the IPC community is also a good way to gain the necessary information and guidance when organizing and developing a program. Indeed, even the most experienced IPC staff benefits and continues to learn from daily activities and through interactions with IPC colleagues (Friedman, Barnette, Buck, et al. 1999; Scheckler, Brimhall, Buck, et al. 1998).

### Formal authority granted to the IPC program

Regulatory authorities should create an IPC infrastructure from the national level down to the healthcare facility level to ensure that there is authority for IPC program activities. IPC staff are responsible for ensuring that all other healthcare facility staff follow evidence-based IPC practices, according to national policies, regulations, and guidelines. Ideally, staff accountable for IPC can influence the behavior of HCWs by building relationships with their colleagues that consist of trust, communication, and respect. However, given the importance of IPC to patients' safety, administrative statements or orders should be issued to formally recognize the authority of IPC program staff to enforce IPC policies and procedures (WHO 2002). The purpose of such an intervention is to formally support the IPC program when HCWs at the facility question or resist recommended measures or do not willingly follow IPC advice. Such administrative statements can include the following:

- Official endorsement of the facility's IPC program

- IPC program organizational structure at the facility level per national guidelines
- Availability of resources for IPC programs
- The roles and authority of the program staff to perform designated duties, for example:
    - Conduct surveillance and respond to outbreaks of epidemiological significance.
    - Implement AMS programs.
    - Develop, implement, and update facility IPC policies and practices, as per the national guidelines.
    - Initiate surveillance of HAIs, and of healthcare risks and prevention and control measures to reduce the risk and HAIs and outbreaks of infections in the facility and beyond.
    - Notify regulatory authorities of any potential outbreak of infectious disease of public health concern.
    - Provide technical updates and competency-based training to HCWs on a regular basis.

### Tangible support from facility leadership

For reasons similar to those on the need for an authority statement, it is important that the facility leadership openly demonstrates support for the IPC program's staff, priorities, and policies. This can include discussions about IPC at staff and leadership level meetings, providing senior leadership support for IPC directives, and other visible ways of demonstrating support. Leadership support lends credibility and importance to IPC initiatives, and helps obtain the cooperation and focused effort of healthcare staff (WHO 2002; WHO 2016).

### Adequate resources for IPC activities (time and budget)

The IPC program focal person or coordinator must work with facility leadership to define the facility's priorities, and to obtain and allocate resources for IPC activities. Identified priorities and problem areas can guide the allocation of scarce resources. Most HAIs and healthcare risks can be prevented with readily available, relatively inexpensive strategies. This means that investment in people, rather than equipment, is the primary resource needed to oversee and optimize IPC practices (WHO 2016).

### Partnerships with key stakeholders and frontline HCWs

No matter how large a program is or how many resources there may be, IPC staff cannot prevent HAIs and unsafe practices alone. Effective implementation of IPC in a healthcare facility requires close partnerships and collaboration between the IPC program staff and a variety of other stakeholders and frontline HCWs in the facility. Ideally, IPC staff provide guidance, expertise, data, education, encouragement, support, and communication to their colleagues at all levels of the facility. In turn, these stakeholders and HCWs contribute their unique viewpoints and clinical perspectives, and work together with IPC staff to implement and sustain evidence-based practices. The design and management of the IPC program should facilitate these partnerships by integrating IPC staff in the organizational structure, locating their workspace close to daily clinical activities, and including them in planning and other meetings, reports, and activities throughout the facility.

### Effective communication about IPC

The importance of good communication between the IPC program and the rest of the healthcare facility cannot be overstated. Communication should be structured so that the information is readily accessible and understandable. Regular feedback of IPC data is one of the most important communication activities. Visual displays of the data, with clearly marked goals and progress are powerful IPC tools, especially if they are structured to promote friendly competition among areas and to reward and celebrate high-performing areas for their work and success. Additional communication about educational topics, priorities, progress updates, emerging threats, and special circumstances, such as outbreaks, is also necessary. Open lines of communication using as many methods as possible (e.g., verbal, written, graphic, posters, notices, electronic) help maintain communication and engagement throughout the facility, and ensure that everyone stays aware and informed about IPC topics.

## Major IPC Program Activities

As discussed earlier in this chapter, the IPC program provides the facility with specific expertise to ensure that care is provided in a safe and efficient manner. Successful IPC programs are based on understanding the facility's problems and needs, prioritizing activities, and using available resources effectively. To achieve this, there are major activities included in the oversight of the program. The designated program leader should ensure that these activities are carried out:

- Risk assessment
- Program planning
- Implementation strategies for evidence-based practice
- Program evaluation

(APIC 2014b; WHO 2002; WHO 2016)

### Facility IPC Risk Assessment

A facility-wide IPC risk assessment is the cornerstone for designing, developing, and implementing specific IPC activities at healthcare facilities. Facility IPC risk assessment helps identify and prioritize surveillance and prevention activities at the facility, based on the risk of healthcare-related adverse events, or acquiring and transmitting infections in the facility. Facility IPC risk assessment helps identify the areas of concern related to patients' risk of infections at the facility, with a focus on high-risk, high-volume, or problem-prone procedures. The facility IPC risk assessment should engage key facility staff, including IPC committee members. The facility IPC risk assessment form (see Appendix 5.2.C) can be used by healthcare facilities to identify and prioritize infection and other risks at the facility (WHO 2016).

### Program Planning

Clear and detailed goals and objectives make up the annual IPC plan, which guides the team and helps allocate available resources appropriately. Appendix 5.2.A provides a checklist for large facilities for developing a comprehensive IPC plan, including the core components of IPC outlined by WHO. The person filling out the checklist should take the type of facility into consideration; for

example, all items will be suitable for acute care hospitals, but some may not be relevant for clinics or smaller facilities (APIC 2014b; WHO 2016). (Sample Template for an Action Plan and Objectives is described in Appendix 5.2.B,)

## IPC Program Planning Goals

The goals and objectives for the IPC program will be determined by:

- Facility IPC risk assessment (described in Appendix 5.2.C)
- Strategic goals of the facility
- Findings from the previous year's activities

Program goals will be focused on high-risk and problem-prone activities and core responsibilities of the IPC program. In general, goals will include limiting unprotected exposure to pathogens and the transmission of infections associated with procedures, and the use of medical equipment/devices/supplies (APIC 2014b; WHO 2016).

Goals state what the program is planning to achieve and provide direction to the IPC plan. They should include a clear description of a timeframe and specific activities needed to achieve them. The healthcare facility IPC committee and staff should jointly identify the areas to be addressed, based on the results of the risk assessment. If the goals are clearly defined, the work plan will focus on achieving the desired achievements. Below are several examples of goals statements:

- Reduce the rate of SSIs following C-section from the current 12% to 6% by the end of the year.
- Initiate quarterly surveillance of CAUTIs in three medical wards (one male and two female wards) of the facility.
- Improve compliance with hand hygiene practices to 40% by the end of the year.

(APIC 2014b; WHO 2016)

**Objectives**

The plan should include specific objectives for accomplishing the program goals. Objectives are statements of specific activities the team will perform to help achieve the goals. They should be SMART:

**S**pecific, **M**easurable, **A**chievable, **R**ealistic, and **T**ime bound

Objectives should use action verbs and describe the activities to be performed in ways that can be measured (APIC 2014). Examples of objectives include:

- Provide a one-day technical update on standard precautions and transmission-based precautions to 40% of the clinical staff by the end of October 2018.
- Conduct an assessment of staff hand hygiene compliance in each inpatient unit of the healthcare facility by December 2018.
- Increase onsite manufacturing of ABHR by 50% by December 2018.

- Administer single-dose antibiotic prophylaxis within 60 minutes of incision to 100% of women undergoing C-sections, per facility guidelines by June 2018.

Appendix 5.2.A provides an example of program objectives for Hospital A. The objectives show the details of how the plan will be accomplished. They use action verbs, like "monitor" and "develop," and include specifics that can be measured, such as "weekly" and "40 opportunities."

Once the work plan has been finalized, the IPC team or hand hygiene task force should prepare an action plan to ensure the timely implementation and completion of each activity in the work plan, and ensure the availability of resources for each activity. It is essential that the team identify the staff or team member who will ultimately be responsible for leading and completing the activities assigned.

The IPC committee members should approve the action plan and track the progress of the activity. The committee should also list the resources needed for the activity and for approval from the administrative and finance departments.

## Infection Prevention and Control and PS Program Evaluation

A process to evaluate the IPC program at the facility should be created. Periodic evaluation of the IPC program should do the following:

- Outline achievements and activities of the IPC program.
- Determine whether the activities are being performed according to requirements.
- Assess the extent to which the objectives are met and the goals accomplished.
- Document the impact of the program in terms of defined outcomes.
- Identify aspects that may need improvement.
- Describe support requirements.

(APIC 2014b; WHO 2016)

A monitoring plan should include defined indicators and tools to collect information in a systematic fashion. Evaluation can address: appropriateness of the program compared with the national goals (outcomes and processes); epidemiological indicators obtained by the surveillance system; efficacy, timeliness, availability, and effectiveness of the program in meeting its goals and objectives; results of assessments of compliance with IPC practices; customer satisfaction; and other process indicators, such as training activities and resource allocation obtained through audits and other means (APIC 2014a; APIC 2014b; WHO 2016).

The focus should be to encourage improvement and promote learning from experience in a blame-free culture, thereby contributing to better patient care and quality outcomes. The value of the IPC program to the organization should be emphasized, along with improved patient outcomes and cost savings. An evaluation report should be created and widely disseminated to high-level facility administration (APIC 2014a; APIC 2014b; WHO 2011; WHO 2016).

## Continuous Improvement of IPC Practices Using a Model for Improvement

### Implementing Quality Improvement Strategies for IPC Program

A major function of an IPC program is to decrease patient harm from infections by identifying areas in which improvements in quality of care are needed. IPC program activities (such as surveillance and observations of clinical practice) should identify these areas. As described previously in this chapter, the person responsible for the IPC program oversees the implementation of evidence-based IPC practices at the facility.

Once areas for improvement are identified, IPC and facility staff need to work together to apply evidence-based IPC strategies to reduce infections. This often involves changing the behavior of staff at the facility to incorporate the best practices into day-to-day care. Change includes both technical challenges for which there is knowledge to implement a solution, and adaptive challenges in which the priorities, beliefs, habits, and loyalties of staff need to be addressed. A knowledge of quality improvement methods is important for those overseeing and implementing IPC programs (Pronovost 2011).

This can be challenging work. Models have been developed to guide quality improvement efforts in healthcare facilities. They can be extremely useful to assist IPC teams and HCWs to develop processes to make the changes needed to improve quality of care. The focus of this section is to provide an introduction to quality improvement in healthcare facilities, and examples of quality improvement models to guide IPC staff in the planning and practical application of IPC quality improvement projects.

Quality improvement involves taking systematic and continuous actions that lead to measurable improvement. Principles that assist with this process include:

- Managing processes (i.e., how you perform procedures, provide services) and staff.
- Continuous measurement: if you cannot measure it, you cannot improve it.
- Collecting data: only the right data in the right format, at the right time, and given to the right people.
- Engaging the appropriate HCWs (e.g., nurses, physicians, and laboratory staff) in the process.

(Haughom 2017)

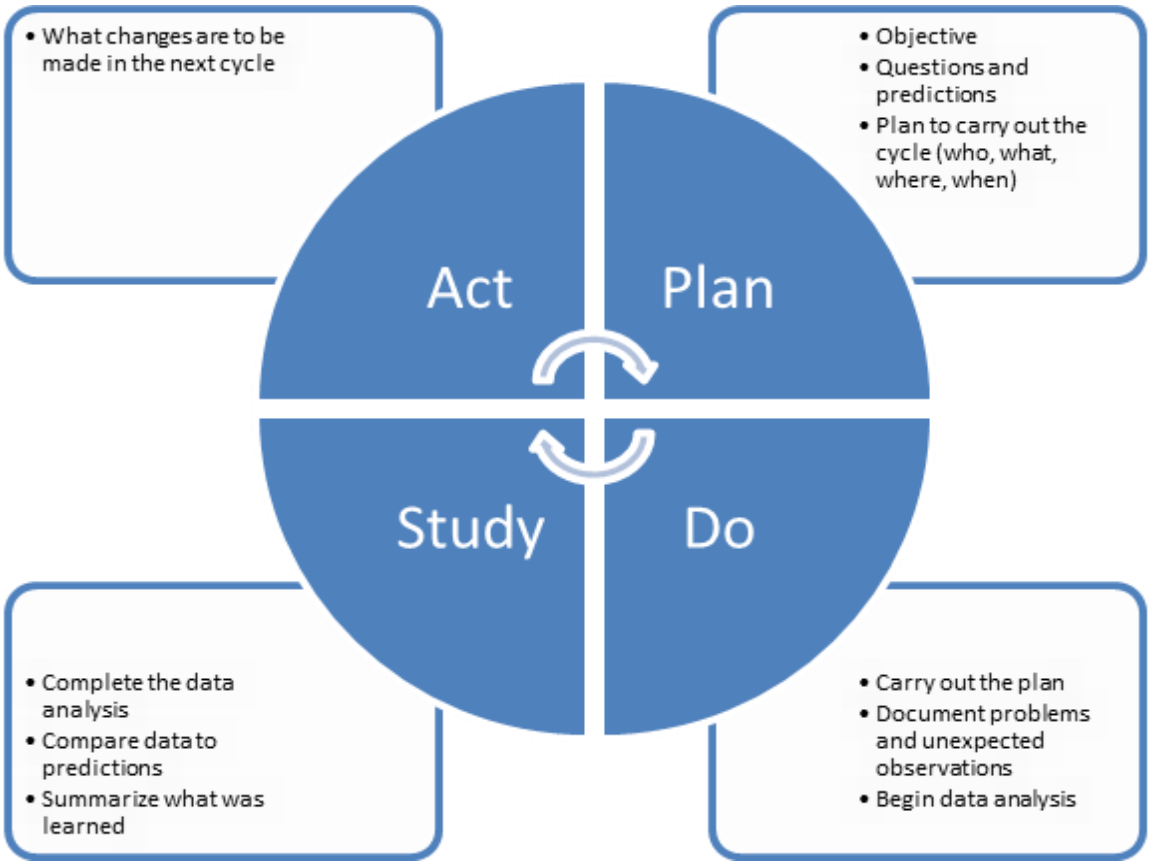
Examples of quality improvement models commonly used by IPC programs for quality improvement initiatives include:

**Plan, Do, Study, Act (PDSA)** was popularized by W. Edward Deming, a leader in total quality management (figure 5.2-2). PDSA outlines a model for the process of continuous quality improvement. This process has been used widely for IPC improvement projects.

1. Plan: Healthcare facility staff design interventions to improve an IPC-related process or to address a gap in IPC practices.
2. Do: Healthcare facility staff implement the intervention.

3. Study: Healthcare facility staff analyze results of the interventions that were gathered through the timely collection of monitoring data.
4. Act: Healthcare facility staff institutionalize or reject the intervention based on the results and plan another intervention (Moen, Norman 2010).

Figure 5.2-2. Deming's PDSA cycle and key elements of each step




*Source*: Curless 2018

**Standards-Based Management and Recognition (SBM-R®)**: Jhpiego, a Johns Hopkins University affiliate, developed and champions the SBM-R process, a continuous quality improvement model. It has been used in healthcare facilities in several countries to improve the quality of family planning, HIV/AIDS care and treatment, IPC, and other areas of healthcare. The four steps of the SBM-R model are:

- Set standards: The IPC quality working group at the facility or the facility staff develop or adapt objective performance standards based on national IPC guidelines and evidence-based recommendations to perform tasks and procedures (e.g., hand hygiene, use of gloves, cleaning medical instruments). HCWs are involved in the process of developing standards.
- Implement the standards: Carry out an assessment of current practices compared with the standards and establish baseline performance. Once the baseline performance has been assessed, apply a performance improvement process to identify gaps and address root causes of performance gaps. The steps in the performance improvement process include:

  - Define the gaps identified in the baseline assessment.
  - With IPC quality improvement working groups, perform a root cause analysis of gaps. Use simple analysis methods, such as "why-why" analysis, brainstorming, and use of key performance factors.
  - Once the root causes of performance gaps are identified, prioritize the gaps that should be addressed first based on the risk, cost, and time available.
  - Design interventions to address the prioritized root causes.
  - Implement interventions to address the gaps in performance.

The root cause analysis may also reveal that HCWs cannot perform due to the lack of resources or motivation. If so, the facility team should design interventions to ensure the availability of appropriate resources and incentives to motivate staff.

- Measure progress: Once the interventions to address the performance gaps have been put in place, use the original set of standards to measure performance to ensure that the interventions were effective in addressing the gaps. Identify additional gaps in performance that affect the quality of care and address them.

- Reward achievement: To motivate HCWs to continue to participate in the quality improvement processes, it is essential to motivate them to make progress. Public recognition is an effective way to motivate staff. From time to time, recognize HCWs and the teams for achieving their goals.

**Translating Evidence into Practice model:** The Johns Hopkins Medicine's Armstrong Institute for Patient Safety and Quality developed the Translating Evidence into Practice model to support hospital-wide IPC interventions (figure 5.2-3). The model focuses on changing behaviors of the healthcare team in a larger hospital system. The approach has five key components:

- A focus on systems (how work is organized) rather than care of individual patients

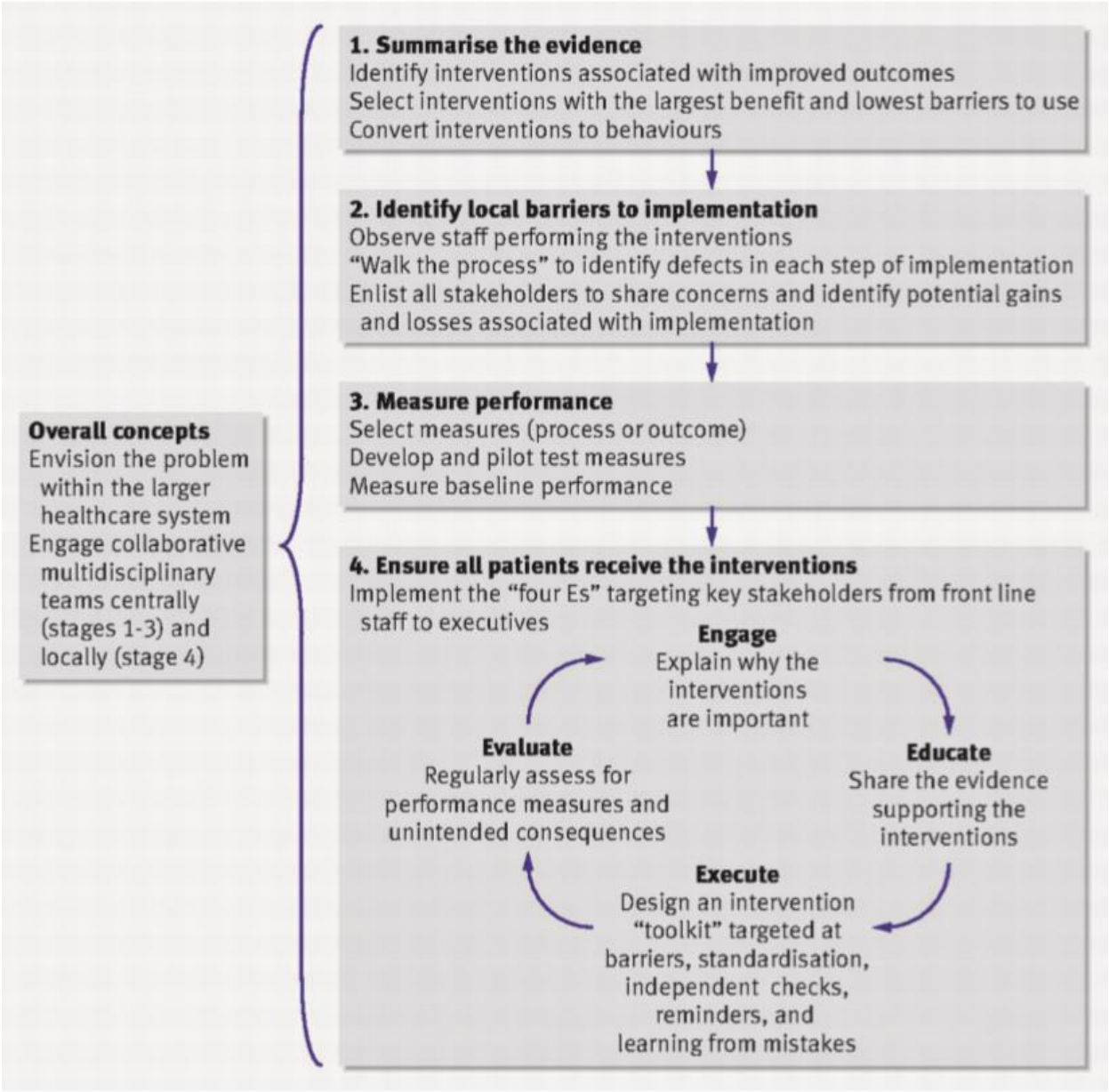
- Engagement of local interdisciplinary teams to assume ownership of the improvement project

- Creation of centralized support for the technical work

- Encouraging local adaptation of the interventions

- Creating a collaborative culture in the local unit and larger system

Figure 5.2-3. The Armstrong Institute's Translating Evidence into Practice model




*Source:* Pronovost, Berenholtz, Needham 2008

## Organizing Principles of the IPC Program

The following are the three recommended organizing principles for managing an IPC program:

1. Establish the relative importance of problems using their level of significance, according to Spaulding's categories of potential infection risk (CDC 2008):
    - Critical
    - Semi-critical

- Non-critical

This kind of potential risk categorization provides a good basis for determining relative importance and for setting priorities (e.g., the most serious and frequent problems and infections involve management in the critical area and, therefore, deserve the most attention and resources).

2. Identify and analyze the reasons for poor or incorrect implementation/performance. Poor staff performance is usually for three possible reasons, because staff:

   - Do not know how to do the task correctly or why they need to do it.
   - Do not have the correct (adequate) protective and PS equipment.
   - Lack motivation.

   In most cases, more than one reason is involved. Understanding how these reasons contribute to performance deficits increases the potential for corrective action to be successful.

3. Cost the issues (i.e., estimate the costs and benefits of various IPC intervention activities). In many settings, this is the most difficult task to implement because the data on which estimates are to be based are often lacking. However, it is highly recommended to use national and locally available data sources for this decision making.

## Developing Successful IPC Programs

Throughout this manual, evidence is presented to help managers make better, more informed decisions and recommendations about frequently encountered problems. In making decisions, managers must often strike a balance between the importance of the problem and the provision of acceptable levels of safety for specific healthcare tasks.

Helping healthcare facilities become safer places in which to work or be cared for is largely about changing practitioner's behavior. Education is not enough. To change unsatisfactory performance by staff (e.g., lack of compliance with handwashing guidelines) requires management reinforcement if the behavior change is going to be sustained. It is the responsibility of administrators and managers, working in conjunction with staff serving on IPC and PS committees, to:

- Set standards for practice, mentor staff, and regularly monitor staff practice.
- Help staff at all levels "buy in" to using common sense when performing their assigned duties and using appropriate PPE at all times.
- Consistent support by hospital administrators and managers of safety efforts (e.g., identified deficiencies corrected, dangerous practices eliminated, and staff actively encouraged to seek inexpensive, doable solutions).
- Supervisors who regularly provide feedback and reward appropriate behavior (e.g., handwashing between patient contacts).
- Role models, especially physicians and other senior staff and faculty, who actively support recommended IP and PS practices and demonstrate appropriate behavior .

**Basic guidance and activities that help managers implement successful IPC program rollout:**

- Have written policies, guidelines, and procedures established to handle situations in which patients or staff are exposed to the risk of infection and clinical malpractices.
- Conduct staff orientation before new policies, recommendations, or procedures are started and provide follow-up training when management reinforcement is needed.
- Ensure the availability of adequate supplies, equipment, and facilities before starting-up to meet the desired set of standards. Conduct regular reviews to ensure the adequacy of the recommended changes or practices to solve emerging problems and to address staff concerns.

## Training and Staff Development

The prevention of infections and the safety of patients primarily involve education linked to behavior change interventions. Staff need to have not only correct information about risks and know how to avoid risks, but also appropriate risk-averting capability and sound patient management behavior recommended. Moreover, personal concerns linked to the risk-taking behavior and tendency to mismanage patients need to be addressed. HCWs are often willing to change bad attitudes and work habits when they understand the rationale and significance of new safety procedures. Nonetheless, positive behavioral change and compliance attained often starts to decline again in a few days or weeks. Therefore, to ensure continued compliance, management reinforcement and a monitoring system that shows the results of overall performance indicators are necessary. HCWs at all levels (e.g., lab technicians, nurses, physicians, housekeepers, and cleaners) need to know why IPC and PS are important.

Training should be standardized in terms of content, modality, and time. All domestically provided training should be in line with the national IPC strategic framework and these guidelines. To achieve long-term effects, the initial training should be followed up, and monitoring should be targeted toward identifying and solving specific problems related to the introduction of new processes or procedures.

General reminders about the importance of maintaining an infection-free environment for the safer delivery of services should also be repeatedly emphasized.

## Supportive Supervision and Review Meeting

Regular supportive supervision and periodic evaluation of the implementations of IP and the safety of patients at various levels is a critical element of IPC program management. Supportive supervision conducted at the health facility level can fully employ the operational standards for IPC in the Ethiopian Health Facility Implementation Guidelines and Ethiopian Health Center Implementation Guideline as follows:

1. Health facility management supports improvement efforts in IP by ensuring that operational and technical capacity, and financial and human resources required to adhere to IP guidelines are available.

2. A designated group and/or individual(s) are in place to effectively implement and monitor IPC activities.
3. The health facility has an operational plan for the implementation of IP activities. The plan follows national guidelines and includes guidance on the practices, procedures, and materials for IP.
4. Standard practices to prevent, control, and reduce risk of HAIs are in place.
5. The health facility has an adequate plan to address transmission-based precautions for staff, patients, caregivers, and visitors.
6. The health facility ensures that equipment, supplies, and facilities/infrastructure necessary for IPC are available.
7. All health facility staff are trained using standard IP training materials.
8. The health facility provides health education to patients, caregivers, and visitors, as appropriate, on infections and preventive activities and control practices.

Program review will provide input on how the overall program is operating compared with the national IPC indicators. Responsible entities at national, regional, and local levels should plan and exercise supportive supervision and program review meetings in their respective settings. Facility-level managers and technical committee members should spearhead the routine implementation of IPC activities and actively collaborate in all supportive supervision and review meetings pertinent to their respective facilities.

## Change Management for Continuous IPC Improvement

Many IPC improvement initiatives come to facilities by different stakeholders. All these initiatives need change management. Introducing interventions to improve performance and the quality of healthcare services involves change, but unfortunately, people are not always comfortable with change. It is not enough to just design an intervention without taking anticipated adverse situations into account. The best ideas can fail because the people who are supposed to implement them are resistant to change. To improve performance and services, one must know how to manage the change process.

People may resist change because they feel:

- Threatened by the change
- Excluded
- Unhappy
- Isolated

It is difficult to eliminate resistance to change completely and permanently, but you can minimize it by taking the following steps:

- Develop common goal
- Involve stakeholders

- Communicate
- Involve all staff
- Anticipate and negotiate
- Monitor
- Demonstrate commitment and consistency

## Monitoring Infection Prevention and PS Practices

Regular monitoring of IP and PS practices and processes is important, not only to assess their effectiveness but also to determine areas of demand for more training or review for different staff members. Keeping records of infections and patient mismanagement occurring in facilities is now the best way to monitor the effectiveness of IP and PS practices. Supervisors and managers at all levels should always use a standardized monitoring and evaluation tool to guide all monitoring and evaluation activities.

In the broadest sense, infection-monitoring (surveillance) activities are designed to guide corrective action based on accurate information, or provide the rationale for not acting when only selective or biased information is available. The activity considers the strengthening of records and reporting systems for IPC activities as a requirement. At the national level, continuous monitoring and evaluation of IPC activities at healthcare facilities should be established. For this, indicators for assuring or improving the quality of IPC practices should be developed and used for periodic evaluation of the status of IPC-related quality. The Ethiopian Hospital Implementation Guidelines listed the following indicators as a monitoring tool to assess the effectiveness/outcomes of the implementation of recommended IPC practices in a given facility.

Table 5.2-2. IPC indictors

| No | Indicators | Formula | Frequency | Comment |
|---|---|---|---|---|
| 1 | Healthcare-acquire infections | Total number of patients with an infection arising > 48 hours after admission during reporting period/ total number of admissions during reporting period x 100 | Quarterly | |
| 2 | a) Number of occupational exposures reported in the hospital, categorized by type of exposure<br>b) Number of non-occupational exposures reported in the hospital, categorized by type of exposure | a) Total number of occupational exposures during the reporting period, categorized by type of exposure<br>b) Total number of non-occupational exposures during the reporting period, categorized by type of exposure | Quarterly | |

| No | Indicators | Formula | Frequency | Comment |
|---|---|---|---|---|
| 3 | The number of people who started post-exposure prophylaxis (PEP) treatment | Total number of people started on PEP treatment during the reporting period | Quarterly | |
| 4 | % of people who completed PEP treatment | Total number of people who completed PEP treatment during the reporting period/ total number of people who should have completed PEP treatment during the reporting period x 100 | Quarterly | |
| 5 | a) Number of days when incinerator was not working<br>b) % of total days | a) Total number of days that the incinerator was not working during the reporting period<br>b) Total number of days that the incinerator was not working | Quarterly | |
| 6 | Inpatient satisfaction survey: % of respondents who answered “always” or “usually” to the question: “during this health facility stay, how often was the room you were sleeping in kept clean?” | Total number of inpatients who respond “always or usually” to the question/ Total number of inpatient respondents x 100 | Biannual | |
| 7 | Outpatient satisfaction survey: % of respondents who “answered “agree” or “strongly agree’ to the question: “the outpatient department was clean.” | Total number of outpatients who respond “agree” or “strongly agree” to the question /total number of outpatients respondents x 100 | Biannual | |

*Source*: FMOH 2016

## SUMMARY

An IPC program should be structured in such a way that it can successfully guide, support, and assess the facility’s IPC activities. Successful programs are based on understanding the problems/needs, prioritizing activities, and using available resources effectively. Program attributes that are integral to an effective program include responsibility and accountability; IPC leaders with appropriate training and education, authority, and administrative and management leadership support; resources; partnerships; and communication. In addition to the designated IPC program leader, there are other key HCWs and groups who play a role in the oversight of a successful IPC program. They all have important roles for promoting IPC at the facility. The structure and organization of the program tasked with achieving the goals of protecting patients and others at the facility can vary and should take into account the unique situation, needs, and resources of each facility and the environment in which it operates. Risk assessment, goal setting, program evaluation, and a focus on PS and quality are among the programmatic activities for program oversight. Last, a knowledge of quality improvement methods is important for those overseeing and implementing IPC programs.

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# APPENDICES

# APPENDIX 1.2.A. ANTIBIOTIC USE MEASURES

Healthcare facilities implementing antibiotic stewardship programs measure antibiotic use either as days of therapy (DOT) or defined daily dose.

## Days of Therapy

DOT, or antibiotic days, are aggregate days for which any amount of a specific antibiotic is administered or dispensed to a specific patient, divided by a standardized denominator (e.g., patient-days, days present, or days admitted in facility) (table A1.2-1). If a patient received two antibiotics for 10 days, the DOT will be 20 days. DOT are reported monthly for inpatient locations, all inpatients, or selected outpatient settings (e.g., outpatient emergency department, pediatric emergency department, 24-hour observation area) for selected antibiotics stratified by route of administration (e.g., IV, intramuscular, digestive, and respiratory) (Registers 1, 2, and 3).

DOT does not take into account the dose of antibiotic administered on any day. Given in any dose, it will be counted as 1 day of therapy. Data from various departments and wards where antibiotics are used should be aggregated to calculate drug-specific DOT for the whole facility. These data should be reviewed and individual antibiotic use should be monitored to track antibiotic use (CDC 2016).

Table A1.2-1. Example of calculation of DOT

During the month of December, the Female Medical Ward admitted one patient, Patient A. Register 1 shows that Patient A in the Female Medical Ward was administered 1 gram of meropenem intravenously once on Monday, three times on Tuesday, and once on Wednesday. Patient A also received amikacin intravenously once on Monday and once on Tuesday.

**Register 1. Patient A Housed in the Female Medical Ward**

| **Medical Ward** | **Monday December 28** | **Tuesday December 29** | **Wednesday December 30** |
|---|---|---|---|
| Meropenem 1 g intravenously every 8 hours | Given: 2300 | Given: 0700<br>Given: 1500<br>Given: 2300 | Given: 0700 |
| Amikacin 1,000 mg intravenously every 24 hours | Given: 2300 | Given: 2300 | |

**Register 2** shows that administration of 1 dose of meropenem on Monday counts as 1 meropenem day, as do the 3 doses on Tuesday, and the 1 dose on Wednesday. Administration of 1 dose of amikacin on Monday counts as 1 amikacin-day as does the 1 dose on Tuesday.

**Register 2. Calculation of DOT for the Female Medical Ward**

| **Calculation** | **Monday December 28** | **Tuesday December 29** | **Wednesday December 30** |
|---|---|---|---|
| Drug-specific DOT (total) | Meropenem days = 1<br>Amikacin days = 1 | Meropenem days = 1<br>Amikacin days = 1 | Meropenem days = 1 Amikacin days = 0 |
| Drug-specific DOT by route of administration | Meropenem days (IV) = 1<br>Amikacin days (IV) = 1 | Meropenem days (IV) = 1<br>Amikacin days (IV) = 1 | Meropenem days (IV) = 1<br>Amikacin days (IV) = 0 |

**Register 3** reflects the monthly totals. If other patients were admitted to the ward and also received an antibiotic, their totals would also be added.

| Register 3. DOT for December for the Female Medical Ward | | | | | | |
|---|---|---|---|---|---|---|
| | | Drug-Specific DOT | | | | |
| **Month/Year –+ Location** | **Antibiotic Agent** | Total | IV | IM | Digestive | Respiratory |
| December – Female Medical Ward | Meropenem | 3 | 3 | 0 | 0 | 0 |
| December – Female Medical Ward | Amikacin | 2 | 2 | 0 | 0 | 0 |

*Adapted from:* CDC 2016

## Defined Daily Dose

Defined daily dose (DDD) is the assumed average maintenance dose per day for a drug used for its main indication in adults. This measure is generally used for the purposes of monitoring drug use. As compared to the DOT, the DDD for antibiotics allows for estimated total antibiotic use in the hospital by aggregating the total number of grams of each antibiotic procured, dispensed, or administered during a period of interest, divided by the WHO-assigned DDD. (WHO has assigned DDDs to all medications including antibiotics [table A1.2-2]). DDDs are not appropriate for use for children and patients with reduced drug excretion, such as in renal impairment, and are less accurate for between-facility benchmarking. DDD does allow for the calculation of antibiotic use in a specific unit of a healthcare facility. Although DDD does not necessarily reflect the recommended or prescribed dose, it does provide a fixed unit of measurement independent of price.

Defined daily dose can be calculated both at the community level and in a healthcare facility using number of DDDs per 1,000 population and per 100 bed-days per day, respectively. For example, 10 DDDs/1,000 inhabitants/day indicate that 1% of the population, on average, receives a certain treatment daily.

The following examples explain the DDD of single and combination products:

**Example 1**: Treatment with two separate products, each containing one active ingredient:

- Product A: Tablets containing 20 mg of drug X (DDD = 20 mg)
- Product B: Tablets containing 25 mg of drug Y (DDD = 25 mg)

The dosing schedule 1 tablet of A and 1 tablet of B daily will be calculated as consumption of 2 DDDs; if both tablets were taken two times a day it will make 4 DDDs, and if both tablets were taken three times a day it will make 6 (remember, DDD considers the amount of medication used).

**Example 2**: Treatment with a combination product containing two active ingredients:

Product C: Tablet containing 20 mg of drug X and 12.5 mg of drug Y.

The DDD of the combination products is assigned as 1 Unit Dose (UD) = 1 tablet. The dosing schedule 1 tablet of C daily or 1 tablet twice a day will be calculated as 1 DDD and 2 DDDs, respectively (even though it will be equivalent to 1.5 DDD of the single active ingredients).

When calculating DDD, the total amount of drug used is the key measure. If the DDD for product A above is 20 mg, and if a patient receives 20 mg three times a day, it is 3 DDDs. If the dose used was 40 mg twice a day, it will make 4 DDDs a day, if 1 DDD is 20 mg.

# APPENDIX 2.1.A. RECOMMENDED DOSES AND RE-DOSING INTERVALS FOR COMMONLY USED ANTIMICROBIALS FOR SURGICAL PROPHYLAXIS

| Antimicrobial | Recommended Dose | | Half-life in adults with normal renal function, in hours | Recommended re-dosing interval (from Initiation of preoperative dose), in hours[c] |
|---|---|---|---|---|
| | Adults[a] | Pediatrics[b] | | |
| Ampicillin-sulbactam | 3 g (ampicillin 2 g/ sulbactam 1 g) | 50 mg/kg of the ampicillin component | 0.8–1.3 | 2 |
| Ampicillin | 2 g | 50 mg/kg | 1–1.9 | 2 |
| Aztreonam | 2 g | 30 mg/kg | 1.3–2.4 | 4 |
| Cefazolin | 2 g, 3 g for pts weighing ≥ 120 kg | 30 mg/kg | 1.2–2.2 | 4 |
| Cefuroxime | 1.5 g | 50 mg/kg | 1–2 | 4 |
| Cefotaxime | 1 g[d] | 50 mg/kg | 0.9–1.7 | 3 |
| Cefoxitin | 2 g | 40 mg/kg | 0.7–1.1 | 2 |
| Cefotetan | 2 g | 40 mg/kg | 2.8–4.6 | 6 |
| Ceftriaxone | 2 g[e] | 50–75 mg/kg | 5.4–10.9 | NA |
| Ciprofloxacin[f] | 400 mg | 10 mg/kg | 3–7 | NA |
| Clindamycin | 900 mg | 10 mg/kg | 2–4 | 6 |
| Ertapenem | 1 g | 15 mg/kg | 3–5 | NA |
| Fluconazole | 400 mg | 6 mg/kg | 30 | NA |
| Gentamicin[g] | 5 mg/kg based on dosing weight (single dose) | 2.5 mg/kg based on dosing weight | 2–3 | NA |
| Levofloxacin[f] | 500 mg | 10 mg/kg | 6–8 | NA |
| Metronidazole | 500 mg | 15 mg/kg<br>Neonates weighing < 1,200 g should receive a single 7.5-mg/kg dose | 6–8 | N |
| Moxifloxacin[f] | 400 mg | 10 mg/kg | 8–15 | NA |
| Piperacillin-tazobactam | 3.375 g | Infants 2–9 mo: 80 mg/kg of the piperacillin component<br>Children > 9 mo and ≤ 40 kg: 100 mg/kg of the piperacillin component | 0.7–1.2 | 2 |
| Vancomycin | 15 mg/kg | 15 mg/kg | 4–8 | NA |
| ***Oral antibiotics for colorectal surgery prophylaxis (used in conjunction with a mechanical bowel preparation)*** | | | | |
| Erythromycin base | 1 g | 20 mg/kg | 0.8–3 | NA |

| Antimicrobial | Recommended Dose | | Half-life in adults with normal renal function, in hours | Recommended re-dosing interval (from Initiation of preoperative dose), in hours[c] |
|---|---|---|---|---|
| | Adults[a] | Pediatrics[b] | | |
| Metronidazole | 1 g | 15 mg/kg | 6–10 | NA |
| Neomycin | 1 g | 15 mg/kg | 2–3 (3% absorbed under normal GI conditions) | NA |

a. Adult doses are obtained from the studies cited in each section. When doses differed between studies, expert opinion used the most-often recommended dose.

b. The maximum pediatric dose should not exceed the usual adult dose.

c. For antimicrobials with a short half-life (e.g., cefazolin, cefoxitin) used before long procedures, re-dosing in the OT is recommended at an interval of approximately two times the half-life of the agent in patients with normal renal function. Recommended re-dosing intervals marked as "not applicable" (NA) are based on typical case length; for unusually long procedures, re-dosing may be needed.

d. Although the US Food and Drug Administration (FDA)-approved package insert labeling indicates 1 g, experts recommend 2 g for obese patients.

e. When used as a single dose in combination with metronidazole for colorectal procedures.

f. Although fluoroquinolones have been associated with an increased risk of tendinitis/tendon rupture in all ages, use of these agents for single-dose prophylaxis is generally safe.

g. In general, gentamicin for surgical antibiotic prophylaxis should be limited to a single dose given preoperatively. Dosing is based on the patient's actual body weight. If the patient's actual weight is more than 20% above ideal body weight (IBW), the dosing weight (DW) can be determined as follows: DW = IBW + 0.4(actual weight – IBW).

*Source:* Bratzler, Dellinger, Olsen, et al. 2013

# APPENDIX 2.1.B: RECOMMENDATIONS FOR ANTIMICROBIAL PROPHYLAXIS FOR SELECTED SURGICAL PROCEDURES

| Type of procedure | Recommended agent(s)[a,b] | Alternative agents in patients with β-Lactam (Penicillin or Cephalosporin group of antibiotics) allergy | Strength of evidence |
|---|---|---|---|
| Biliary tract<br>Open procedure | Cefazolin, cefoxitin, cefotetan, ceftriaxone,[d] ampicillin–sulbactam[f] | Clindamycin or vancomycin+ aminoglycoside[e] or aztreonam or fluoroquinolone[f–h]<br>Metronidazole + aminoglycoside[e] or fluoroquinolone[f–h] | A |
| Laparoscopic procedure<br>Elective, low-risk[i] | None | None | A |
| Laparoscopic procedure<br>Elective, high-risk[i] | Cefazolin, cefoxitin, cefotetan, ceftriaxone,[d] ampicillin–sulbactam[f] | Clindamycin or vancomycin+ aminoglycoside[e] or aztreonam or fluoroquinolone[f–h]<br>Metronidazole + aminoglycoside[e] or fluoroquinolone[h–j] | A |
| Appendectomy for uncomplicated appendicitis | Cefoxitin, cefotetan, cefazolin + metronidazole | Clindamycin +aminoglycoside[e] or aztreonam or fluoroquinolone[f–h]<br>Metronidazole + aminoglycoside[e] or fluoroquinolone[f–h] | A |
| Small intestine<br>Non-obstructed | Cefazolin | Clindamycin +aminoglycoside[e] or aztreonam or fluoroquinolone[f–h] | C |
| Obstructed | Cefazolin + metronidazole, cefoxitin, cefotetan | Metronidazole + aminoglycoside[e] or fluoroquinolone[f–h] | C |
| Hernia repair (hernioplasty and herniorrhaphy) | Cefazolin | Clindamycin, vancomycin | A |
| Colorectal[j] | Cefazolin + metronidazole (better than either cefotetan or cefoxitin alone), cefoxitin, cefotetan, ampicillin–sulbactam,[f] ceftriaxone + metronidazole,[k] ertapenem | Clindamycin + aminoglycoside[e] or aztreonam or fluoroquinolone[f–h], metronidazole + aminoglycoside[e] or fluoroquinolone[f–h] | A |
| Cesarean delivery | Cefazolin | Clindamycin + aminoglycoside | A |
| Hysterectomy (vaginal or abdominal) | Cefazolin, cefotetan, cefoxitin, ampicillin–sulbactam[f] | Clindamycin or vancomycin+ aminoglycoside[e] or aztreonam or fluoroquinolone[f–h]<br>Metronidazole + aminoglycoside[e] or fluoroquinolone[f–h] | A |

| Type of procedure | Recommended agent(s)[a,b] | Alternative agents in patients with β-Lactam (Penicillin or Cephalosporin group of antibiotics) allergy | Strength of evidence |
|---|---|---|---|
| Ophthalmic | Topical neomycin–polymyxin B–gramicidin or fourth-generation topical fluoroquinolones (gatifloxacin or moxifloxacin) given as 1 drop every 5–15 min for 5 doses[l]<br><br>Addition of cefazolin 100 mg by subconjunctival injection or intracameral cefazolin 1–2.5 mg or cefuroxime 1 mg at the end of procedure is optional | None | B |
| Orthopedic<br>Clean operations involving hand, knee, or foot and not involving implantation of foreign materials | None | None | C |
| Spinal procedures with and without instrumentation | Cefazolin | Clindamycin,[m] vancomycin[m] | A |
| Hip fracture repair | Cefazolin | Clindamycin,[m] vancomycin[m] | A |
| Implantation of internal fixation devices (e.g., nails, screws, plates, wires) | Cefazolin | Clindamycin,[m] vancomycin[m] | C |
| Total joint replacement | Cefazolin | Clindamycin,[m] vancomycin[m] | A |
| Urologic<br>Lower tract instrumentation with risk factors for infection (includes transrectal prostate biopsy) | Fluoroquinolone,[f–h] trimethoprim–sulfamethoxazole, cefazolin | Aminoglycoside[e] with or without clindamycin | A |
| Clean without entry into urinary tract | Cefazolin (the addition of a single dose of an aminoglycoside may be recommended for placement of prosthetic material [e.g., penile prosthesis]) | Clindamycin,[m] vancomycin[m] | A |
| Involving implanted prosthesis | Cefazolin ± aminoglycoside, cefazolin ± aztreonam, ampicillin–sulbactam | Clindamycin ± aminoglycoside | A |

| Type of procedure | Recommended agent(s)[a,b] | Alternative agents in patients with β-Lactam (Penicillin or Cephalosporin group of antibiotics) allergy | Strength of evidence |
|---|---|---|---|
| Clean with entry into urinary tract | Cefazolin (the addition of a single dose of an aminoglycoside may be recommended for placement of prosthetic material [e.g., penile prosthesis]) | Fluoroquinolone,[f–h] aminoglycoside[e] with or without clindamycin | A |
| Clean-contaminated | Cefazolin + metronidazole, cefoxitin | Fluoroquinolone,[f–h] aminoglycoside[e] + metronidazole or clindamycin | A |
| Vascular[n] | Cefazolin | Clindamycin,[m] vancomycin[m] | A |
| Plastic surgery<br>Clean with risk factors or clean-contaminated | Cefazolin, ampicillin–sulbactam | Clindamycin,[m] vancomycin[m] | C |

a. The antimicrobial agent should be started 60 minutes before surgical incision (120 minutes for vancomycin or fluoroquinolones). Although single-dose prophylaxis is usually sufficient, the duration of prophylaxis for all procedures should be less than 24 hours. If an agent with a short half-life is used (e.g., cefazolin, cefoxitin), it should be re-administered if the procedure duration exceeds the recommended re-dosing interval (from the time of initiation of the preoperative dose). Re-administration may also be warranted if prolonged or excessive bleeding occurs or if there are other factors that may shorten the half-life of the prophylactic agent (e.g., extensive burns). Re-administration may not be warranted in patients in whom the half-life of the agent may be prolonged (e.g., patients with renal insufficiency or failure).

b. For patients known to be colonized with MRSA, it is reasonable to add a single preoperative dose of vancomycin to the recommended agent(s).

c. Strength of evidence that supports the use or nonuse of prophylaxis is classified as A (levels I–III), B (levels IV–VI), or C (level VII). Level I evidence is from large, well-conducted, randomized controlled clinical trials. Level II evidence is from small, well-conducted, randomized controlled clinical trials. Level III evidence is from well-conducted cohort studies. Level IV evidence is from well-conducted case-control studies. Level V evidence is from uncontrolled studies that were not well conducted. Level VI evidence is conflicting evidence that tends to favor the recommendation. Level VII evidence is expert opinion.

d. Ceftriaxone use should be limited to patients requiring antimicrobial treatment for acute cholecystitis or acute biliary tract infections that may not be determined prior to incision, not patients undergoing cholecystectomy for noninfected biliary conditions, including biliary colic or dyskinesia without infection.

e. Gentamicin or tobramycin.

f. Due to increasing resistance of *Escherichia coli* to fluoroquinolones and ampicillin–sulbactam, local population susceptibility profiles should be reviewed prior to use.

g. Ciprofloxacin or levofloxacin.

h. Fluoroquinolones are associated with an increased risk of tendonitis and tendon rupture in all ages; however, this risk would be expected to be quite small with single-dose antibiotic prophylaxis. Although the use of fluoroquinolones may be necessary for surgical antibiotic prophylaxis in some children, they are not drugs of first choice in the pediatric population due to an increased incidence of adverse events as compared with controls in some clinical trials.

i. Factors that indicate a high risk of infectious complications in laparoscopic cholecystectomy include emergency procedures, diabetes, long procedure duration, intraoperative gallbladder rupture, age of > 70 years, conversion from laparoscopic to open cholecystectomy, American Society of Anesthesiologists classification of 3 or greater, episode of colic within 30 days before the procedure, re-intervention in less than 1 month for noninfectious complication, acute cholecystitis, bile spillage, jaundice, pregnancy, nonfunctioning gallbladder, immunosuppression, and insertion of prosthetic device. Because a number of these risk factors are not possible to

determine before surgical intervention, it may be reasonable to give a single dose of antimicrobial prophylaxis to all patients undergoing laparoscopic cholecystectomy.

j. For most patients, a mechanical bowel preparation combined with oral neomycin sulfate plus oral erythromycin base or with oral neomycin sulfate plus oral metronidazole should be given in addition to IV prophylaxis.

k. Where there is increasing resistance to first- and second-generation cephalosporins among gram-negative isolates from SSIs, a single dose of ceftriaxone plus metronidazole may be preferred over the routine use of carbapenems.

l. The necessity of continuing topical antimicrobials postoperatively has not been established.

m. For procedures in which pathogens other than staphylococci and streptococci are likely, an additional agent with activity against those pathogens could be considered. For example, if there are surveillance data showing that gram-negative organisms are a cause of SSIs for the procedure, practitioners may consider combining clindamycin or vancomycin with another agent (cefazolin if the patient is not β-lactam allergic; aztreonam, gentamicin, or single-dose fluoroquinolone if the patient is β-lactam allergic).

n. Prophylaxis is not routinely indicated for brachiocephalic procedures. Although there are no data in support, patients undergoing brachiocephalic procedures involving vascular prostheses or patch implantation (e.g., carotid endarterectomy) may benefit from prophylaxis.

*Adapted from:* Bratzler, Dellinger, Olsen, et al. 2013

# APPENDIX 2.1.C. COMMONLY USED ANTISEPTICS

| Antiseptics | Gram-positive bacteria | Gram-negative bacteria | Viruses enveloped | Viruses non-enveloped | Myco-bacteria | Fungi | Spores |
|---|---|---|---|---|---|---|---|
| Alcohols | +++ | +++ | +++ | ++ | +++ | +++ | - |
| Chloroxylenol | +++ | + | + | ± | + | + | - |
| Chlorhexidine | +++ | ++ | ++ | + | + | + | - |
| Hexachlorophene[a] | +++ | + | ? | ? | + | + | - |
| Iodophors | +++ | +++ | ++ | ++ | ++ | ++ | ±[b] |
| Triclosan[d] | +++ | ++ | ? | ? | ± | ±* | - |
| Quaternary ammonium compounds[c] | ++ | + | + | ? | ± | ± | - |

| Antiseptics | Typical conc. in % | Speed of action | Residual activity | Use |
|---|---|---|---|---|
| Alcohols | 60-80 % | Fast | No | HR |
| Chloroxylenol | 0.5-4 % | Slow | Contradictory | HW |
| Chlorhexidine | 0.5-4% | Intermediate | Yes | HR,HW |
| Hexachlorophene[a] | 3% | Slow | Yes | HW, but not recommended |
| Iodophors | 0.5-10 %) | Intermediate | Contradictory | HW |
| Triclosan[d] | (0.1-2%) | Intermediate | Yes | HW; seldom |
| Quaternary ammonium compounds[c] | | Slow | No | HR,HW; Seldom; +alcohols |

Good = +++, moderate = ++, poor = +, variable = ±, none = –
HR: handrubbing; HW: handwashing
*Activity varies with concentration.
[a] Bacteriostatic.
[b] In concentrations used in antiseptics, iodophors are not sporicidal.
[c] Bacteriostatic, fungistatic, microbicidal at high concentrations.
[d] Mostly bacteriostatic.
* Activity against *Candida* spp., but little activity against filementous fungi.

*Source:* Adapted from WHO 2009

# APPENDIX 2.2.A. DAILY CAUTI MAINTENANCE BUNDLE CHECKLIST TO DETERMINE CONTINUATION OF URINARY CATHETER

Patient Name/Identification: _____

| Date | Daily documented assessment of need | Tamper-evident seal Is intact | Catheter secured, securement device in place | Hand hygiene performed for patient contact | Daily meatal hygiene with soap and water | Drainage bag emptied using a clean container | Unobstructed flow maintained | Action |
|---|---|---|---|---|---|---|---|---|
| | YES NO | YES NO | YES NO | YES NO | YES NO | YES NO | YES NO | Remove or Continue |
| | YES NO | YES NO | YES NO | YES NO | YES NO | YES NO | YES NO | Remove or Continue |
| | YES NO | YES NO | YES NO | YES NO | YES NO | YES NO | YES NO | Remove or Continue |
| | YES NO | YES NO | YES NO | YES NO | YES NO | YES NO | YES NO | Remove or Continue |

*Adapted from*: Allen, APIC 2014

# APPENDIX 2.5.A. DIARRHEA SOURCE SURVEY FORM

**Diarrhea Source Survey Form**

*Please return completed form to:*

Date form completed: _____

Name of person completing this form: _____

Name of person being surveyed:

Age: _____Sex: _____

Patient: □ No □ **Yes** *(If yes, go to patient section below)*

Healthcare worker: □ No □ **Yes** ***(****If yes, go to healthcare worker section below)*

**Healthcare Worker Section**

If healthcare worker, type of work:

□ Nurse □ Clerical □ Physician □ Housekeeper □ Student □ Other: □ not applicable

Shift or work hours: _____

Unit/Area: _____

Do you work in any other places besides this facility? □ No □ **Yes.** *If yes, where?* _____

Did you work with symptoms? □ No □ **Yes** *If yes: Date worked:* _____

Unit worked: _____

Names of staff and patients you had contact with: _____

**Patient Section**

If patient, date admitted: _____Unit: _____ Room/Bed: _____

If patient, were symptoms present on admission: □ Yes □ No

Please check (√) any of these symptoms that apply:

| Symptom | Yes | No | Onset (date) | Duration (days) |
|---|---|---|---|---|
| Diarrhea | | | | |
| Vomiting | | | | |
| Abdominal cramps | | | | |
| Nausea | | | | |
| Fever | | | | |
| Blood in stool | | | | |
| Headache | | | | |
| Chills | | | | |
| Muscle ache | | | | |
| Diaphoresis | | | | |
| Other | | | | |

Were you hospitalized for this problem? □ No □ Yes

If seen by a physician or hospitalized, was a stool culture taken?
□ No □ Yes**.** *If yes, what was the result:* _____

Did you have exposure to an ill (with gastrointestinal illness) healthcare worker? □ Yes □ No

Did you have exposure to an ill patient? □ Yes □ No

If yes, list symptoms of person whom you had contact with: _____

Date of contact: _____Place of contact_____

Type of contact: _____

Comments: _____

How can we get in contact with you? _____

*Adapted from*: Johns Hopkins Medicine Department of Hospital Epidemiology and Infection Control. n.d. Gastrointestinal Illness Survey Form

# APPENDIX 3.2.A. VISUAL DISPLAYS OF DATA

### Graphs and Tables

When sharing IPC data, different data should be shown in different ways. For example, some data are best shown in a graph, whereas other data are best shown in a table. It is important to take into account with whom the data are being shared and the goals of data sharing.

Tables, graphs, and charts are all common ways to share IPC data:

- A table is a set of data arranged in rows and columns, detailing various elements of the data.
- Graphs show quantitative (i.e., measurable) data and are useful in showing data over long periods of time.
- Charts, such as pie charts, are useful in comparing the magnitude of data or in showing pieces of the whole picture.

(APIC 2014c)

The goal of using visual techniques, such as tables, graphs, and charts, is to share enough data in the display so that the reader can understand the data without having to read any additional text (table 3.2.A-1) (Bonita, Beaglehold, Kjellstrom, et al. 2006). Simple graphs and charts can be made using Excel and displayed in PowerPoint.

Table 3.2.A-1. Advantages of graphs and tables

| Advantages of graphs | Advantages of tables |
|---|---|
| Simple and clear | Able to show more complex data with more precision and flexibility |
| Memorable visual images for the reader | Able to include more details |
| Able to show complex relationships | Do not require technical skills or statistical skills to create |
| Emphasize numbers | Take up less space for a given amount of information |

*Adapted from*: Bonita, Beaglehold, Kjellstrom, et al. 2006

Properly formatted tables and graphs help the reader understand and interpret data. Titles and labels are helpful. Titles should contain specific information describing exactly what the data are showing, where the data came from, and when they were collected. When a graph is missing key elements, such as titles and axis labels, it is may be unclear what the data represent. This can lead to confusion and even misinterpretation of the data. When making graphs, it is also important to think about the scale of the axis and ensure that it is evenly distributed (figure 3.2.A-1) (Bonita, Beaglehold, Kjellstrom, et al. 2006; CDC 2012).

Figure 3.2.A-1. Helpful formatting tips for tables and graphs

**When Making a Table or Graph**

- Use clear title names that describe the "what, where, and when" of the data.
- Include enough information in the figure so that you can understand it by looking just at the figure, without having to read any additional text.
- Label each row and column of a table and label each axis of a chart or graph.
- Identify missing or unknown data with a footnote below the figure.
- Explain any codes, symbols, or abbreviations included in the table or graph by using a footnote below the figure.
- Pay attention to the scale when making a graph.

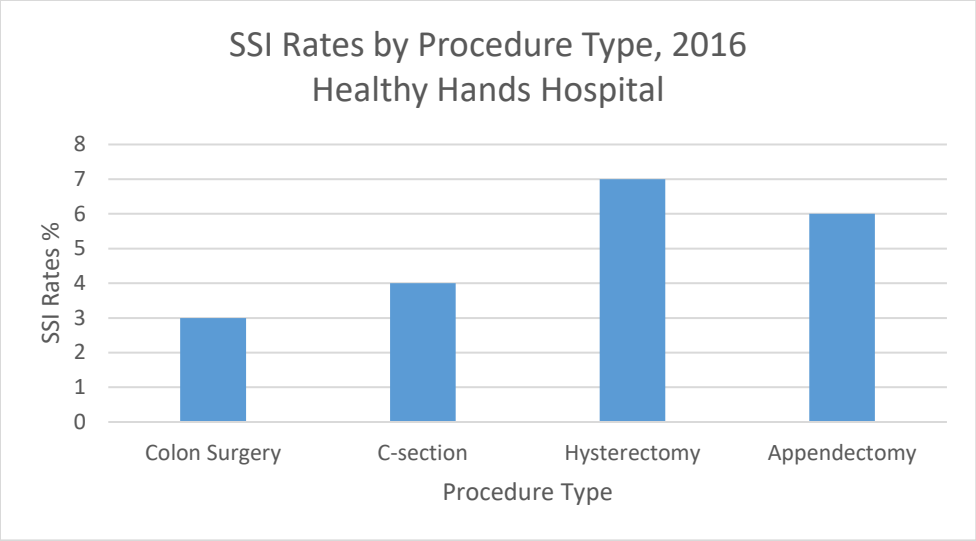
*Source*: CDC 2012

## Graphs

A good-quality graph has the following key features:

- **Title**: The title should clearly communicate the basic information about the data being presented. In the graph on SSI rates, the title tells the reader that the graph is about the rates of SSIs for different types of surgery (what) at Healthy Hands Hospital (where) during the year 2016 (when) (figure 3.2.A-2).
- **Axis labels**: Both the horizontal axis (Procedure Types) and the vertical axis (SSI Rates %) should be appropriately labeled. The horizontal axis label helps readers understand that the data are about different surgical procedures and the vertical axis label helps readers understand that the numbers on this axis represent the SSI incidence rates per 100 procedures (%) in each category and not the number of infections.
- **Data labels**: Data labels provide information on individual datasets. For example, the first column provides the SSI incidence rates per 100 procedures among patients who had colon surgery (3%). You can further indicate the number of procedures in each category to provide more detail.
- **Scale**: Selecting appropriate scale allows readers to visualize the variability between data. In the graph below, readers can easily compare the SSI rates; SSI rates following hysterectomies were nearly double rates after C-sections. A scale of five percentage points would not allow a comparison as easily as a scale of one. Always select the scale that allows better visualization of data.

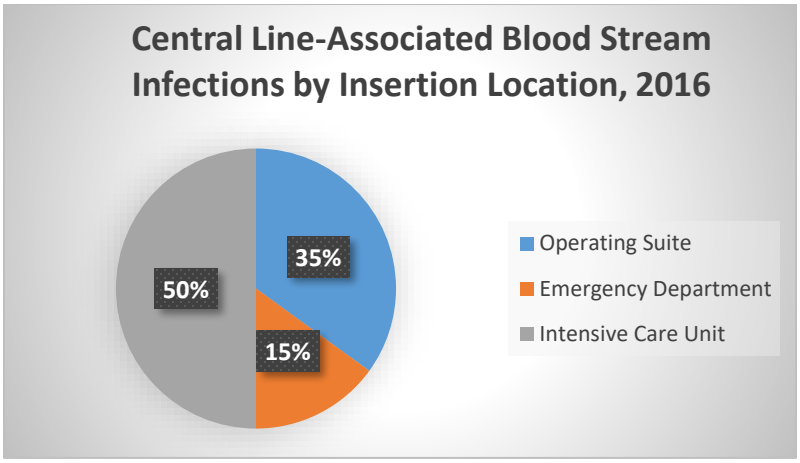
Figure 3.2.A-2. SSIs at Healthy Hands Hospital, 2016, by type of procedure




There are many types of graphs that can be used to show IPC data, including pie charts, bar graphs, and histograms.

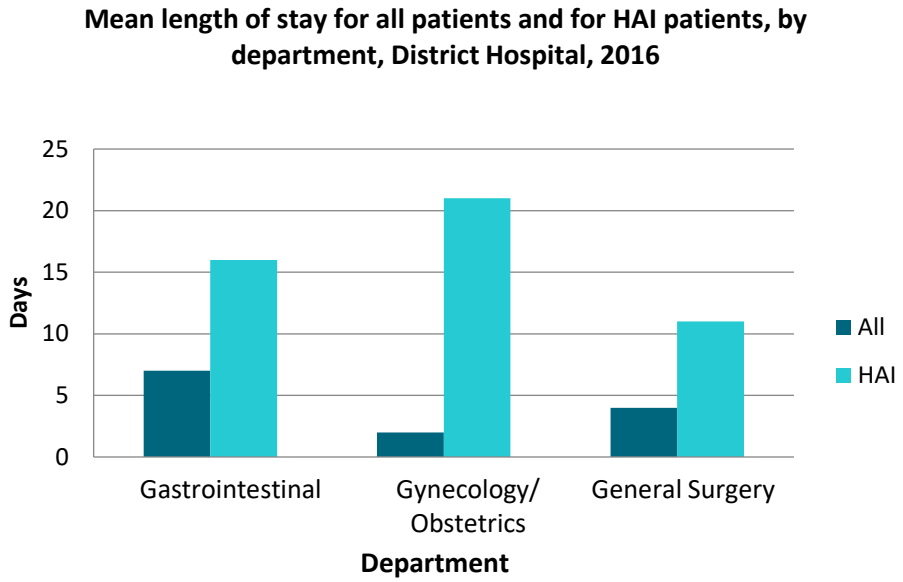
**Pie charts** show components of a whole and are commonly used to graphically display discrete data (e.g., proportion of each type of HAI in a healthcare facility). The primary purpose of a pie chart is to communicate the names and relative sizes of the components (wedges). Figure 3.2.A-3 allows readers to compare the percentage of CLABSIs in 2016 by the department where the central lines were inserted. The pie chart clearly shows that most of the CLABSIs resulted from central lines inserted in the ICU.

Figure 3.2.A-3. Pie chart showing percentage of central line-associated bloodstream infections by department in 2016




**Bar charts** display data to compare the size and magnitude of differences. For example, the bar chart in figure 3.2.A-4 shows data on the length of stay for all patients and patients who developed an HAI in three departments at District Hospital.

Figure 3.2.A-4. Bar chart comparing departments' data on length of stay for all patients and patients who developed an HAI at District Hospital

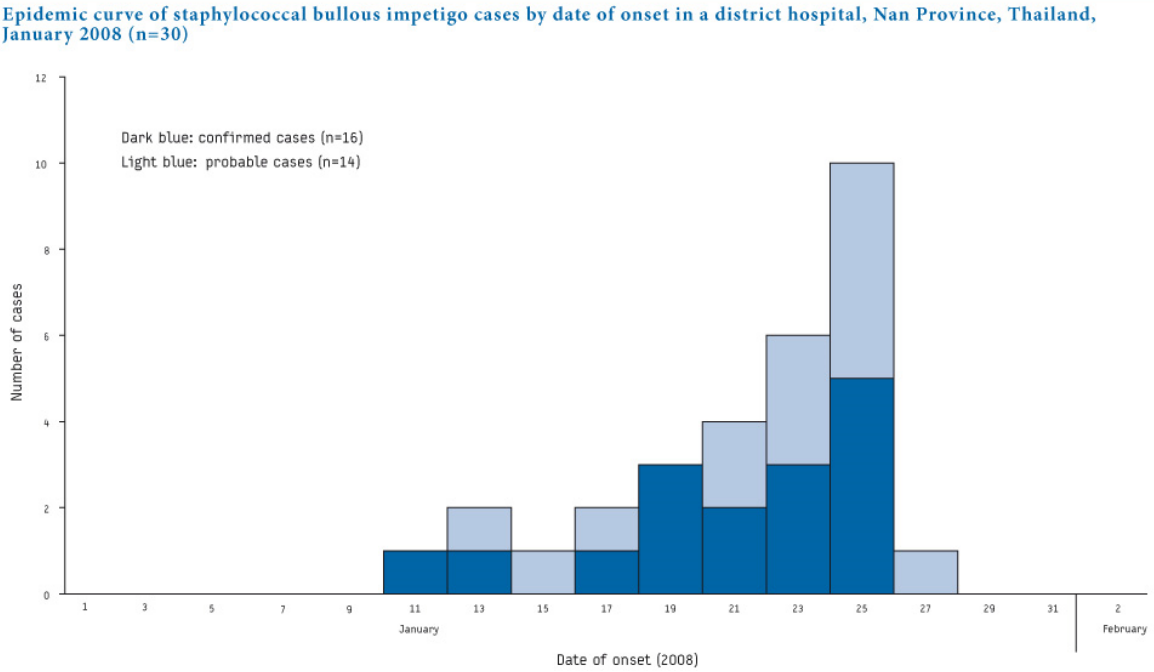



*Source*: Singh, Chaturvedi, Garg, et al. 2013

This chart presents information from three departments in one graph. One can see that the mean hospital stay for patients with an HAI is higher than for those without an HAI. The mean length of stay due to HAIs in the GYN (gynecology/obstetrics) department is longer than in the GI and general surgery departments. Based on this information, the IPC team should work on reducing HAIs for all patients in the hospital by improving IPC practices, conducting a further assessment of HAI cases in the GYN department, and addressing any specific IPC-related issues.

**Histograms** are used to show how often a value occurs in a given interval in a data set. They are frequently used to display continuous data. Figure 3.2.A-5 is a histogram showing transmission of a skin infection during an outbreak in a hospital in Thailand. It illustrates a gradual increase in the number of cases at the beginning of the outbreak, a sharp increase in the second week, and a peak on January 25. The outbreak ended after the ward was closed for two days, January 26 and 27.

Figure 3.2.A-5. An outbreak of hospital-acquired Staphylococcus aureus skin infection among newborns




*Source*: Pawun, Jiraphongsa, Puttamasute, et al. 2009

## Dashboards

An additional visual way to share IPC data is with a data dashboard. An IPC dashboard is information presented on a single page showing a variety of measures, such as hand hygiene compliance, SSI rates, CLABSIs, and non-central line-related BSI (sepsis) rates. The idea comes from a dashboard in a car showing speed, fuel, and temperature gauges all in one place that the driver can quickly see and analyze. Dashboards can be effective tools for communicating IPC data because various measurements and performance indicators can be shown in one place in an easily understandable way.

# APPENDIX 4.1.A. SAFE SURGERY CHECKLIST

## Surgical Safety Checklist

World Health Organization | Patient Safety

### Before induction of anaesthesia

(with at least nurse and anaesthetist)

**Has the patient confirmed his/her identity, site, procedure, and consent?**
- ☐ Yes

**Is the site marked?**
- ☐ Yes
- ☐ Not applicable

**Is the anaesthesia machine and medication check complete?**
- ☐ Yes

**Is the pulse oximeter on the patient and functioning?**
- ☐ Yes

**Does the patient have a:**

Known allergy?
- ☐ No
- ☐ Yes

Difficult airway or aspiration risk?
- ☐ No
- ☐ Yes, and equipment/assistance available

Risk of >500ml blood loss (7ml/kg in children)?
- ☐ No
- ☐ Yes, and two IVs/central access and fluids planned

### Before skin incision

(with nurse, anaesthetist and surgeon)

- ☐ **Confirm all team members have introduced themselves by name and role.**
- ☐ **Confirm the patient's name, procedure, and where the incision will be made.**

**Has antibiotic prophylaxis been given within the last 60 minutes?**
- ☐ Yes
- ☐ Not applicable

**Anticipated Critical Events**

To Surgeon:
- ☐ What are the critical or non-routine steps?
- ☐ How long will the case take?
- ☐ What is the anticipated blood loss?

To Anaesthetist:
- ☐ Are there any patient-specific concerns?

To Nursing Team:
- ☐ Has sterility (including indicator results) been confirmed?
- ☐ Are there equipment issues or any concerns?

**Is essential imaging displayed?**
- ☐ Yes
- ☐ Not applicable

### Before patient leaves operating room

(with nurse, anaesthetist and surgeon)

**Nurse Verbally Confirms:**
- ☐ The name of the procedure
- ☐ Completion of instrument, sponge and needle counts
- ☐ Specimen labelling (read specimen labels aloud, including patient name)
- ☐ Whether there are any equipment problems to be addressed

**To Surgeon, Anaesthetist and Nurse:**
- ☐ What are the key concerns for recovery and management of this patient?

This checklist is not intended to be comprehensive. Additions and modifications to fit local practice are encouraged.

Revised 1 / 2009



WHO Patient Safety | WHO Guidelines for Safe Surgery 2009

# APPENDIX 4.6.A. MORTUARY—INFECTION PREVENTION AND CONTROL FOR HANDLING HUMAN REMAINS

## Microorganisms that can be transmitted after death

- Anthrax
- Avian influenza (bird flu)
- Cholera
- Creutzfeldt-Jacob (mad cow) disease
- GI infections
- Hepatitis B
- Hepatitis C
- HIV
- Influenza A (H1N1)
- Meningitis and septicemia produced by meningococcus
- Middle East respiratory syndrome (MERS) co-virus
- Plague
- Rabies
- Severe acute respiratory syndrome (SARS)
- Streptococcal infections
- TB
- Typhus
- Viral hemorrhagic fevers

## Recommendations for Design and Layout Plan of a Mortuary

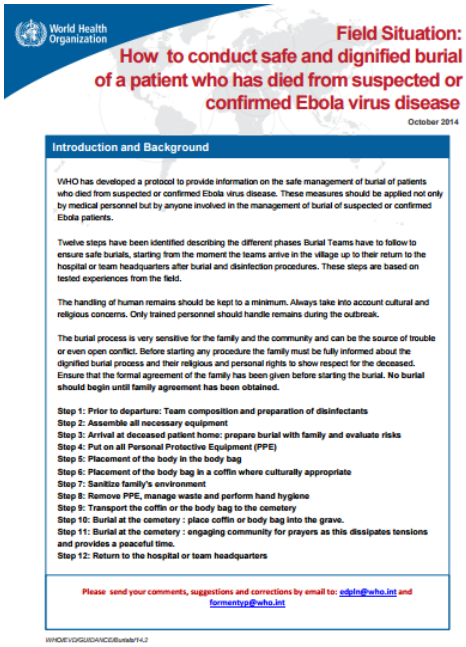
- The design of the mortuary should have appropriate power supply.
- Room should be well lit and ventilated or have air conditioning. The floors should be non-slip tiles, easy to clean, and have adequate drainage.
- There should be adequate space for:
    - Receiving and releasing bodies
    - Body viewing areas
    - Performing procedures and area for observation by visitors or students
    - Room with cabinets for storing bodies at 4$^{o}$C (39.2°F); if it is not possible, bodies should be cremated or buried as soon as possible
    - Areas to store supplies
- Number of staff allowed to perform postmortem should be kept to minimum required (e.g., a physician trained in performing postmortem, an assistant, and a support staff)
- Changing room for providers to change and store PPE

## How to conduct safe and dignified burial of a patient who has died from

## suspected or confirmed Ebola virus disease

This document gives information on safe management of dead bodies who died from suspected or confirmed Ebola virus disease. These measures should be applied by anyone involved in the management of dead bodies and burials of suspected or confirmed Ebola patients.

**The 12 steps are:**


World Health Organization

Field Situation:
How to conduct safe and dignified burial of a patient who has died from suspected or confirmed Ebola virus disease

October 2014

Introduction and Background

WHO has developed a protocol to provide information on the safe management of burial of patients who died from suspected or confirmed Ebola virus disease. These measures should be applied not only by medical personnel but by anyone involved in the management of burial of suspected or confirmed Ebola patients.

Twelve steps have been identified describing the different phases Burial Teams have to follow to ensure safe burials, starting from the moment the teams arrive in the village up to their return to the hospital or team headquarters after burial and disinfection procedures. These steps are based on tested experiences from the field.

The handling of human remains should be kept to a minimum. Always take into account cultural and religious concerns. Only trained personnel should handle remains during the outbreak.

The burial process is very sensitive for the family and the community and can be the source of trouble or even open conflict. Before starting any procedure the family must be fully informed about the dignified burial process and their religious and personal rights to show respect for the deceased. Ensure that the formal agreement of the family has been given before starting the burial. No burial should begin until family agreement has been obtained.

Step 1: Prior to departure: Team composition and preparation of disinfectants
Step 2: Assemble all necessary equipment
Step 3: Arrival at deceased patient home: prepare burial with family and evaluate risks
Step 4: Put on all Personal Protective Equipment (PPE)
Step 5: Placement of the body in the body bag
Step 6: Placement of the body bag in a coffin where culturally appropriate
Step 7: Sanitize family's environment
Step 8: Remove PPE, manage waste and perform hand hygiene
Step 9: Transport the coffin or the body bag to the cemetery
Step 10: Burial at the cemetery : place coffin or body bag into the grave.
Step 11: Burial at the cemetery : engaging community for prayers as this dissipates tensions and provides a peaceful time.
Step 12: Return to the hospital or team headquarters

Please send your comments, suggestions and corrections by email to: edpin@who.int and formentyp@who.int

WHO/EVD/GUIDANCE/Burials/14.2

Step 1: Prior to departure: Team composition and preparation of disinfectants

Step 2: Assemble all necessary equipment

Step 3: Arrival at deceased patient home: prepare burial with family and evaluate risks

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Step 12: Return to the hospital or team headquarters

Please see the document for detailed descriptions of the steps.
http://apps.who.int/iris/bitstream/10665/137379/1/WHO_EVD_GUIDANCE_Burials_14.2_eng.pdf?ua=1

# APPENDIX 5-A. PREVENTION OF FETAL AND NEWBORN INFECTIOUS DISEASES

## Bacterial Infections

### Group B streptococcal septicemia

GBS, a gram-positive bacterium, causes invasive disease primarily in infants and pregnant or postpartum women. GBS has emerged as a major cause of newborn meningitis and septicemia in eastern and southern Africa (Gray, Kafulafula, Matemba, et al. 2011).

GBS septicemia is divided into two categories: early-onset and late-onset.

Early-onset infections occur within the first six days of life. Typically, early-onset sepsis is considered to be maternally acquired, usually from the maternal genital tract. Generally, the maternal antibodies protect most babies against GBS infection so only one or two newborns per 1,000 develop GBS disease. Women with diabetes are more likely to be colonized with GBS (AAP 2012). Symptoms and signs of GBS disease include respiratory distress, apnea, or other signs of sepsis, mostly characterized by pneumonia and sepsis.

Late-onset infections occur in infants 7 days to 89 days of age. Late-onset GBS disease is considered to be an HAI.

Two approaches used for screening pregnant women for GBS are:

The risk factor approach: If the woman has any one of the following intrapartum risk factors, IV antibiotic prophylaxis is indicated:

- Childbirth at less than 37 weeks' gestation
- Amniotic membrane rupture for 18 or more hours
- Intrapartum temperature of at or above 38°C (100.4°F)

Culture-based screening: This approach is based on a positive vaginal-rectal swab, obtained at 35–37 weeks of gestation and cultured for GBS.

The best practice is to screen all pregnant women for GBS when in labor and to provide intrapartum antibiotic prophylaxis at the onset of active labor for those who have a positive GBS culture. However, in facilities where cultured-based screening is not possible, prophylaxis is indicated in the following conditions:

- Previous infant with invasive GBS disease
- GBS bacteriuria during any trimester of the current pregnancy
- Positive GBS vaginal-rectal screening culture in late gestation during current pregnancy
- Unknown GBS status at the onset of labor and any of one of the following:
    - Childbirth at less than 37 weeks' gestation

- Amniotic membrane rupture for 18 or more hours
- Intrapartum temperature of at or above 38°C (100.4°F)
- Intrapartum tests positive for GBS

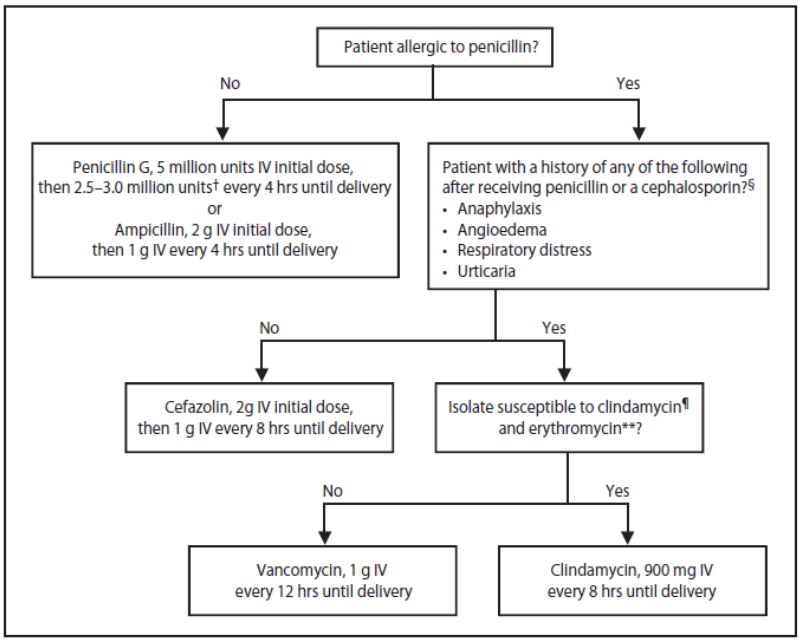
Prophylaxis is not indicated in the following conditions in the absence of any of the above indications:

- Colonization with GBS during the previous pregnancy
- GBS bacteriuria during previous pregnancy
- Negative genital and rectal GBS screening culture in late gestation during current pregnancy, regardless of intrapartum risk factors
- Elective C-section (with intact membrane) regardless of GBS colonization status or gestational age.

(CDC 2010)

Prophylaxis against early-onset GBS is effective only when given during labor. Intrapartum penicillin prophylaxis given to women colonized with GBS will reduce early-onset GBS disease by 30 fold (Allen, Navas, King 1993). The algorithm in figure 5-A-1 below can be used to determine the appropriate antibiotic, based on the patient's history of allergies to antibiotics.

Figure 5-A-1. Recommended regimens for intrapartum antibiotic prophylaxis for prevention of early-onset GBS disease*




IV = intravenously

* Broader-spectrum agents, including an agent active against GBS, might be necessary for the treatment of chorioamnionitis.

*Source*: CDC 2010

Doses ranging from 2.5 to 3.0 million units are acceptable for the doses administered every four hours following the initial dose. The choice of dose within that range should be guided by which formulations of penicillin G are readily available to reduce the need for pharmacies to specially prepare doses.

Penicillin-allergic patients with a history of anaphylaxis, angioedema, respiratory distress, or urticaria following administration of penicillin or a cephalosporin are considered to be at high risk for anaphylaxis and should not receive penicillin, ampicillin, or cefazolin for GBS intrapartum prophylaxis. For penicillin-allergic patients who do not have a history of those reactions, cefazolin is the preferred agent because pharmacologic data suggest it achieves effective intra-amniotic concentrations. Vancomycin and clindamycin should be reserved for penicillin-allergic women at high risk for anaphylaxis.

If laboratory facilities are adequate, clindamycin and erythromycin susceptibility testing should be performed on prenatal GBS isolates from penicillin-allergic women at high risk for anaphylaxis. If no susceptibility testing is performed, or the results are not available at the time of labor, vancomycin is the preferred agent for GBS intrapartum prophylaxis for penicillin-allergic women at high risk for anaphylaxis (CDC 2010).

Prevention of late-onset GBS disease requires meticulous use of standard precautions with very high compliance with hand hygiene practices. When caring for patients with GBS, use standard precautions. During nursery outbreaks, cohorting ill and colonized infants is recommended, as are good hand hygiene practices (APIC 2014).

**Chlamydial Infection**

Chlamydia trachomatis is transmitted to newborns from infected mothers during birth; approximately 50% of infants delivered vaginally from infected mothers will acquire an infection. Of infected newborns, 25%–50% will develop purulent conjunctivitis unless treated prophylactically at birth with antibiotic eye drops (tetracycline or erythromycin), and 5%–20% will develop pneumonia.

Prevention of chlamydia infection during pregnancy includes treatment of infected pregnant women in the third trimester (after 30 weeks' gestation) with erythromycin (tetracycline should not be used because it is deposited in the teeth of the developing fetus). Because antenatal testing is not available in most low-income countries, use of eye drops is the only preventive measure usually available. Unfortunately, neither tetracycline nor erythromycin eye drops prevents chlamydial pneumonia. Chlamydial pneumonia is usually mild and treated easily and inexpensively.

Infants with chlamydial conjunctivitis or pneumonia can be treated with erythromycin base or erythromycin ethylsuccinate 50 mg/kg/day in four divided daily doses for 14 days (AAP 2012).

Oral sulfonamides may be used to treat chlamydial conjunctivitis if the infant does not tolerate erythromycin.

Topical treatment of conjunctivitis is not effective (AAP 2012).

Standard precautions should be used for newborns with purulent conjunctivitis in a nursery or NICU. When caring for patients with chlamydial conjunctivitis or pneumonia and mothers with

genital chlamydia, use standard precautions. Good hand hygiene practices are recommended (Siegel, Rhinehart, Jackson, et al. 2007).

### Gonorrhea Infection

Gonococcal infection among infants usually occurs during birth from an infected mother and appears within two to five days after birth. Most severe manifestations of gonorrhea in newborns are ophthalmia neonatorum (a condition of the eye that may result in blindness) and sepsis.

Prevention of gonorrhea during pregnancy includes screening, diagnosis, and treatment of infected pregnant women using appropriate antibiotics (tetracycline should not be used because it is deposited in the teeth of the developing fetus). Because antenatal testing is not available in most low-income countries, use of eye drops (tetracycline or erythromycin) is the only preventive measure usually available (CDC 2015).

Standard precautions should be used for newborns with purulent conjunctivitis in a nursery or NICU. When caring for patients with ophthalmia neonatorum and mothers with gonorrhea infection, use standard precautions. Good hand hygiene practices are recommended (Siegel, Rhinehart, Jackson, et al. 2007).

For management of sepsis, refer the baby to a higher level for expert care.

### Listeriosis

Listeriosis is predominantly a foodborne infection caused by Listeria monocytogenes. One in seven pregnant women becomes infected with listeria; pregnant women are 10 times more likely than the general population to get listeria infection. Infection during pregnancy can cause fetal loss, preterm labor, and illness or death in newborn infants. Fetuses or newborns can get listeria infection in utero (transfer across the placenta), during labor and childbirth (vertical transmission), and in the postnatal period though contact with infected mothers or HCWs.

Similar to GBS disease, listeriosis can present as an early- or late-onset syndrome. Preterm birth, pneumonia, and septicemia are common in early-onset disease. An erythematous rash with small pale papules can also occur in early onset with severe newborn infection. Late-onset infection will usually result in meningitis (AAP 2012).

Severe infections can be treated with IV ampicillin and an aminoglycoside. Immunocompetent patients with mild infections can be treated with ampicillin alone (AAP 2012).

When caring for patients with listeriosis, use standard precautions because this infection is rarely transmitted from person to person. Good hand hygiene practices are always recommended (APIC 2014).

### Neonatal Tetanus

Neonatal tetanus is a major health problem in many low-income countries where maternity services are limited and immunization against tetanus is inadequate. UNICEF reported that by the end of December 2013, 34 countries had eliminated maternal and neonatal tetanus; 25 countries had not eliminated the disease (UNICEF 2014a).

Although maternal and neonatal tetanus is lethal and mortality rates are extremely high, it can be easily prevented with hygienic childbirth and clean cord care practices. Moreover, immunizing mothers with the tetanus vaccine, which is inexpensive and effective, is essential for prevention. Infants become infected during childbirth through the use of an unclean instrument to cut the umbilical cord or following childbirth by placement of substances heavily contaminated with tetanus endospores (e.g., ashes, cow dung, or dust from the hearth or doorway) on the umbilical stump. Often this is done as part of a traditional birthing practice.

**Maternal and neonatal tetanus is easily preventable through**:

- Immunization of women with tetanus toxoid vaccine—a child born to a woman protected against tetanus is also protected from the disease in the first few months of life.
- Hygienic birth practices to ensure that infection is not contracted by mothers or newborns during the birth process and practices.
- Proper cord care to ensure that contamination of the cord does not put the newborn at risk.

To be effective, non-immunized pregnant women should receive at least two doses of tetanus toxoid before childbirth. If there is sufficient time before childbirth, two doses should be administered at least four weeks apart, and the second dose should be given at least two weeks before childbirth.

When caring for patients with tetanus, use standard precautions because this infection is not transmitted from person to person. Good hand hygiene practices are always recommended (Siegel, Rhinehart, Jackson, et al. 2007).

**Syphilis**

Syphilis is a sexually transmissible infection caused by Treponema pallidum. It is transmitted through sexual contact with an infected partner and is also transmitted from mother to child during pregnancy. Antenatal testing of pregnant women should be done to identify and treat women who are seropositive for syphilis and to prevent congenital syphilis in their newborns. If the results of serologic tests for syphilis are equivocal or not available, a cord blood or venous sample from the newborn should be tested.

Regardless of the stage of pregnancy, infected women should be treated with penicillin according to the dosage appropriate for the stage of syphilis as recommended for non-pregnant patients (WHO 2017b).

Although the clinical findings of congenital syphilis in the newborn may be non-specific, moist open lesions, which may be due to syphilis, are infectious. When caring for patients with syphilis, use standard precautions. Always use good hand hygiene practices (Siegel, Rhinehart, Jackson, et al. 2007).

## Viral Infections

### HBV

Mother-to-child transmission is the major route of transmission of HBV in many parts of the world, especially in China and Southeast Asia (WHO 2015a). Maternal-newborn transmission of HBV and the subsequent development of chronic hepatitis B in infected children have been reduced drastically with the introduction of hepatitis B immune globulin (HBIG) for newborn babies of HBV carrier mothers, in conjunction with the first dose of HBV vaccine. HBV vaccination and one dose of HBIG, administered within 24 hour after birth, are 85%–95% effective in preventing both HBV infection and the chronic carrier state. HBV vaccine administered alone, beginning within 24 hour after birth, is 70%–95% effective in preventing perinatal HBV infection. (WHO 2015a).

**Note:** No special care is required for an infant whose mother is infected with HBV other than removal of maternal blood from the injection site to avoid introducing the virus when the infant is given HBIG prophylaxis.

Routine infant immunization programs have shown that currently available vaccines confer as much protection on the infants as does a combination of vaccine and HBIG. Therefore, the additional expenses for the administration of HBIG can be avoided.

It is safe for a mother infected with HBV to breastfeed her infant immediately after birth.

After birth, the baby should be bathed by an HCW wearing gloves, with clean water to remove blood and amniotic fluid from the skin. This minimizes the risk of exposing other infants or HCWs to blood or potentially contaminated amniotic fluid. Standard precautions apply to all patients (women and their babies) irrespective of their HBV vaccine status or disease status. Infants can stay in the nursery or NICU with other patients.

**Note**: For infants of mothers infected with HBV, after blood has been removed from the newborn, gloves do not need to be worn for changing diapers and other routine nursing care.

For all patients, there is no specific treatment for acute HBV. Care is aimed at maintaining comfort and adequate nutritional balance, including replacement of fluids that are lost from vomiting and diarrhea. Use standard precautions when caring for patients with known HBV. Ensure that HCWs are vaccinated against HBV (APIC 2014).

### HCV

Mothers infected with HCV can transmit the virus to their children during birth. According to the WHO, HCV is not spread through breast milk, food, or water, or by casual contact, such as hugging, kissing, and sharing food or drinks with an infected person (WHO 2014b). Transmission of HCV from a mother to her child occurs in 4%–8% of births in women with HCV infection and in 17%–25% of births in women with HIV and HCV coinfection. There is no treatment or vaccine for prevention of HCV; therefore, primary prevention must be vigorously promoted. Interventions for prevention of HCV infection in healthcare facilities include:

- Hand hygiene, including surgical hand preparation

- Handwashing and use of gloves
- Safe handling and disposal of sharps and waste
- Safe cleaning of equipment
- Testing of donated blood
- Improved access to safe blood
- Training of health personnel

Because HCV, HBV, and HIV are transmitted by the same mechanisms, behavior change messages should be linked to HIV and HBV prevention efforts (WHO 2014b). Breastfeeding is not contraindicated, but if her nipples are cracked and bleeding, the mother may wish to abstain (APIC 2014).

**Herpes Simplex Virus**

Pregnant women with HSV infection have increased risk of abortion or preterm birth. Transmission of HSV from mother to neonate can cause severe disease in neonates and high morbidity and mortality even with treatment with antiviral medication. If the mother has primary HSV infection around the time of childbirth, the risk of transmission to the neonate ranges from 25%–60% (AAP 2012). However, it is often difficult to determine whether an infection is recurrent or primary.

Cesarean delivery for women who have clinically apparent HSV infection decreases the risk of newborn HSV infection. In the absence of genital lesions, a maternal history of genital HSV is not an indication for a C-section (AAP 2012).

Use standard and contact precautions when caring for infants with congenital HSV infection. The duration of contact precautions is until lesions are dry and crusted.

Use standard and contact precautions when caring for asymptomatic, exposed infants delivered vaginally or by C-section, and if the mother has active infection and membranes have been ruptured for more than four to six hours. The duration of contact precautions is until infant surface culture is negative after 48 hours' incubation.

Use standard and contact precautions for mothers with mucocutaneous, disseminated, or severe primary HSV. The duration of contact precautions is until lesions are dry and crusted (Siegel, Rhinehart, Jackson et al. 2007).

Use standard precautions when caring for patients with recurrent mucocutaneous, HSV (skin, oral, genital), and HSV encephalitis (non-congenital, without lesions) (Siegel, Rhinehart, Jackson et al. 2007).

Mothers with herpetic whitlow should not have hands-on contact with their infants (APIC 2014).

Mothers with HSV (except herpetic whitlow, see above) should perform hand hygiene before and after caring for their infants, and cover their lesions, such as with gowns or masks if herpes is around the lips or if stomatitis is present, until lesions have crusted and dried (APIC 2014). People with oral HSV should not kiss infants until lesions are dry and crusted. Mothers can continue to

breastfeed their babies, provided there are no lesions in the breast area and all skin lesions are covered (APIC 2014)

**Human Immunodeficiency Virus**

HIV can be transmitted from a woman infected with the virus to her baby during pregnancy, childbirth, or breastfeeding. Approximately 90% of HIV infections among children are a result of mother-to-child transmission of HIV. There has been a 43% reduction in the number of new HIV infections in 23 Global Plan priority countries since 2009 (Joint United Nations Programme on HIV/AIDS [UNAIDS] 2014) due to the following policies:

- Testing all pregnant women for HIV
- Using an opt-out approach (an approach in which all pregnant women are offered HIV testing as part of routine antenatal care unless they refuse testing)
- Initiating lifelong treatment for every pregnant woman with HIV using a three-drug combination antiretroviral (ARV) (Option B+), irrespective of the CD4 count
- Providing prophylactic ARVs for children born to HIV-infected mothers
- Testing and early treatment of children who test positive

Lifelong treatment using a triple-drug combination of ARVs and elective C-sections can reduce mother-to-child transmission of HIV to less than 1%.

Follow the national guidelines on prevention of mother-to-child transmission for screening pregnant women and managing those testing positive for HIV. Patients with HIV are cared for using standard precautions.

**Human Papillomavirus**

Human papillomavirus (HPV) is a sexually transmitted virus that can cause genital warts and is associated with genital cancer in women (cervix, vagina, and vulva), anal cancer in both sexes, and penile cancer in men. Primary prevention should involve education and counseling. All girls ages 9–13 should be vaccinated with two doses of HPV vaccine, preferably before they become sexually active (WHO 2014a). There is a small risk that infants born to mothers infected with certain types of HPV may be at increased risk of developing lesions in their respiratory tracts (papillomatosis). Because the risk is low, delivery of infected women by C-section is not indicated to protect the infant. C-section may be necessary, however, in women whose genital warts are so extensive that soft tissue stretching of the vulva and perineum may not be sufficient to allow vaginal delivery.

Infants born to mothers infected with genital HPV are cared for with standard precautions.

**Influenza**

Care for patient with influenza using droplet and standard precautions. Consider separation of a mother who is ill with suspected or confirmed influenza from her newborn during her hospital stay. Mothers with influenza should wear a surgical mask while breastfeeding and when within three feet of the infant (APIC 2014).

## Rubella

Rubella, also known as German measles, is a disease caused by the rubella virus. It causes mild disease with fever, rash, and lymphadenopathy that disappear in three days. However, developing fetuses of mothers who have not been vaccinated against rubella lack passively acquired maternal antibodies and can develop congenital rubella syndrome if exposed to the virus during pregnancy. Women receiving rubella vaccine should be counseled to avoid pregnancy for three months because of the possible small risk that the vaccine could cause a congenital abnormality. Rubella infection during early pregnancy can result in miscarriage and stillbirth. Congenital rubella syndrome can cause cataracts, congenital heart disease, hearing impairment, and developmental delays. The risk is highest during the first 12 weeks of gestation and decreases after the twelfth week; defects are rare after the twentieth week of gestation. Vaccination of all children and non-pregnant women is the most effective method of preventing congenital rubella in infants.

The following precautions should be observed for pregnant women with active rubella, newborns with congenital rubella infection, or those born to mothers known to have had rubella during pregnancy:

- Initiate standard and droplet precautions for seven days after the onset of the rash.
- Use contact precautions for newborns with proven or suspected congenital rubella. The duration of precautions is until they are at least one year of age because they may shed virus from the throat and urine until they are older than one year unless two cultures of clinical specimens obtained one month apart after three months of age are negative.
- Place exposed, susceptible patients on droplet precautions.
- Susceptible HCWs should not enter the room if immune caregivers are available. Pregnant women who are not immune (have not been vaccinated or had rubella) should not care for these patients (AAP 2012; APIC 2014; CDC 2012).

## Tuberculosis

The newborn may acquire congenital or perinatal TB from an infected mother and can rapidly develop severe TB (meningeal or disseminated TB). Prevention of TB in the newborn includes protection from exposure, early detection, treatment of TB in pregnant women and mothers, TB screening of HCWs, and attention to proper environmental air controls in healthcare facilities (APIC 2014).

Care for patients with suspected or confirmed pulmonary TB using airborne and standard precautions. Infants are unlikely to transmit infection by coughing, but suctioning may generate infectious aerosols, therefore, airborne precautions will be needed. For infants with extra-pulmonary TB, use airborne precautions until active pulmonary TB in visiting family members is ruled out (APIC 2014).

The mother and her infant should be separated until the mother has been evaluated and, if TB disease is suspected, until the mother and infant are receiving appropriate anti-TB therapy; the mother wears a mask; and the mother understands and is willing to adhere to infection control

measures. Mothers with multidrug-resistant and extensively drug-resistant TB should be separated from their infants (APIC 2014).

**Varicella (Chicken Pox)**

Chicken pox, a highly contagious disease, is caused by varicella-zoster virus (VZV), a herpes virus. Herpes zoster (shingles) is caused by reactivation of VZV in adults and can be very painful.

Unborn babies lacking passively acquired maternal antibodies can develop a life-threatening infection if exposed to the virus within the last two weeks of pregnancy (viral transfer occurs across the placenta) or at the time of childbirth. The greatest risk is if the baby is born within two days before or five days after the onset of maternal chicken pox.

A post-exposure vaccine should be provided to exposed persons as soon as possible, but within 120 hours of exposure. For susceptible exposed persons for whom the vaccine is contraindicated (newborns whose mothers' varicella onset is less than five days before delivery or within 48 hours after delivery, pregnant women, and immunocompromised persons), provide varicella-zoster immunoglobulin (VZIG), when available, within 96 hours; if unavailable, use IV immunoglobulin (APIC 2014; Siegel, Rhinehart, Jackson, et al. 2007).

Pregnant women with active varicella at the time of admission and babies born to women with varicella at the time of childbirth should be placed on airborne and contact precautions. While hospitalized, the newborn should remain on these precautions until 21 days of age (or 28 days of age if VZIG is given) (APIC 2014; Siegel, Rhinehart, Jackson, et al. 2007).

Susceptible HCWs should not enter the room of mothers with varicella if immune caregivers are available. Pregnant HCWs who are not immune (have not been vaccinated or had chicken pox) should not care for these patients if other staff are available. Where possible, only HCWs known to have had varicella or those previously vaccinated should provide care to the newborns and mothers (Siegel, Rhinehart, Jackson, et al. 2007).

# APPENDIX 5.1.A. PREPARING FOR A PUBLIC HEALTH EMERGENCY: A FACILITY PREPAREDNESS CHECKLIST

*The following is a sample facility preparedness checklist. Assessing how prepared your facility is to handle a public health emergency or outbreak is the first step in the preparedness process.*

**Getting Started**

- Dedicate adequate resources to emergency preparedness planning efforts.
- Secure facility leadership support for emergency preparedness plans.
- Designate individuals responsible for making the facility's emergency preparedness plans.
- Involve individuals and representatives from various backgrounds in the emergency preparedness plans.
- Ensure that everyone involved in the emergency preparedness plan knows what their roles and responsibilities are during a public health emergency.
- Perform a facility risk assessment of emergency preparedness.
- Establish relationships with local ministries of health.
- Develop standard operating procedures for essential functions, including:
    - Procedures for outbreak alert and outbreak verification
    - The flow of information
    - The development and distribution of information to the public
    - Staffing management
    - Designated roles and responsibilities

**Communication**

- Designate a spokesperson who is responsible for communications during an outbreak.
- Develop a plan for how to communicate key messages to various groups during an outbreak, including:
    - Facility staff
    - The community
    - Public health authorities

**Surveillance**

- Ensure that mechanisms are in place to detect unusual disease events or clusters.
- Check that a system is in place to create and revise case definitions.
- Designate staff who are able to perform enhanced surveillance during an outbreak, including:

- Monitoring hospital admissions for cases of the disease
- Monitoring deaths in suspected or confirmed cases
- Monitoring staff absenteeism
- Monitoring vaccine usage if a vaccine is being administered during an outbreak
- Collecting data on vaccine and antiviral usage

**Laboratory Considerations**

- Designate an area to store specimens in case there are too many specimens collected to process during an outbreak.
- Locate WHO protocols for specimen collection and transportation.
- Identify a local laboratory in the country with biosafety security levels 3 or 4 (BSL3 or BSL4) capability. (WHO has a national inventory of laboratories with BSL3 and BSL4 capability.)
- Ensure that your facility has access to a designated reference laboratory.

**Infection Control Considerations**

- Basic IPC procedures are followed in the facility.
- Staff are trained and assessed for competency on basic IPC procedures.
- Equipment is available to implement infection control measures, including soap, water, alcohol-based hand rub, and PPE.
- Areas in the facility are designated for patient screening, triage, and patient care during an outbreak.
- Overflow areas are designated for screening, triage, and patient care in case there is an influx of patients.
- Supply needs (including PPE) have been calculated and ways to stockpile supplies has been explored.
- A system has been developed for the distribution of stockpiled supplies.

**Staffing Considerations**

- Ensure that staff are aware of the emergency preparedness plans in the facility.
- Estimate the number of HCWs at the facility who may need PPE.
- Determine sources from which additional HCWs could be recruited in instances where staff absenteeism is high.
- Consider how psychosocial support will be given to your staff during and after an emergency.

**Vaccines and Antivirals**

- Determine how vaccines or antivirals can be obtained during an outbreak.
- Develop contingency plans for storage, distribution, and safe administration of vaccines and antivirals.
- Plan how to distribute available vaccines or antivirals during an outbreak based on priority groups in case there is a limited supply.
- Develop a process to monitor adverse reactions to antivirals or vaccines.

**Management of the Deceased**

- Identify the emergency capacity for storage of corpses before culturally acceptable burial.
- Develop protocols for the safe handling of corpses, making sure to consider cultural and religious beliefs.
- Determine the maximum capacity for the disposal of corpses during an outbreak using culturally acceptable burial methods.

**Implementing and Updating the Plan**

- Assess the effectiveness of the emergency preparedness plan.
- Perform drills using the emergency preparedness plan, targeting specific areas of the plan.
- Revise emergency preparedness plans based on true emergency events or drills.
- Determine a set interval of time to revise the emergency preparedness plans (e.g., yearly, every 2 years).

*Adapted from:* WHO 2005b

# APPENDIX 5.1.B. PREPARING FOR A PUBLIC HEALTH EMERGENCY: CALCULATING PPE NEEDS

**A Case Study on PPE Stockpiling**

The Healthy Hospital wants to obtain a stockpile of PPE so that it is prepared for an outbreak of novel influenza. The hospital has asked the Emergency Preparedness Planning Team to calculate an approximate number of PPE sets to be obtained for the stockpile. The Healthy Hospital decides that one PPE set should include a respirator, goggles, gloves, and a gown.

**What key pieces of information does the Emergency Preparedness Planning Team need to know to calculate the number of PPE sets needed for the stockpile?**

The Emergency Preparedness Planning Team needs to know the number of HCWs in the facility who will need PPE, the number of PPE sets per HCW per day, and the estimated number of days in the outbreak period. The Emergency Preparedness Planning Team gathers the following information:

- The average number of HCWs is 50.
- The number of PPE sets (respirator, goggles, gloves, and gown) per HCW per day is 3.
- The estimated number of days in the outbreak period is 8 weeks, or 56 days.

**How should the Emergency Preparedness Planning Team calculate the number of PPE sets to stockpile?**

- Number of HCW x number of PPE sets x estimated days in outbreak = estimated number of PPE sets needed for stockpile
- 50 x 3 x 56 = estimated number of PPE sets needed for stockpile
- = 8,400 estimated number of PPE sets needed for stockpile

**What should the Emergency Preparedness Planning Team recommend for the PPE stockpile?**

The Emergency Preparedness Planning Team should recommend an estimated 8,400 sets of PPE for the PPE stockpile at The Healthy Hospital.

(Hashikura, Kizu 2009)

# APPENDIX 5.2.A. IPC PLAN CHECKLIST FOR LARGE HEALTHCARE FACILITIES

| IPC Plan Checklist | |
|---|---|
| **Administrative** | ☐ Authority statement<br>☐ Vision/mission statement<br>☐ Budget<br>☐ Staffing ratio<br>☐ IPC committee or equivalent<br>☐ Administrative support (secretary, IT equipment, Internet access)<br>☐ Risk assessment<br>☐ Program responsibilities, goals, and objectives<br>☐ Technical guidelines<br>☐ Program monitoring and evaluation |
| **Staff** | ☐ Program leader<br>☐ IPC team<br>☐ Link nurses<br>☐ Other staff<br>☐ Job descriptions<br>☐ Training for IPC staff<br>☐ Information technology and data support |
| **Core components of IPC activities** | ☐ Surveillance of HAIs and antimicrobial resistance<br>☐ IPC activities related to patients', visitors', and HCWs' safety and the prevention of antimicrobial resistance<br>☐ Development or adaptation of guidelines and standardization of effective preventive practices (standard operating procedures) and their implementation<br>☐ Outbreak prevention and response, including triage, screening, and risk assessment, including during community outbreaks of communicable disease<br>☐ HCW education and practical training<br>☐ Maintenance of effective aseptic techniques for healthcare practices<br>☐ Assessment and feedback of compliance with IPC practices<br>☐ Assurance of continuous procurement of adequate supplies relevant for IPC practices, including innovative equipment when necessary, as well as functioning WASH services that include water and sanitation facilities and a healthcare waste disposal infrastructure<br>☐ Assurance that patient care activities are undertaken in a clean and hygienic environment and supported by adequate infrastructures |
| **Investigations** | ☐ Assessment of IPC practices<br>☐ Surveillance for HAIs<br>☐ HAI outbreak management<br>☐ Assessment of rational use of antibiotics |

| | |
|---|---|
| **General organizational policies** | □ Standard Precautions (hand hygiene, PPE, respiratory hygiene, reuse of medical devices, sharps safety, prevention/management of sharps injuries, waste management, laundry, environmental cleaning)<br>□ Cleaning, disinfection, and sterilization<br>□ Isolation Precautions (Contact, Droplet, Airborne Precautions)<br>□ Prevention of HAIs (surgical site, bloodstream, urinary tract infections, lower respiratory tract infections, HAI of GI tract)<br>□ Occupational health activities<br>□ Emergency preparedness<br>□ Rational use of antibiotics<br>□ Remodeling and construction in clinical areas |
| **Collaboration** | □ Medical leadership<br>□ Nursing leadership<br>□ Microbiology laboratory<br>□ Pharmacy<br>□ Public health services<br>□ Other programs (e.g., HIV, TB)<br>□ Antimicrobial stewardship<br>□ Occupational health |

*Adapted from*: Hoffmann 2000; WHO 2016

# APPENDIX 5.2.B. SAMPLE TEMPLATE FOR AN ACTION PLAN AND OBJECTIVES

| Goal | Objectives | Activity | End Date | Responsible Persons | Resources Needed |
|---|---|---|---|---|---|
| Hand hygiene compliance on all wards will improve 25% from baseline by the end of the year. | 1. Form a hand hygiene task force consisting of a representative from each ward.<br>2. Obtain baseline hand hygiene compliance data for each ward by observing 20 hand hygiene opportunities each week for 1 month, using ward staff as secret, trained observers.<br>3. Analyze and share hand hygiene compliance data weekly with the hospital administration and the HCWs on each ward.<br>4. Review and update the hospital policy on hand hygiene.<br>5. Provide hand hygiene education to staff on any wards with baseline hand hygiene compliance less than 90%; include demonstration, practice, and workplace reminders.<br>6. Guide and encourage the safety team on each ward to identify and address two barriers to hand hygiene compliance.<br>7. Monitor hand hygiene compliance on all units by observing 40 hand hygiene opportunities each week for 1 month, using ward staff as secret, trained observers.<br>8. Analyze and share ongoing hand hygiene compliance data weekly with the hospital administration and HCWs on each ward.<br>9. Create a hand hygiene competition to reward the wards with the best hand hygiene.<br>10. Plan a hospital-wide hand hygiene awareness and promotion event on World Hand Hygiene Day.<br>11. Evaluate the intervention every 3 months to measure progress toward the goal of 25% improvement. | | | | |

# APPENDIX 5.2.C. FACILITY INFECTION PREVENTION AND CONTROL RISK ASSESSMENT TOOL

The IPC program provides the facility with specialized expertise to ensure that care is provided in a safe and efficient manner. Successful IPC programs are based on understanding the facility's problems and needs, prioritizing activities, and using available resources effectively. An IPC risk assessment helps identify the areas of greatest infection/PS risk at the facility from high-risk, high-volume, or problem-prone procedures. A case study of fictional Hospital A is provided below, followed by a blank form for use in your facility.

**Facility IPC Risk Assessment**

An IPC risk assessment should be conducted periodically and involve key people at your facility. Members of the assessment team should include the members of the IPC committee, if there is one, staff with IPC responsibilities, leaders of the main clinical departments, nursing services, support services (e.g., central supply, microbiology laboratory), administration, housekeeping, sanitation, and environmental services).

**Case Study: Facility IPC Risk Assessment for Hospital A**

**Facility IPC Risk Assessment: Part 1**

Become familiar with the state of IPC at your facility to prioritize IPC activities.

Fill out the Facility IPC Risk Assessment Form, Part 1:

a. Indicate the date and the groups involved in the process.

b. Insert information about factors and characteristics that increase risks using local population and epidemiological information and data from your facility, local sources, and local knowledge.

c. Review healthcare epidemiology and IPC data available at your facility and impressions from the team obtained during direct observation and discussion with HCWs.

## Facility IPC Risk Assessment Form, Part 1

Date: _____

This assessment was developed by:

- ☐ IPC committee
- ☐ Safety committee
- ☐ Legal team
- ☐ Occupational health committee
- ☐ Quality team
- ☐ Leadership
- ☐ Others:

This IPC risk assessment provides guidance on the priority focus areas for the IPC program. The risk assessment should be reviewed periodically, at least annually or whenever significant changes occur in elements that affect risk.

| Factors | Characteristics that increase risks |
|---|---|
| **Geographic location and community environment:**<br>Sub-Saharan Africa<br>Urban hospital<br>Near slum area | Highly populated city<br>Crowded housing conditions<br>Variable access to sanitation |
| **Care, treatment, and services provided**:<br>Referral hospital<br>Full surgical services provided | High volume of surgical cases<br>Routine and complex procedures<br>High volume of ICU beds<br>Complex medical devices |
| **Population characteristics**:<br>Mix of low- and middle-income patients<br>Frequent movement of population | High incidences of TB and other communicable diseases<br>55% of population under 15<br>High birth rate |
| **Analysis of Healthcare Epidemiology and Infection Prevention and Control Data** | |
| **High-risk areas/issues**:<br>Use of medical devices in ICUs<br>GI endoscopy<br>BSI (sepsis) in newborn nursery | **Problem-prone areas/issues**:<br>Spread of TB in facility |
| **High-volume procedures and infections**:<br>C-section<br>Colorectal surgery | **Improvement needed:**<br>Hand hygiene non-compliance<br>Postpartum endometritis |

## Facility IPC Risk Assessment: Part 2

Use information provided in Part 1 to list IPC hazards in the left-hand column of the table. The type of hazards listed may include items such as the following, but should be specific and relevant to your facility:

- Specific HAIs

- Non-compliance with measures that prevent HAI (such as hand hygiene)
- Infection risks common in the community that can spread to patients or staff in the hospital (such as TB)
- IPC measures that are required to be reported to health authorities or to the public

## Facility IPC Risk Assessment: Part 3

Based on the risk assessment (Part 2), the facility IPC risk assessment team ranked the risks they listed in the Infection Prevention and Control Hazards column of Part 2 from highest to lowest preparedness score. Items scoring 6 or greater in Preparedness Score should be IPC priority focus areas.

## Facility IPC Risk Assessment Form, Part 3

**Risk Prioritization**: Based on the risk assessment, prioritize the risks from high Preparedness Scores to low, with 1 having the highest priority. Items scoring 6 or greater in Preparedness Score in the risk assessment are IPC priority focus areas.

| Priority | Risk |
|---|---|
| 1 | Hand hygiene compliance (Preparedness Score = 9) |
| 2 | BSI (sepsis) in the newborn nursery (Preparedness Score = 6) |
| 3 | Postpartum endometritis (Preparedness Score = 4) |
| 4 | C-section SSI (Preparedness Score = 3) |
| 5 | Spread of TB in the facility (Preparedness Score = 3) |

For Hospital A, comparison of the preparedness scores for noncompliance with hand hygiene and C-section SSIs shows that improving hand hygiene compliance at Hospital A should be the first priority.

Discuss each hazard with the IPC committee (or key people) one by one to determine:

**Probability of Occurring:** How likely is it to occur based on previous surveillance, other data, experience, or local knowledge? In many cases this may be an educated guess. Probability ranges from High = 3 to Low = 0.

**Outcome Severity:** If the hazard occurs, how serious is the outcome or disruption (i.e., will the person die, experience serious illness/disability, be difficult or expensive to treat versus experience an easily rectifiable illness with only a few extra days of hospitalization)? In many cases this may be an educated guess. Severity ranges from Very High = 4 to None = 0.

**Make the calculations**: Probability of Occurring x Outcome Severity = Assessment Score.

**Obtain the Level of Preparedness Needed:** What is the level of work needed to prevent the hazard from occurring? Use the Assessment Score to determine the level of preparedness needed. Levels range from High = 3 to Low = 1.

* Level of Preparedness Needed:

| Assessment Score | Level of Preparedness |
|---|---|
| ≤ 2 | Low |
| 3 to 5 | Medium |
| ≥ 6 | High |

Note: All HAI are scored a minimum of 2 on Level of Preparedness Needed

**Level of Preparedness Achieved:** How much work has already been done successfully to prevent the hazard from occurring? Achievement ranges from High = 1 to Low = 3.

**Calculate the Preparedness Score:** Level of Preparedness Needed x Level of Preparedness Achieved = Preparedness Score; enter in the final column.

## Infection Prevention and Control Risk Assessment: Part 4

**Priority Risks**: Based on the risk assessment, this hospital has identified those items scoring **6** or greater in **Preparedness Score** in the risk assessment as priority focus areas for infection control. Please rank them from 1 to 10 (1 having the highest priority).

| Priority | Risk |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| 10 | |